

‘A Call for Bold Policy’

Innovation, Technology and Productivity ‘Shaping a Welsh National Manufacturing Institute’

“Be happy with nothing, if you like, but never be content with less.”

William E Gladstone

Jason Murphy

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1. Abstract

‘The best way to predict the future is to create it’ – Peter F Drucker

There are several key challenges facing the Welsh economy, particularly in terms of productivity and the transition over recent decades from a manufacturing nation to one that is heavily services driven. These challenges require a nuanced understanding of both global trends and local dynamics.

In today's dynamic global landscape, technological advancements are happening at pace, shifting political and economic thinking. The formulation of effective industrial policies in this context hinges on robust empirical evidence and reliable data. Accurate statistics serve as the cornerstone for policymakers to foster inclusive and sustainable industrial growth tailored to the unique circumstances of their nations and regions, thereby facilitating informed decision-making.

Pre-Covid, emerging research suggests that structural changes brought about by technology adoption are occurring in the global economy that are not well understood. Interpretation of current data reveals a concerning trend: a small percentage of firms at the productivity frontier are significantly outperforming the rest and the gap is widening. These high performing firms are winning ‘the productivity war’ through a combination of advanced technology adoption, globalisation and a competitive advantage through tacit knowledge that is developed as a result of being at the technology frontier and working with the most advanced technologies. The productivity gap between the firms at the productivity (and technology) frontier and the rest is the widest in countries with weak government policy to support the diffusion of knowledge across firms and regions.

This disparity poses a significant risk of exacerbating inequalities, particularly for countries with less technologically advanced manufacturing sectors and weak policy. Addressing this issue requires

urgent action, including initiatives such as promoting technology transfer, bolstering capacity development, facilitating better access to finance, and developing effective policies. By bridging these technology and policy gaps, economies can strive towards a more equitable and sustainable industrial landscape.

This thesis proposes a National Manufacturing Institute for Wales (NMIW) that is equitably funded by Innovate UK, as a strategic step towards fostering innovation and technology-led growth. A body that is owned by Wales and working for Wales'. By focusing on regional strengths and needs, rather than solely on technology, this approach acknowledges the unique economic landscape of Wales. It also aligns with the growing recognition that productivity gains often occur at the regional level, where local conditions and resources play a significant role.

Implementing such an initiative will undoubtedly face obstacles. One challenge is ensuring that the NMIW effectively integrates with existing national and regional economic strategies. Coordination with other institutions and initiatives, both within Wales and across the UK, will be crucial for maximizing the impact of the NMIW and avoiding duplication of efforts. Additionally, securing adequate funding and resources for the NMIW will be essential for its success, particularly since the public sector fiscal debt (a combination of subsidisation and government borrowing) is close to £14 bn annually.

However, given the importance of manufacturing to the Welsh economy, investing in initiatives like the NMIW is essential. Long-term benefits would include increased productivity, high value job creation, and economic resilience (which brings the potential to reduce Welsh public sector borrowing if the stimulus is bold enough).

Overall, the proposal for a National Manufacturing Institute for Wales represents a proactive approach to addressing the productivity challenges facing the regions and drive sustainable economic growth and improve living standards for the people of Wales.

2. Aim

The Aim of this thesis is to present a model and a compelling argument for a National Manufacturing Institute of Wales that works for all regions of Wales.

There is a plethora of academic research that is concerned with the chronic productivity malady that has troubled the UK economy (and particularly that of Wales) since the financial crash of 2007/8. But as acknowledged by the late Garel Rhys (Professor of Economics at Cardiff University), a critique of academics is that their perspective, often characterised as an 'ivory tower' mentality, is so disconnected from reality that it lacks relevance in the practical world.

Whilst that acknowledgement will no doubt have been 'tongue in cheek', it fits a scenario where there appears to be very little research examining the regional manufacturing landscape of Wales, its scale, diversity, strengths and weaknesses, ownership models, absorptive capacity and needs. Therefore, a void must also exist concerning how best government policy should be shaped to support the real needs of the sector – since the sector is not well understood.

The aim of this project is to explore the productivity challenges facing the Welsh manufacturing sector and present a bold vision for the future. A future that grows the Welsh economy by competing internationally through innovation driven by technology.

The Chapters of this thesis make no assumption about the readers understanding of economics, manufacturing and innovation:

Chapter 4 – Introduction: Puts a boundary around the 'productivity puzzle' and provides a global context.

Chapter 5 - Measures of Economic Performance: Describes the indicators that are used to measure the economic performance of countries.

Chapter 6 – The Welsh Economy: Looks at the history of the Welsh economy, its regions and its economic performance.

Chapter 7 – The Welsh Manufacturing Sector: Maps out a high-level landscape of manufacturing in Wales.

Chapter 8 – Innovation, Technology and the Productivity Link: Discusses the link between innovation, technology and productivity.

Chapter 9 – Levers for Growth: Looks at the economic levers that economists refer to when discussing growth.

Chapter 10 – Funding and the Welsh Public Sector Fiscal Debt: Focuses on the Welsh public sector and how it is funded.

Chapter 11 – The High Value Manufacturing Catapult Network: Reviews the functioning of the UK Governments High Value Catapult Network and its impact on Wales.

Chapter 12 – A National Manufacturing Institute for Wales: Brings everything together to present a skeleton outline for a national manufacturing Institute for Wales. Two examples of a place-based approach are provided.

Chapter 13 – Conclusion

3. Research Methodology

In the writing of this thesis, a significant amount of time was spent conducting a literature review. There is a mountain of reports, papers, journals, books, government think-tanks, newspaper articles, documentaries and even films about the topics of innovation, technology and productivity.

The author focused mainly on collaborative government driven research and the work of internationally recognised 'Think-Tanks', published by organisations such as The Organisation for Economic Cooperation and Development (OECD), The UK Productivity Institute, The United Nations Industrial Development Organisation (UNIDO), The London School of Economics (LSE), The McKinsey Institute, The University of Cambridge Institute for Manufacturing (IfM) and The World Development Bank.

Some of the critical thinking by the author is influenced by Ha-Joon Chang who lectured in economics at The University of Cambridge. His seminal writing includes the publications: '23 Things They Don't Tell You about Capitalism' and 'Economics: The User's Guide.

The subject matter is a true passion of the author who started his career as a 16yr old boy as a technical apprentice. Since, he spent more than three decades embedded in the world of manufacturing – particularly heavy engineering supporting technology driven global energy projects for the oil and gas, nuclear and renewable sectors.

4. Introduction

“Mae hen wlad fy nhadau yn annwyl i mi” – Land of my Fathers

‘This land of my fathers is dear to me’

If statistics are to be believed, then the policies aimed at growing the Welsh economy are falling short. The economy of Wales exhibits the lowest level of productivity (broadly defined as the efficiency of transferring inputs into outputs) among the twelve regions of the UK (ITL1) (Henley, 2023). Output per capita (Gross Value Added) stood at 74% of the UK average in 2021—a disparity that has remained virtually constant since 2000 (refer to Appendix B – GVA per Capita – Wales (2000 to 2021)) .

Concerns regarding the productivity of the UK economy have persisted among economists since the financial crash of 2007/8. UK average productivity between 2010 and 2019 grew annually at an average rate of 0.3%, marking the lowest rate of growth over a decade since the 1800’s (Figure 1) (RSS. (2019, December 19)).

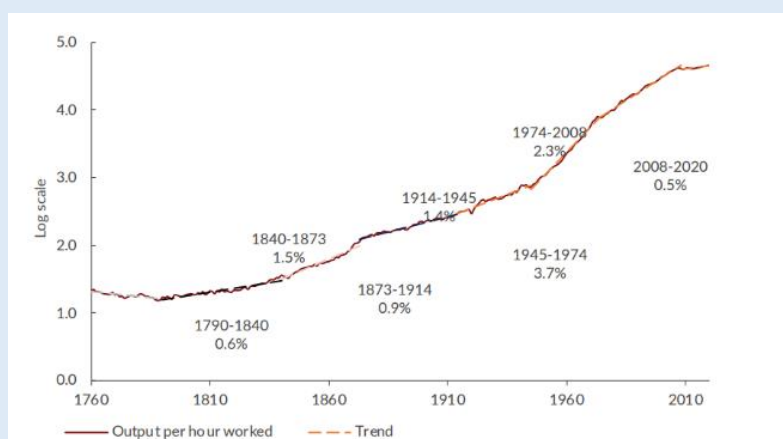


Figure 1 – UK output per hour worked (1760 to 2019): source (Office for National Statistics (ONS))

Productivity is important because it is widely regarded as a crucial ‘key performance indicator’ for the economic performance of a country and its regions. It is closely linked to long-term living standards.

Highly productive countries tend to pay higher wages and boast better healthcare, public infrastructure, and general well-being of the population (Beatty & Fothergill, 2020).

Whilst productivity growth has slowed across much of the developed world since the financial crash, UK productivity growth has been weaker than that of many of international peers (Figure 2). Indeed, the graph below shows a divergence that started around 1970.

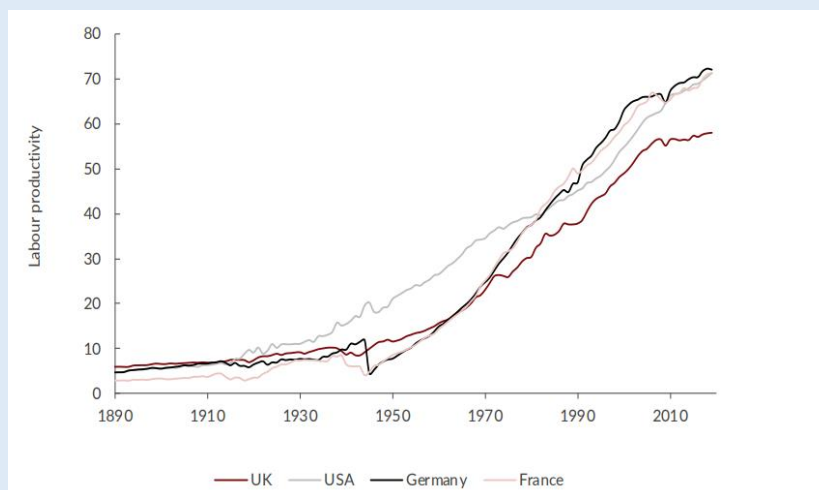


Figure 2 – Output per hour (UK, USA, Germany and France) 1890 to 2019 (\$US 2010 ppp¹ per hour): source ONS

Since the 1970s, there has been a notable shift from manufacturing to services across much of the developed world. While many jobs have migrated from the manufacturing sector to the services sector, changes in manufacturing output in real terms have not been as pronounced due to improvements in the efficiency of new manufacturing processes over time (Custolito & Maloney, 2018). To demonstrate this point, since 2001, manufacturing output calculated using constant prices has risen in countries such as the US, Switzerland, Finland, and Sweden, and has only modestly declined in Germany, Italy, and France. However, a significant outlier is the UK, where manufacturing output has significantly fallen when calculated using both constant and current prices, indicating a loss of competitiveness (Chang, 2014).

¹ XXX

	Share of output at current prices	Share of output at constant prices	Share of labour
		1924 industrial classification	
1924	30.9	30.9	32.9
1937	31.3	34.8	32.9
		1958 industrial classification	
1937	29.5	29.5	30.4
1951	35.7	34.6	35.1
1964	33.6	37.0	36.1
1973	30.1	38.2	34.7
		1995 industrial classification	
1973	31.9	31.9	26.1
1979	29.0	28.7	23.7
1990	22.8	25.7	16.3
2000	17.3	21.3	13.0
2007	12.4	18.7	9.5

Figure 3 – UK manufacturing share of output at current prices and constant prices: source (Broadberry & Leunig, 2013)

This is supported by evidence that the UK manufacturing sector made a significant contribution to the slowdown (a negative growth rate of 5.211% compared with the previous decade) of the whole economy following the crash of 2007 (Figure 4) (Coyle & Mei, 2023).

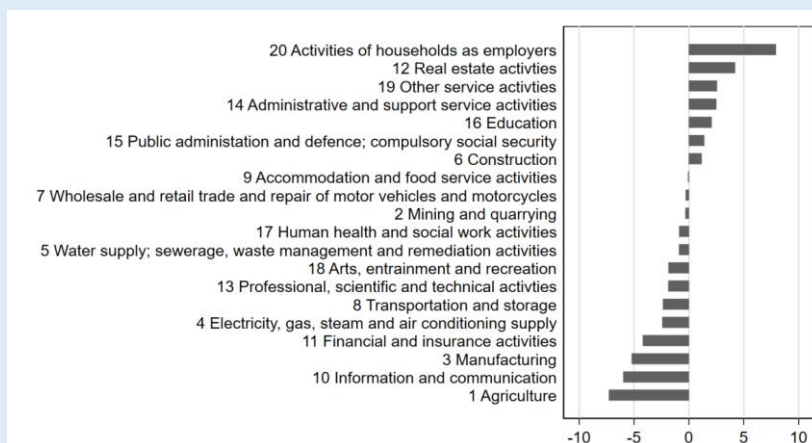


Figure 4 – Labour Productivity Slowdown Across Industries 2008 to 2019: source (Coyle & Mei, 2023)

Indeed, across peers and other competing economies within the OECD (), the UK had the lowest year on year growth in 2022 (see Figure 5 and Figure 6)

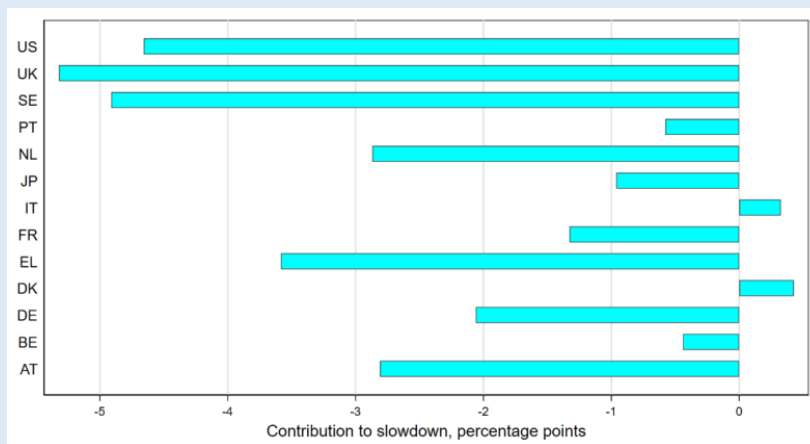


Figure 5 – Manufacturing Productivity Slowdown Across Other Advance Economies (1998-2008 vs 2008-2019): source (Coyle & Mei, 2023)

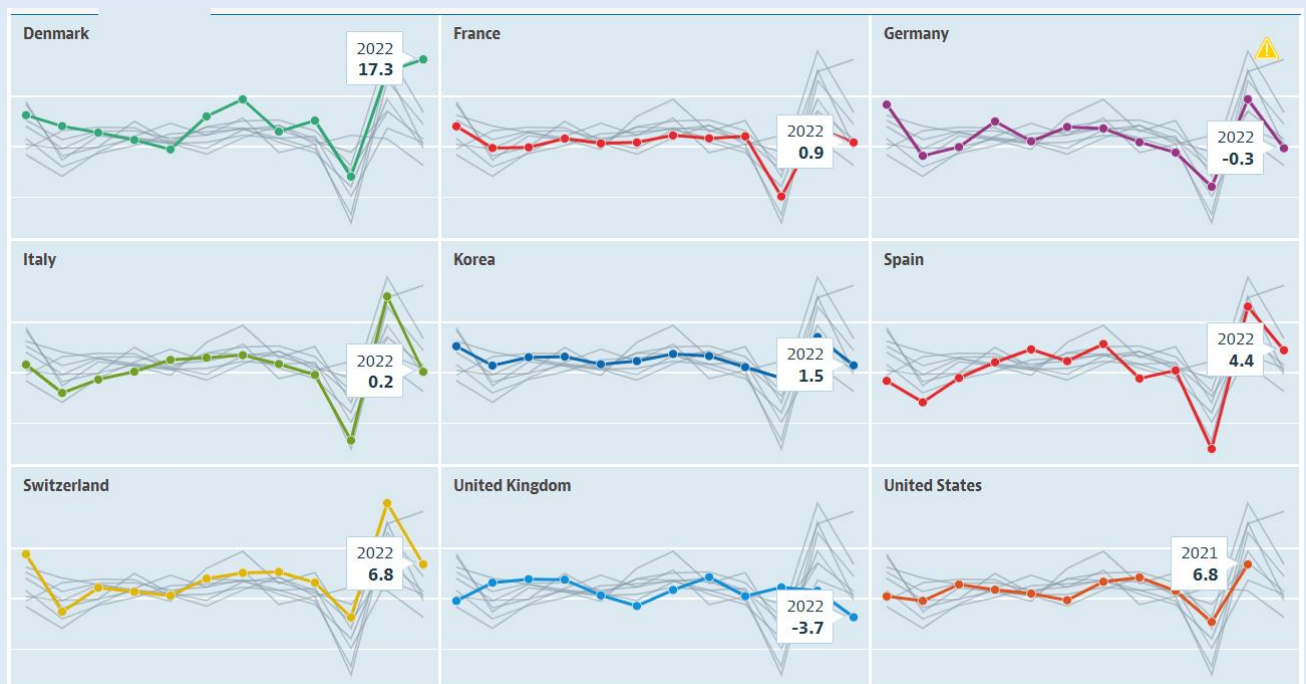


Figure 6 - % Growth in GVA in Manufacturing for OECD Developed Economies 2011 to 2022

A slowdown since the financial crash occurred in almost all manufacturing subsectors with the largest slowdown occurring in transport equipment (aerospace and automobile), followed by basic pharmaceutical products and machinery and equipment (see Table 1) (Coyle & Mei, 2023).

	$\bar{\omega}_j \Delta \ln(V_j/H_j)$			$\Delta(\bar{\omega}_j \Delta \ln(V_j/H_j))$
	98-19	98-08	08-19	Slowdown
	(1)	(2)	(3)	(3)-(2)
<i>Manufacturing Sub-sectors</i>				
Food products, beverages and tobacco	0.272%	0.530 %	0.0487%	-0.4813%
Textiles	0.373%	0.528 %	0.193%	-0.335%
Wood and paper products	0.391%	0.595 %	0.267%	-0.328%
Coke and refined petroleum products	0.021%	-0.048 %	0.083%	0.131%
Chemicals and chemical products	0.369%	0.389%	0.384%	-0.005%
Basic pharmaceutical products	0.108%	0.618 %	-0.188%	-0.811%
Rubber and plastics products	0.271%	0.349 %	0.145%	-0.204%
Basic metals and fabricated metal products	0.234%	0.306%	0.204%	-0.102%
Computer, electronic and optical products	0.546%	0.850 %	0.263%	-0.587%
Electrical equipment	0.142%	0.280 %	0.046%	-0.234%
Machinery and equipment n.e.c.	0.286%	0.620 %	-0.117%	-0.737%
Transport equipment	0.3718%	0.879 %	-0.138%	-1.017%
Other manufacturing; repair	0.277%	0.459 %	0.069%	-0.390%
<i>Information and Communication Sub-sectors</i>				
Publishing activities	0.650%	1.271%	0.065%	-1.206%
Motion picture, video and TV programme	0.147%	0.349%	0.004%	-0.345
Programming and broadcasting activities	-0.057%	0.129%	0.065%	-0.064%
Telecommunications	7.174%	8.313%	5.869%	-2.444%
Computer programming	0.707%	1.643%	-0.316%	-1.959%
Information service activities	-0.162%	-0.041%	-0.400%	-0.359%

Table 1 – Manufacturing Sub-sector Slowdown 2008 to 2019: source (Coyle & Mei, 2023)

Typically, the determinants of sustainable productivity growth include capital deepening, technological advancements, innovation, research and development intensity, workforce skills, global economic shocks, labour cost, and labour availability. These factors are considered by many economists as pivotal in shaping productivity outcomes, for better or worse (Reenan & et al, 2023).

Although developed nations have experienced a notable transition towards service-based economies, manufacturing continues to hold significant importance for all countries (Chang, 2014). As of 2022, industrial sectors contributed 21% to the global economy (Figure 7), with manufacturing emerging as the primary contributor (Figure 8) (UNIDO, 2023).



Figure 7 – Contribution of the industrial sectors to the global economy: source (UNIDO, 2023)

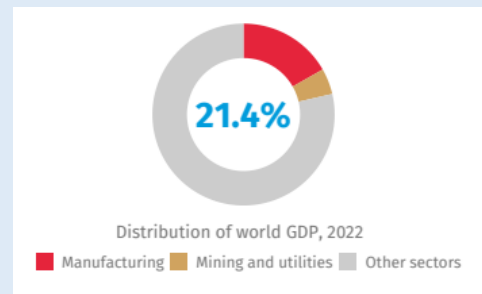


Figure 8 – Contribution of manufacturing to global GDO: source: (UNIDO, 2023)

Since 2000, there has been a small renaissance in manufacturing, with growth in the share of global GDP. However, as Figure 9 shows, there has been a noticeable divergence in the share of employment with a widening gap, especially since 2012. This could be an indication that innovation and technology is starting to reduce the requirement of human inputs in manufacturing.

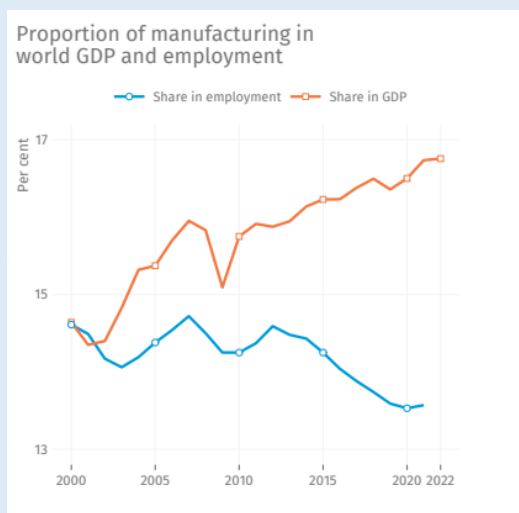


Figure 9 – Growth in manufacturing jobs and share of GDP globally: source (UNIDO, 2023)

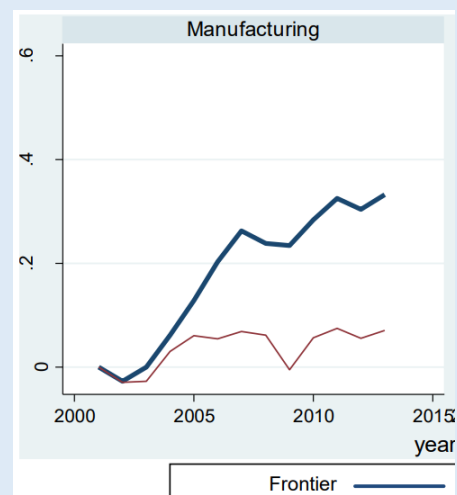


Figure 10 – Frontier Firms and the Rest (The divergence in productivity): source (Andrews, Criscuolo, & Gal, 2016)

Coinciding with this trending behaviour in manufacturing jobs and GDP growth, is a significant development that is not well understood. At the productivity frontier, a small number of global firms are bucking the general productivity malaise and substantially outperforming all others (Schwellnus &

et al, 2018) (Andrews, Criscuolo, & Gal, 2016). It is thought that large investments in technology are behind this exceptional performance (Reenan & et al, 2023), which is discussed more in Chapter 8.

It might appear obvious, but technology is important to economic performance. The economist and best-selling author Ha-Joon Chang defines economic development as:

‘A process of economic growth that is based on the increase in an economy’s productive capabilities: its capabilities to organise – and more importantly transform its production activities’.

He considers ‘**changes in technologies**’ to be at the root of economic development.

Whilst globally, the UK has the 6th highest output, the United Nations Industrial Development Organisation (UNIDO) indicators for economic development tell a different story. Their 2020 Competitive Industrial Performance (CIP) Report placed the UK 15th in the overall CIP world league table. The overall ranking was computed from the league position for three dimensions (Table 2).

Dimension	UK Global Ranking
Capacity to produce and export manufactures	39th
Technological deepening and upgrading	35th
World impact	9th

Table 2 – UNDO ranking for UK productive capabilities across 3 dimensions: source (UNIDO, 2021)

What is most notable and equally concerning is how lowly the UNIDO rank the UK in terms of technology deepening and the capacity to produce and export manufactured goods. Again, this is discussed more in Chapter 8.

In Wales, the manufacturing sector contributes 17% to the total Gross Value Added (GVA) and employs approximately 150,000 people (Rhodes, Manufacturing: Statistics & Policy, 2020). These contributions to the economy by the manufacturing sector are significantly greater (as a percentage) for Wales than for the UK.

This thesis focuses on an innovation and technology driven approach to reshaping a key part of the economy – ‘manufacturing’. There is a real danger that manufacturing in Wales, akin to Lewis Carroll's 'Red Queen,' is running fast to stand still.

5. Measures of Economic Performance

“Productivity isn’t everything, but, in the long run, it is almost everything”. Paul Krugman

The concept of productivity lacks a single, definitive measure. Instead, it can be approximated through various proxies such as labour productivity (output per hour worked), capital productivity (output per unit of capital stock), or total factor productivity (TFP) and multi factor productivity (both weighted ratios of output to input) (Beatty & Fothergill, 2020). Each measure has its own strengths and weaknesses, and their usefulness depends on availability and purpose. However, these broad indicators offer a high-level view, encapsulating the results of multiple interacting factors and processes within economic activity.

5.1 Value Added Output – GDP and GVA

There is no ‘one shoe fits all’ approach to measuring productivity – see Table 3

Aggregate national or sectoral indicators	GDP per capita	
	GVA per hour worked	
	GVA per worker	
	Total Factor Productivity (TFP)	
Micro measures	Labour Productivity	Output per hour worked
	Capital Productivity	Output per unit of capital stock
	Total Factor Productivity	A weighted sum of outputs divided by a weighted sum of inputs

Table 3 – Productivity Indicators (Headline): source (Ortega-Argiles & McCann, *The Innovation-Productivity Paradox*, 2021)

Those most favoured by economists are Gross Domestic Product (GDP) and Gross Value Added (GVA). GVA is calculated as the monetary sum of all that has been produced in each period, minus the cost of associated intermediate inputs such as raw materials and utilities (Chang, 2014). GDP is similar to GVA, but it includes government taxes and excludes government subsidies.

According to the Eurostat definition, intermediate consumption refers to goods and services consumed as inputs by the production process, excluding fixed assets whose consumption is recorded

as consumption of fixed capital. These goods and services are either transformed or used up during the production process.

GDP comprises four main components: Investments (money spent by firms to produce goods and services), Consumption (household spending), Government (expenditure on public services, etc.), and Net Exports (exports minus imports).

According to data from the World Bank, global GDP was \$101 trillion (Table 4) in 2022. The USA made the largest contribution with \$25.5 trillion, closely followed by China's \$18 trillion (World Bank Group, 2023).

	Gross domestic product		Agriculture		Industry		Manufacturing		Services	
	\$ billions		% of GDP		% of GDP		% of GDP		% of GDP	
	2015	2022	2015	2022	2015	2022	2015	2022	2015	2022
World	75,215.1	100,562.0	4.2	4.3	26.8	28.0	16.4	16.2	64.3	63.9
East Asia & Pacific	21,997.2	30,655.2	6.1	6.0	35.4	37.1	24.2	24.8	56.9	58.2
Europe & Central Asia	20,487.3	25,192.0	2.1	2.2	23.2	24.8	14.1	14.0	64.4	63.1
Latin America & Caribbean	5,376.5	6,246.6	5.4	7.0	28.9	30.7	16.0	16.6	67.4	64.8
Middle East & North Africa	3,179.4	4,414.4	5.3	4.5	38.0	44.8	12.2	13.0	54.9	47.4
North America	19,769.2	27,610.1	1.1	1.0	19.0	18.2	11.5	10.5	76.0	76.6
South Asia	2,704.8	4,361.6	16.7	16.5	26.4	25.9	15.3	14.2	48.9	49.3
Sub-Saharan Africa	1,696.0	2,047.3	16.6	17.3	24.0	28.0	10.0	11.2	53.7	46.9

Table 4 – GDP of World and Regions: source (World Bank Group, 2023)

GDP for the UK was \$3.1 trillion, with the manufacturing sector contributing 8.4% in 2022. The largest sector by far was the service sector, contributing 71% (Table 5).

	Gross domestic product		Agriculture		Industry		Manufacturing		Services	
	\$ billions		% of GDP		% of GDP		% of GDP		% of GDP	
	2015	2022	2015	2022	2015	2022	2015	2022	2015	2022
United Kingdom	2,934.9	3,070.7	0.6	0.7	18.0	17.9	9.2	8.4	70.6	71.0

Table 5 – GDP of UK: source (World Bank Group, 2023)

For almost two centuries, the UK has transitioned from being a manufacturing nation to one that is services-led (UK_Gov, 2015). In the 1960s, there was a sharp acceleration of this transition (see Figure 11).

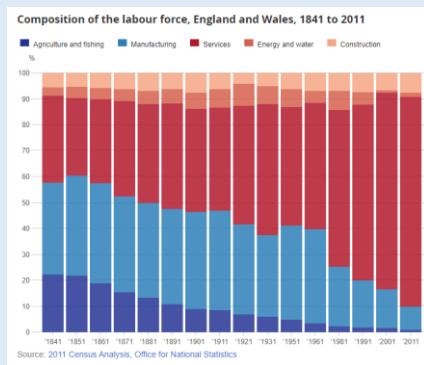


Figure 11 – Labour force composition – England and Wales ((UK_Gov, 2015)

Between 1998 and 2017, significantly more manufacturing jobs disappeared in the UK than in Italy, France, Germany, and the United States combined (see Figure 12).

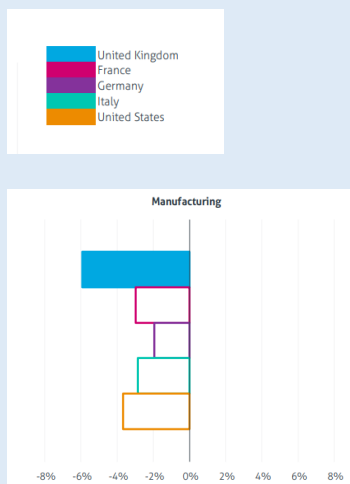


Figure 12 – UK Manufacturing Reduction in Employment 1998-2017 (Economic Policy Institute, 2000)

5.2 Total Factor Productivity (TFP)

Total Factor Productivity (TFP) serves as a key measure of technological progress. It is derived as the residual error, also known as the Solow residual, in a regression analysis. This residual term accounts for the unexplained portion of output growth that is not attributable to the growth of primary inputs such as capital and labour (Tenreyro, 2018).

6. Wales and the Welsh Economy

6.1 Summary

Population - 3.1 million (see Appendix A for a regional breakdown).

People in work – 1.4 million.

People working in manufacturing – 167,000 (12% of the workforce).

Unemployment Rate - 3.8%.

People living in poverty - 710,000 (including 185,000 children, 405,000 working-age adults and 120,000 pensioners). This is the highest level of all UK nations (Save the Children, 2012),

Wales	
GDP	£80 bn (approximated)
GVA	£70 bn
Exports	£16b (Europe £9.5 bn, North America £2.5 bn)
Nº Businesses	248,000

There are approximately 250,000 active businesses in Wales (across both the services and production sectors), with a combined annual turnover of almost £120bn. A breakdown of employment by business size is shown in Figure 13.

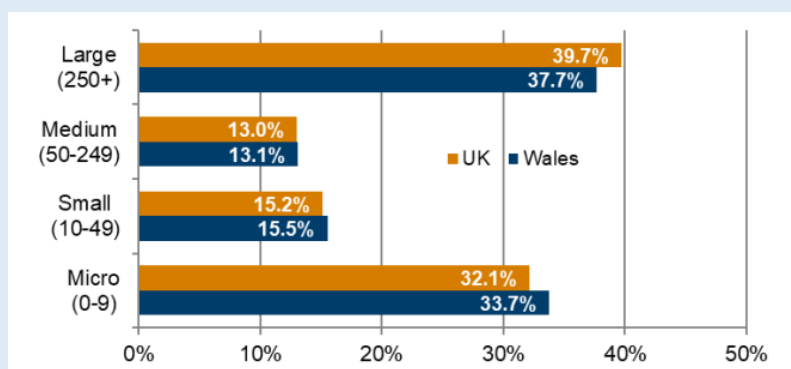


Figure 13 – Employee share for different sizes of firms (Statistics for Wales, 2023)

Almost 95% of all firms in Wales are micro businesses and 98% employ less than 50 people. Less than 1% are large businesses (1700 firms in total).

6.2 A Brief History of the Economy

The current fiscal challenges in Wales can be traced back to its economic history. Initial overreliance on primary sectors and missed opportunities for diversification during the second industrial revolution had lasting effects.

At the turn of the 18th century, Wales had a population of 0.5 million, the land was mainly rural and the economy was based solely on agriculture. The Industrial Revolution in the middle of the century started to change the economy due to the global need for Iron (naval armament) and Copper (brass and bronze) that could be mined in abundance in Wales – some of the Iron and Copper manufacturing processes that were considered world leading at the time. In the 19th century, the reliance of locomotive steam engines on coal led to the exploration and discovery of large amounts of high-quality coal in South Wales. At the same time, Welsh Slate was in high demand from quarries in North Wales. These businesses needed manpower and there was a significant movement of people to these sites from the rural areas of Wales and from England (Figure 14). While Wales experienced significant economic development and population growth in the late nineteenth and early twentieth centuries, it remained dependent on primary sectors. Despite economic output per head in Wales being close to the British average in 1891, its economy was characterized by a reliance on agriculture and mining, with manufacturing and services forming a smaller share.

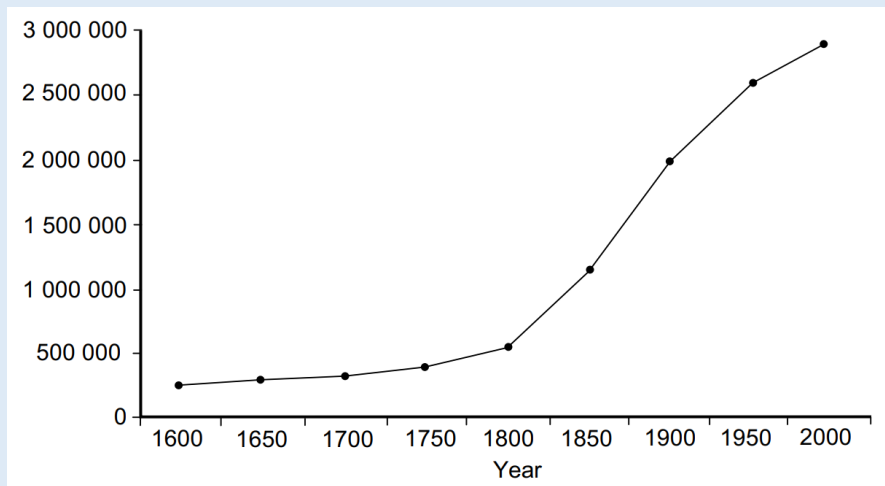


Figure 14 – The exponential growth of the population in Wales from the 19th century: source (Bryan & Jones, 2000)

Into the 20th century, Government policies and limited regional initiatives, exacerbated Welsh economic challenges. After the 2nd world war economic recovery saw significant government intervention, leading to diversification and growth, particularly in manufacturing. However, dependency on external investment emerged, contributing to vulnerability during economic downturns. By the late 1970s and 1980s, Wales faced mass unemployment and a shrinking manufacturing sector, exacerbated by the decline of coal mining. The decline coincided with a reduction in central government's regional policies, leading to increased dependence on fiscal transfers from the rest of the UK.

This period of relative economic decline occurred alongside a widening inter-regional inequality within the UK. As a result, Welsh Government policy switched to attracting inward investment in manufacturing and bringing foreign firms to Wales. Whilst this policy was mostly successful concerns persisted about their long-term commitment and value to the local communities, which resulted in a pivot around the year 2000 to supporting indigenous SME's. Between 2003 and 2022, the number of Micro businesses grew by almost a half and the number of Small Medium Enterprises (SME's) grew by almost a third. It is noteworthy that the number of large businesses only grew by 4% ((Figure 15) during these years..

	Enterprises [Note 3]				Employment				Turnover [Note 4]					
	Level (000s)	% change since			Level (000s)	% change since			Level (£bn)	% change since				
		2003	2022			2003	2022			2003	2022			
SMEs	246.4	46.7	↑	-2.8	↓	718.3	33.8	↑	-0.3	↓	54.7	[b]	10.7	↑
Micro (0 - 9)	234.6	47.6	↑	-2.9	↓	388.4	36.1	↑	-1.6	↓	21.8	[b]	7.2	↑
Small (10 - 49)	9.5	32.5	↑	0.8	↑	178.8	30.9	↑	-0.6	↓	14.5	[b]	11.9	↑
Medium (50 - 249)	2.2	27.5	↑	0.5	↑	151.0	31.6	↑	3.4	↑	18.4	[b]	14.2	↑
Large (250+)	1.7	4.3	↑	1.3	↑	433.8	13.7	↑	2.0	↑	71.5	[b]	6.8	↑
All	248.1	46.3	↑	-2.7	↓	1,152.1	25.4	↑	0.5	↑	126.2	[b]	8.5	↑

[Note 1] This table contains shorthand [b] which indicates a break in the time series

[Note 2] The full series are available on [StatsWales](#).

Figure 15 – Changes in No Enterprises, Employment and Turnover 2003 to 2022: source (Statistics for Wales, 2023)

Despite less than 1% of firm being classified as large, these firms account for 38% of people employed and 56% of turnover.

6.3 The Welsh Regions

The four economic regions of Wales are North Wales, Mid Wales, South East Wales and South West Wales, which each have their own Regional Economic Framework (REF). The first iteration of the Regional Economic Framework documents was released in 2022. They are a broad and high-level set of ambitions for each region (see 5.2, 5.3, 5.4 and 5.5)

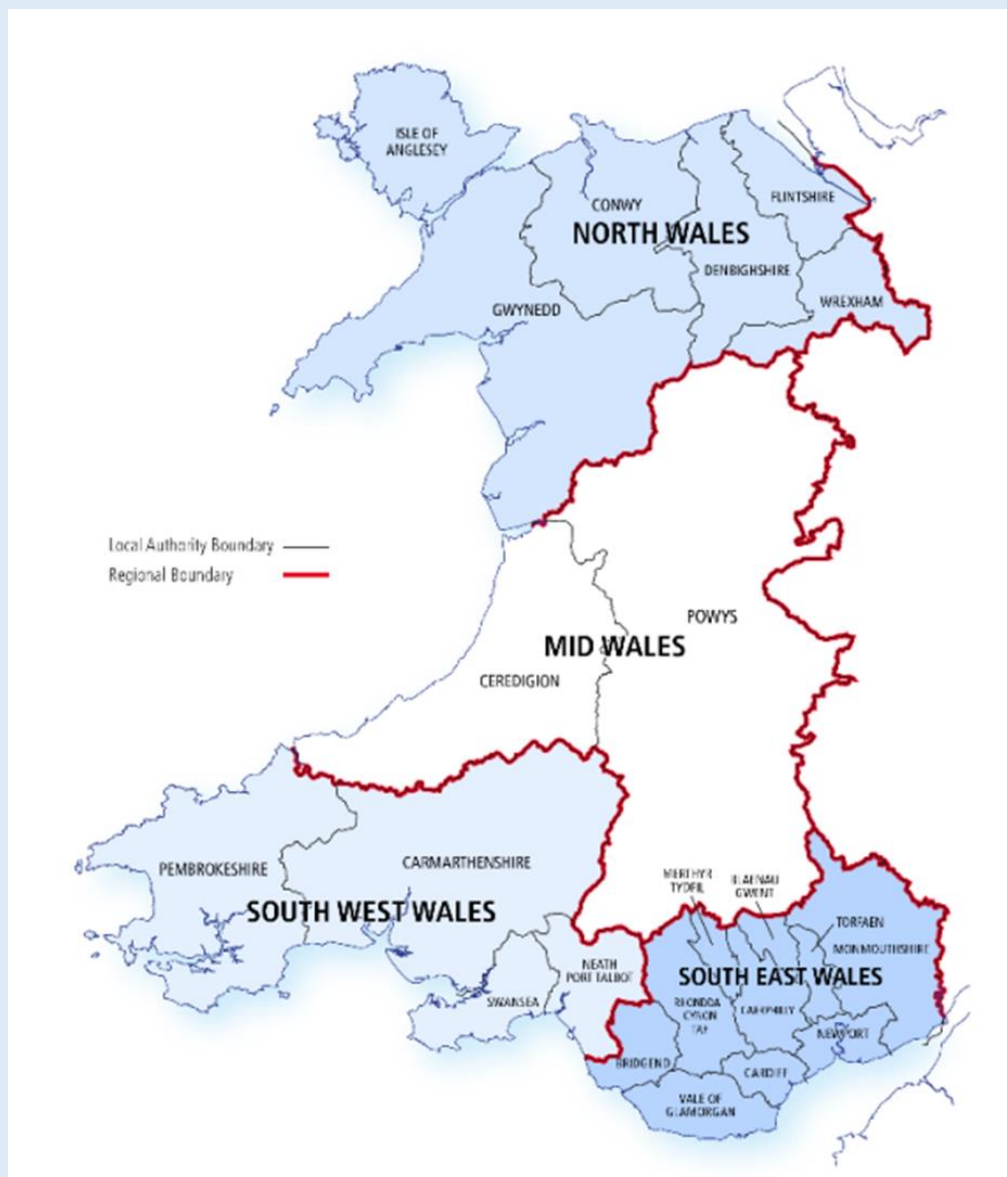


Figure 16 – The 4 Economic Regions of Wales

The population of Wales was estimated to be 3.1 million in 2021 and GVA was £70 billion. GVA per capita was therefore circa £22,500. For the same year, GDP was estimated to be £80 billion (GDP is calculated for the UK, but not for the ITL1 regions such as Wales), and GDP per capita was therefore circa £25,800. Wales had the second lowest GVA per capita (Figure 17) of the 12 off ITL1 regions.

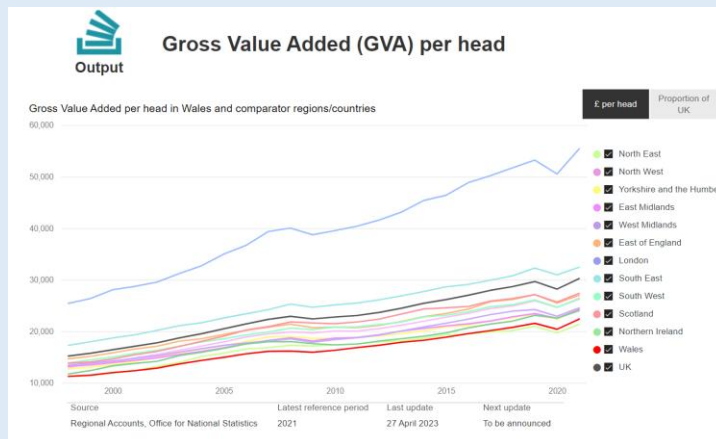


Figure 17 – GVA per hour worked all sectors (UK) – 2021 (Welsh_Gov, 2023)

Output per head in Wales, relative to the UK average has been falling since the 1980's

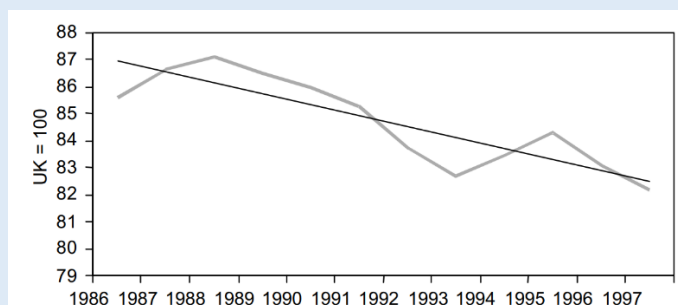


Figure 1.3 GDP per head in Wales relative to UK, plus trend-line
Source: Compiled from ONS, *Regional Trends*, various.

Figure 18 – GDP per Head trend since 1986 (Wales): source (Bryan & Jones, 2000)

Welsh GVA per hour worked was £32.19/hr. Wales had the lowest GVA per hour worked (Figure 19) of the 12 off ITL1 regions.

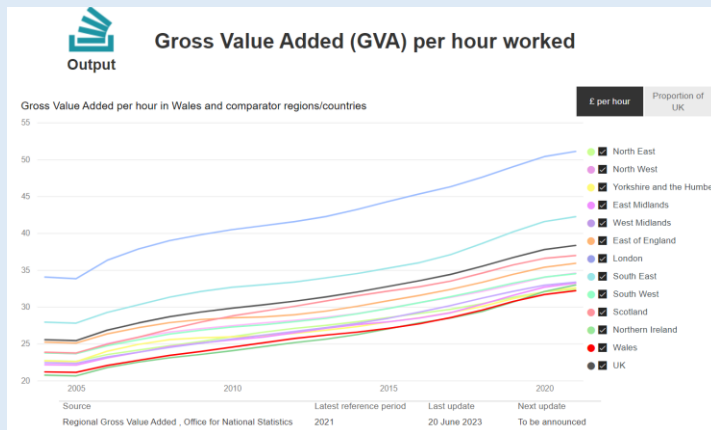


Figure 19 – GVA per hour worked all sectors (UK) – 2021 (Welsh_Gov, 2023)

6.4 Size and Growth

The total GVA per capita for each of the different local areas within Wales (ITL 3) is shown below (Figure 20) from 2012 through to 2021.

Measure	Area		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
£ million	Wales		(r) 53,163	(r) 55,077	(r) 56,482	(r) 58,434	(r) 60,833	(r) 62,917	(r) 65,167	(r) 67,955	(r) 64,634	(p) 69,500
	Wales		(r) 17,294	(r) 17,868	(r) 18,267	(r) 18,855	(r) 19,541	(r) 20,132	(r) 20,763	(r) 21,553	(r) 20,392	(p) 22,380
		West Wales and the Valleys	(r) 14,907	(r) 15,574	(r) 16,026	(r) 16,473	(r) 16,987	(r) 17,552	(r) 18,039	(r) 18,807	(r) 17,645	(p) 19,585
		Isle of Anglesey	(r) 12,277	(r) 12,348	(r) 12,361	(r) 13,100	(r) 14,013	(r) 14,405	(r) 15,304	(r) 16,278	(r) 13,807	(p) 15,012
		Gwynedd	(r) 17,122	(r) 18,060	(r) 17,900	(r) 18,155	(r) 18,117	(r) 18,918	(r) 19,153	(r) 19,825	(r) 17,697	(p) 20,951
		Conwy and Denbighshire	(r) 13,603	(r) 14,473	(r) 14,912	(r) 15,342	(r) 15,975	(r) 16,878	(r) 17,243	(r) 17,509	(r) 16,780	(p) 17,758
		South West Wales	(r) 14,333	(r) 15,245	(r) 15,386	(r) 16,990	(r) 17,322	(r) 17,659	(r) 17,785	(r) 18,887	(r) 17,801	(p) 21,218
		Swansea	(r) 18,244	(r) 18,667	(r) 20,166	(r) 19,810	(r) 20,646	(r) 21,394	(r) 22,486	(r) 23,158	(r) 21,901	(p) 23,591
		Bridgend and Neath Port Talbot	(r) 15,848	(r) 16,626	(r) 17,281	(r) 17,482	(r) 17,775	(r) 18,424	(r) 19,055	(r) 20,424	(r) 18,789	(p) 20,297
		Central Valleys	(r) 15,168	(r) 15,651	(r) 16,141	(r) 15,999	(r) 16,789	(r) 17,098	(r) 17,334	(r) 17,623	(r) 17,311	(p) 18,640
		Gwent Valleys	(r) 12,758	(r) 13,289	(r) 13,460	(r) 13,887	(r) 14,335	(r) 14,912	(r) 15,551	(r) 16,222	(r) 15,067	(p) 16,720
		East Wales	(r) 21,371	(r) 21,775	(r) 22,077	(r) 22,901	(r) 23,869	(r) 24,493	(r) 25,358	(r) 26,181	(r) 25,011	(p) 27,013
		Flintshire and Wrexham	(r) 21,972	(r) 22,826	(r) 22,555	(r) 23,470	(r) 24,148	(r) 25,015	(r) 26,036	(r) 26,864	(r) 25,973	(p) 28,993
		Powys	(r) 14,325	(r) 14,810	(r) 15,385	(r) 16,096	(r) 16,550	(r) 16,487	(r) 17,116	(r) 17,295	(r) 16,662	(p) 17,296
		Cardiff and the Vale of Glamorgan	(r) 23,602	(r) 23,946	(r) 24,516	(r) 25,259	(r) 26,429	(r) 27,150	(r) 27,570	(r) 28,725	(r) 27,506	(p) 29,724
		Monmouthshire and Newport	(r) 20,121	(r) 20,016	(r) 20,294	(r) 21,215	(r) 22,359	(r) 22,855	(r) 24,532	(r) 24,994	(r) 23,303	(p) 24,597
	Wales		(r) 73.1	(r) 73.0	(r) 71.8	(r) 72.1	(r) 72.4	(r) 72.0	(r) 72.4	(r) 72.7	(r) 72.3	(p) 74.1
		West Wales and the Valleys	(r) 63.0	(r) 63.6	(r) 63.0	(r) 63.0	(r) 62.9	(r) 62.8	(r) 62.9	(r) 63.4	(r) 62.6	(p) 64.8
		Isle of Anglesey	(r) 51.9	(r) 50.4	(r) 48.6	(r) 50.1	(r) 51.9	(r) 51.5	(r) 53.4	(r) 54.9	(r) 49.0	(p) 49.7
		Gwynedd	(r) 72.3	(r) 73.8	(r) 70.4	(r) 69.4	(r) 67.1	(r) 67.7	(r) 66.8	(r) 66.9	(r) 62.8	(p) 69.3
		Conwy and Denbighshire	(r) 57.5	(r) 59.1	(r) 58.6	(r) 58.7	(r) 59.2	(r) 60.4	(r) 60.1	(r) 59.0	(r) 59.5	(p) 58.8
		South West Wales	(r) 60.6	(r) 62.3	(r) 60.5	(r) 65.0	(r) 64.2	(r) 63.2	(r) 62.0	(r) 63.7	(r) 63.1	(p) 70.2
		Swansea	(r) 77.1	(r) 76.3	(r) 79.3	(r) 75.7	(r) 76.5	(r) 76.6	(r) 78.4	(r) 78.1	(r) 77.7	(p) 78.1
		Bridgend and Neath Port Talbot	(r) 67.0	(r) 67.9	(r) 67.9	(r) 66.8	(r) 65.9	(r) 65.9	(r) 66.5	(r) 68.9	(r) 66.7	(p) 67.2
		Central Valleys	(r) 64.1	(r) 63.9	(r) 63.4	(r) 61.2	(r) 62.2	(r) 61.2	(r) 60.5	(r) 59.4	(r) 61.4	(p) 61.7
		Gwent Valleys	(r) 53.9	(r) 54.3	(r) 52.9	(r) 53.1	(r) 53.1	53.4	(r) 54.2	(r) 54.7	53.4	(p) 55.3
		East Wales	(r) 90.3	(r) 89.0	(r) 86.8	87.6	88.4	(r) 87.6	(r) 88.4	(r) 88.3	(r) 88.7	(p) 89.4
		Flintshire and Wrexham	(r) 92.8	93.3	(r) 88.7	(r) 89.7	(r) 89.5	(r) 89.5	(r) 90.8	(r) 90.6	(r) 92.1	(p) 95.9
		Powys	(r) 60.5	(r) 60.5	(r) 60.5	(r) 61.5	(r) 61.3	(r) 59.0	(r) 59.7	(r) 58.3	(r) 59.1	(p) 57.2
		Cardiff and the Vale of Glamorgan	(r) 99.7	(r) 97.8	(r) 96.4	(r) 96.6	(r) 97.9	(r) 97.2	(r) 96.2	96.9	(r) 97.6	(p) 98.4
		Monmouthshire and Newport	(r) 85.0	(r) 81.8	(r) 79.8	(r) 81.1	(r) 82.9	(r) 81.8	85.6	(r) 84.3	(r) 82.7	(p) 81.4

Figure 20 – GVA per Capita(£UK) and Index (UK = 100) 2012 to 2021: source (Welsh Government, 2023)

In 2021, ‘Flintshire and Wrexham’, and ‘Cardiff and the Vale of Glamorgan’ were significantly more productive than many other regions.

The composition of Welsh GVA is shown in Figure 21. The production sector contributed 23% to total GVA, the construction sector contributed 6%, whilst the Service sector made the largest contribution by far, 71%.

Area (Wales)		Year (2021)	
Area	Year		
		Measure	
Industry		Percentage of all industries	Total (million)
All industries		(p) 100.0	(p) 69,500
Production Sector		(p) 23.1	(p) 16,076
Agriculture, forestry and fishing		(p) 1.1	(p) 787
Mining and quarrying		(p) 0.3	(p) 183
Manufacturing		(p) 17.3	(p) 11,991
Electricity, gas, steam and air-conditioning supply		(p) 2.7	(p) 1,904
Water supply, sewerage, waste management		(p) 1.7	(p) 1,211
Construction		(p) 5.9	(p) 4,125
Construction of buildings		(p) 1.7	(p) 1,195
Civil engineering		(p) 1.4	(p) 949
Specialised construction activities		(p) 2.9	(p) 1,985
Services sector		(p) 70.9	(p) 49,295
Wholesale and retail trade, repair of motor vehicles		(p) 9.8	(p) 6,782
Transportation and storage		(p) 2.4	(p) 1,665
Accommodation and food service activities		(p) 2.7	(p) 1,903
Information and communication		(p) 3.0	(p) 2,110
Financial and insurance activities		(p) 5.6	(p) 3,923
Real estate activities		(p) 10.9	(p) 7,585
Professional, scientific and technical activities		(p) 3.7	(p) 2,587
Administrative and support service activities		(p) 3.6	(p) 2,526
Public administration and defence; compulsory social security		(p) 8.4	(p) 5,860
Education		(p) 6.7	(p) 4,630
Human health and social work activities		(p) 11.6	(p) 8,032
Arts, entertainment and recreation		(p) 1.0	(p) 700
Other service activities		(p) 1.3	(p) 929
Activities of Households		(p) 0.1	(p) 63

Figure 21 – Composition of Welsh GVA 2021: source (Welsh Government, 2023)

A split of GVA for the three industries across the different regions of Wales is shown in Figure 22 for the year 2021. Flintshire and Wrexham made the highest GVA contribution to production with 25%, followed by South West Wales (15%) and Cardiff/Vale of Glamorgan (11%).

GVA Approach (GVA (B))		Measure (Total (million))		Year (2021)	
Measure	Year	GVA Approach ()			
		Industry ()			
Area ()					
Wales		All Industries			All Industries
		Production	Construction	Services sector	
		(p) 16,076	(p) 4,129	(p) 49,295	(p) 69,500
West Wales and the Valleys		(p) 8,554	(p) 2,465	(p) 26,912	(p) 37,931
Isle of Anglesey		(p) 248	(p) 67	(p) 720	(p) 1,035
Gwynedd		(p) 428	(p) 201	(p) 1,823	(p) 2,453
Conwy and Denbighshire		(p) 434	(p) 344	(p) 2,967	(p) 3,745
South West Wales		(p) 2,475	(p) 406	(p) 5,235	(p) 8,116
Swansea		(p) 399	(p) 251	(p) 4,961	(p) 5,611
Bridgend and Neath Port Talbot		(p) 1,441	(p) 395	(p) 4,003	(p) 5,839
Central Valleys		(p) 1,455	(p) 488	(p) 3,581	(p) 5,524
Gwent Valleys		(p) 1,675	(p) 312	(p) 3,622	(p) 5,609
East Wales		(p) 7,522	(p) 1,664	(p) 22,383	(p) 31,569
Flintshire and Wrexham		(p) 3,946	(p) 347	(p) 4,121	(p) 8,414
Powys		(p) 517	(p) 106	(p) 1,687	(p) 2,310
Cardiff and the Vale of Glamorgan		(p) 1,830	(p) 784	(p) 12,011	(p) 14,626
Monmouthshire and Newport		(p) 1,229	(p) 427	(p) 4,564	(p) 6,219

Figure 22 – Gross value added by industry across the Welsh regions

6.5 Regional Economic Frameworks

6.5.1 North Wales

The intention of the North Wales REF is to drive economic impact through place based and inclusive actions.

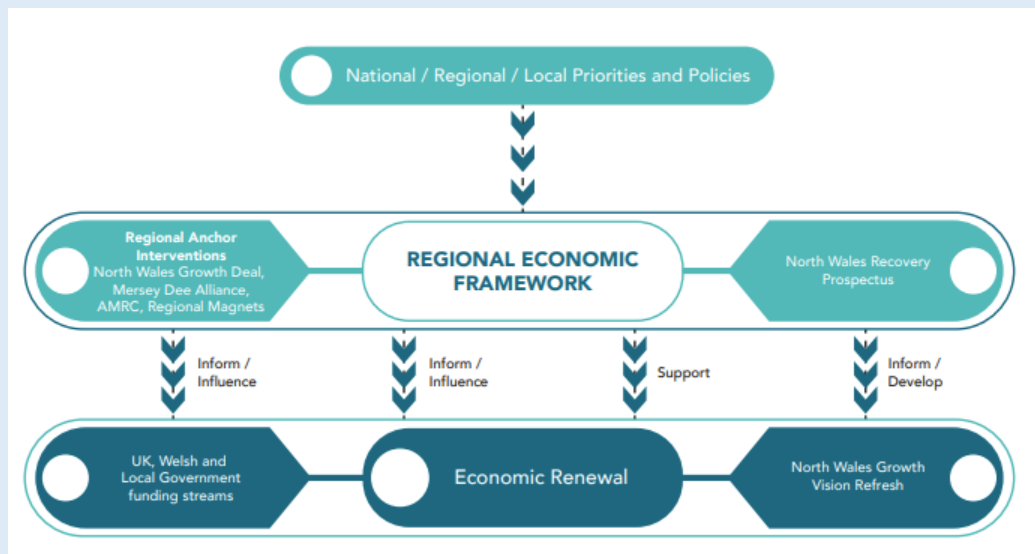


Figure 23 – North Wales Regional Economic Framework

The growth vision focuses on improving the well-being (economic, social, environmental and cultural) of North Wales through high value economic clusters – Energy, Advanced Manufacturing, Digital, including cross border collaboration with the Northern Powerhouse. At its core, the vision is to drive productivity, competitiveness and growth across the region.

Energy Cluster

There is a strategic emphasis on expertise in energy generation and low-carbon technologies, with a particular focus on opportunities arising from investments in various energy projects such as Wylfa Newydd, Trawsfynydd Small Modular Reactors, offshore wind, biomass, and tidal energy. The goal is to establish strong linkages with leading energy research centres, especially in the Northern Powerhouse area, to facilitate knowledge exchange, innovation, research and development, and

technology commercialization. The vision also emphasizes leveraging synergies with neighbouring regions to maximize supply chain opportunities, positioning North Wales as a key location for energy generation and related supply chain investment on both a national and global scale.

Advanced Manufacturing Cluster

The aim is to enhance the region's competitiveness on the global stage, building upon a network of anchor companies with international profiles and expertise in sectors such as aerospace, marine engineering, automotive, electronics, and food processing. The cluster will be supported by a network of SMEs known for delivering high-quality products and services. Growth in this cluster will be driven by strategic investments in key locations such as Enterprise Zones and industrial parks, along with the availability of applied knowledge assets and facilities, particularly in higher education institutions. In 2019, The Advanced Manufacturing Research Centre (a department of Sheffield University) opened in North Wales. The centre brought High Value Manufacturing Catapult revenue into Wales for the first time to support translational research in Manufacturing (see Chapter 11).

The Digital Cluster

The digital cluster encompasses various sectors, including high-performance computing, data analytics, media and cognitive computation, which will contribute to forging new innovative sectors and transforming traditional business models. The digital cluster is envisioned as the engine for growth in North Wales, leveraging the region's competitive advantages.

Key components of the digital cluster include creative industries, software development, health technology, and financial science, all of which will contribute to its momentum for growth. The region's strength in digital technology will be supported by applied research from universities and further education colleges, with a focus on specialties such as hardware and wireless communication. Several strategic sites, including Menai Science Park, Wrexham Technology Park, and St. Asaph Business Park, will serve as focal points for digital activities, facilitating collaboration and innovation

within the sector. The recently announced Anglesey Freeport, Ynys Mon will be a pivotal part of the Anglesey Energy Island Programme (EIP) by focusing on wind and tidal energy.

6.5.2 Mid Wales Regional Economic Framework

OUR ECONOMIC PRIORITIES			
Agriculture, Food And Drink	Applied Research And Innovation	Digital Connectivity	Energy
Enterprise And Entrepreneurship	Skills And Employment	Tourism	Transport And Infrastructure
← Welsh Language, Heritage And Culture →			

Figure 24 – Mid Sivanathan Economic Priorities: source (Welsh Government, 2021)

The REF for Mid Wales recognises the regions weaknesses and threats as low productivity, a narrow economic base, low earnings and rural market failures. Place based production assets include advanced manufacturing industrial clusters in automation, motion engineering and life sciences. The AberInnovation (a department of Aberystwyth University) provides research and development support in bioscience, food and drink and Agri-tech to support the rural economy.

6.5.3 South East Wales Regional Economic Framework

South East Wales is home to almost half of the population of Wales. GDP per capita is approximately 85% of the UK average, although significant disparities exist across the region. For instance, Cardiff & Vale of Glamorgan reached 99% of the UK average in 2021, whereas the Central and Gwent Valleys lagged at 62% and 55% respectively (see Figure 10). Other economic weaknesses include the lack of critical mass and insufficient investment in R&D. Furthermore, some areas within South Wales rank among the poorest in Europe.

The Regional Economic Framework (REF) encompasses a broad range of ambitions, including commercializing applied research activity, developing and localising supply chains, recognising the importance of and supporting entrepreneurial activity, investment-ready sites, and adopting a mission-driven approach to public sector spend. The REF acknowledges that South Wales has a uniquely diverse economy.

6.5.4 South West Wales Regional Economic Framework



Figure 25 – Vision and Priorities for South West Wales: source (Welsh Government, 2021)

The REF for South West Wales acknowledges the region's weaknesses and threats, which include lagging productivity, insufficient digital and transport connectivity in certain areas, and inadequate business infrastructure.

In 2021, the GVA per Capita (compared to the UK average of 100%) for specific areas within South West Wales was as follows: Bridgend and Neath Port Talbot = 67%, Swansea = 78%, and other areas = 71%. The 2018 Regional Regeneration Plan for South Wales established a target to elevate productivity in the region to 90% of the UK average by 2030.

Advanced manufacturing capabilities exist in Llanelli and Port Talbot, which boasts a deep-water harbour. There are two Enterprise Zones at the Haven Waterway and Port Talbot Waterfront and the recent green light announcement of the Celtic Sea Freeport in Milford Haven and Port Talbot, provides

opportunities around low carbon technologies, including hydrogen, carbon capture utilisation and storage (CCUS), and floating offshore wind (FLOW) energy.

The closure of the Tata steel plant at Port Talbot is a significant blow for the region with up to 3000 jobs to be lost as the plant closes for three years whilst the two blast furnaces are replaced with electric arc furnaces.

The opening of a small satellite HVMC centre in Baglan could support the ambitions for an Advanced Manufacturing Centre to be built in the region with capital budget that has already been secured.

7. The Welsh Manufacturing Sector

The manufacturing sector is an important component of the Welsh economy, contributing 17% to the total GVA and employs approximately 150,000 people. In terms of GVA as a contribution to total GVA, Wales outscores all other ITL 1 regions in the UK (Figure 26)

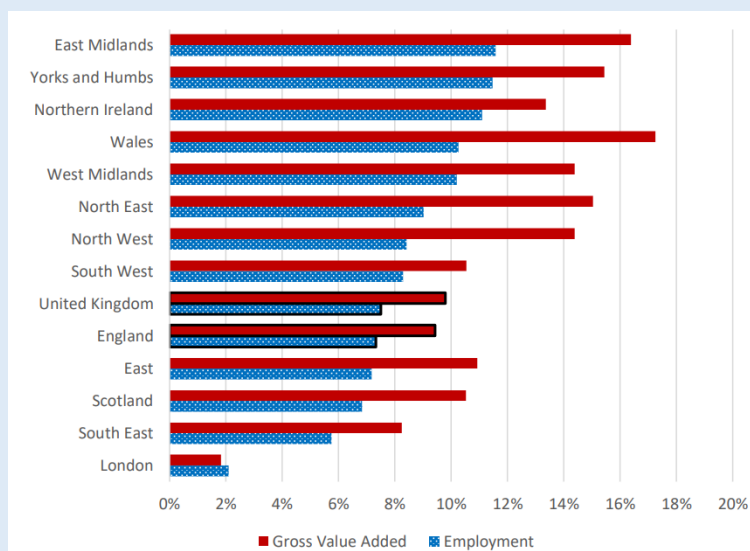


Figure 26 – GVA and Employment as Total Share (in region):source (BEIS, 2023)

The composition of the Welsh economy across industries in 2016 is shown in Figure 27. The manufacturing sector contributed almost £11 bn to the total GVA of almost £60 bn.

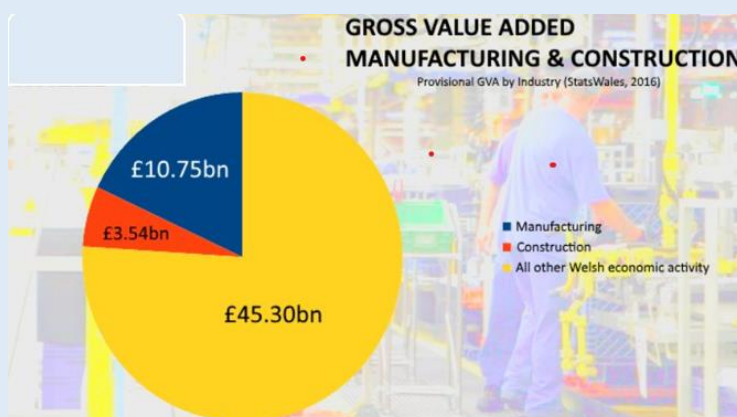


Figure 27 – GVA by Industry 2016 (Wales): source (Donovan, 2018)

A breakdown of the sub-sectors within the manufacturing sector is shown in

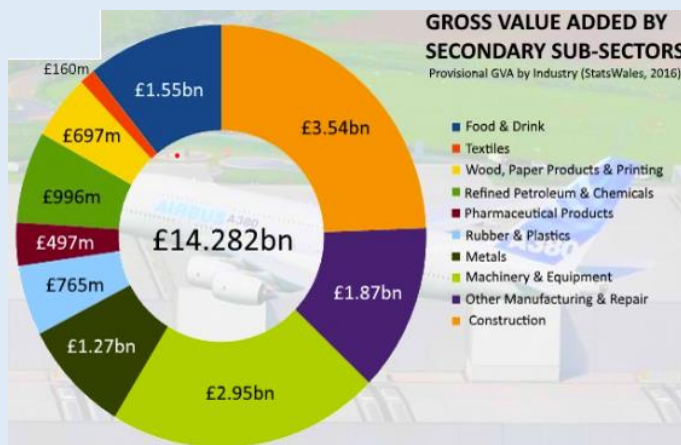


Figure 28 – GVA by Secondary Sub-Sector: source (Donovan, 2018)

Each year, Business Live release an online digital platform called Wales Top 300. The platform provides a rich resource of company performance in Wales from which to map out regional manufacturing density by sub-sector.

From the Wales Top 300 platform for 2018, Wales has more than fifty large manufacturing business (turnover > £50m and > 250 employees) – a list of these businesses with a hyperlink to their websites is provided overleaf in Appendix C.

These businesses have a combined turnover in excess of £10bn and employ more than 30,000 people. There are other large and significant manufacturing businesses in Wales such as Airbus (Broughton), Toyota (Deeside), Tata Steel (Port Talbot and Newport), Kelloggs (Wrexham) whose business accounts are not filed in Wales.

Similarly, Wales has over fifty SME's in manufacturing that are included in Wales Top 300. These firms have a turnover between £20M and £50M. A list of these businesses is provided overleaf in Appendix D. They have a combined turnover of approximately £1.8bn and employ more than 10,000 people.

Transport		Steel/Aluminium Production & Fabrication (> £1 bn)	Food & Drink (including animal feed) (estimated > £1 bn)	Wood, Paper & Packaging (>£1 bn)	Medical (Appliances & Pharmaceutical) (> £1 bn)	Building Materials & Office/Home Furnishing (> £0.9 bn)	Specialist Chemicals & Materials (> £0.8 bn)	Money (> £0.6 bn)	Semiconductors (> £0.4 bn)	Mobile Electronic Devices & Office Machinery (> £0.3 bn)	Others
Aerospace	Automotive										
Airbus (UK)	Toyota Engines	Tata Steels	Wynnstay Group (£0.37 bn)	International Greetings (£0.31 bn)	Ortho-Clinical (£0.2 bn)	Kronospan Holdings (£0.35 bn)	Dow Corning (£0.51 bn)	The Royal Mint (£0.5 bn)	Spts Technologies (£0.22 bn)	Panasonic (£0.23 bn)	Morris Mclellan (>£0.05 bn)
GE Aircraft Engine Systems (£2.4 bn)	Marelli Automotive Systems Europe (£0.73 bn)	Celsa (£0.44 bn)	Finsbury Food Group (£0.31 bn)	Nice-Pak (£0.24 bn)	Ipsen Biopharm (£0.18 bn)	Kingspan (£0.33 bn)	Solutia (£0.1 bn)	Notemachine (£0.1 bn)	IQE PLC (£0.13 bn)	Brother (£0.08 bn)	Qioptic (£0.07 bn)
Zodiac Seats UK (£0.3 bn)	Yusa Battery (£0.21 bn)	Alcoa (£0.12 bn)	S.A Brain & Company (£0.14 bn)	Plastipak (£0.16 bn)	Convatec (£0.16 bn)	Rockwool (£0.1 bn)	Hexion (£0.09 bn)		Newport Wafer Fab (£0.12 bn)		Nidec Industrial (£0.1 bn)
	Cequent (0.12 bn)	Liberty Steel (0.18 bn)	Kelloggs	Intertissue (£0.13 bn)	Biomet (£0.1 bn)	Bisley Office Equipment (£0.08 bn)	Monument Chemicals (£0.07 bn)				
	Meritor Heavy Vehicle Braking (£0.1 bn)	Hydro Aluminium (£0.05 bn)		Premier Forest Group (£0.12 bn)	Wockhardt (£0.09 bn)	Abingdon Flooring (£0.07 bn)	Cytec Engineered Materials (£0.06 bn)				
	Enersys (£0.09 bn)			Northwood & Wepa (£0.11 bn)	PCI Penn (£0.08 bn)		A. Schulman (£0.05 bn)				
	Sofegi Filtration (£0.06 bn)			Seda (£0.09 bn)	Norgine (£0.07 bn)						
				Northwood Hygiene Products (£0.06 bn)	BBI Diagnostics (£0.06 bn)						
					Catalent Cts (£0.06 bn)						

Table 6 – Wales Top 300 Large Manufacturing Businesses by Sector: source (Buiness Live, 2020)

Transport (Aircraft, Automotive)	Steel/Aluminium Production, Castings & Fabrication	Food & Drink (including animal feed)	Wood, Paper & Packaging	Medical (Appliances & Pharmaceutical)	Building Materials & Office/Home Furnishing	Specialist Chemicals & Materials	Semiconductors	Others
Showa UK Nissan (£0.05 bn)	Capital Coated Steel (£0.03 bn)	OP Chocolate (£0.04 bn)	Klockner Pentaplast (£0.04 bn)	Gyrus Medical (£0.04 bn)	Quinn Radiators (£0.05 bn)	Headland Agrochemical (£0.04 bn)	Pure Wafer (£0.02 bn)	Airborne Systems Ltd (£0.04 bn)
Continental Teves (£0.04 bn)	Castalum (£0.03 bn)	Radnor Hills (£0.03 bn)	Bemis (£0.03 bn)	Protherics (£0.04 bn)	IG Doors (£0.04 bn)	Zeon Chemicals (£0.04 bn)		SEI Interconnect (£0.04 bn)
Lawrence Automotive Interiors (£0.04 bn)	Tritech (£0.03 bn)	Deeside Cereals (£0.03 bn)	Glatfelter (£0.03 bn)	Fillcare (£0.03 bn)	Euroclad (£0.04 bn)	Ensinger (£0.03 bn)		TT Electronics (£0.04 bn)
Mollertech (£0.03 bn)	Amerex (£0.03 bn)	CDT Sidoli (£0.03 bn)	F Bender (£0.03 bn)	Pelican (£0.03 bn)	Pd Edenhall (£0.03 bn)			Henrob (£0.04 bn)
Mitsui Components (0.03 bn)	Sandvik (£0.03 bn)	Braces Bakery (£0.03 bn)			Altrad (£0.03 bn)			Reflexallen (£0.04 bn)
Electroimpact (£0.03 bn)	Real Alloy (£0.03 bn)	PB Gelatins (£0.03 bn)			Stately-Albion (£0.03 bn)			Coveris (£0.04 bn)
JTEKT (£0.03 bn)	Blackwood (£0.03 bn)				Parker Knoll (£0.02 bn)			Talis (£0.03 bn)
TRB (£0.03 bn)								Volcke (£0.03 bn)
Eftec (£0.03 bn)								Wall Colmonoy (£0.03 bn)
Ksr Electronics (£0.03 bn)								Lenstec (£0.03 bn)
Bergstrom (£0.02 bn)								Eriez (£0.03 bn)

Table 7 – Wales Top 300 SMEe Manufacturing Businesses by Sector: source (Buiness Live, 2020)

The businesses in Table 6 Figure 6 and Table 7 have been populated by the author of this thesis onto maps to look at the geographic density of large and SME organisations by sector across Wales – see Appendix E. It is striking to see the clustering of the majority of the Top 300 businesses (manufacturing) in North East Wales and South East Wales

In terms of productivity (GVA per job), the Welsh manufacturing sector of Wales appears to have a productivity level that broadly aligns with the UK average (Figure 29). Productivity in East Wales is 10% above the UK average whilst West Wales and the Valleys is 7% below.

Table 4: Manufacturing productivity by sub-region, 2018

	GVA per job UK=100	Employment
Cheshire & Warrington	241	41,500
Hertfordshire	157	34,500
Thames Valley Berkshire	151	25,500
Highlands & Islands	148	14,500
Coast to Capital	146	42,500
Swindon & Wiltshire	145	29,500
Oxfordshire	139	26,500
Coventry & Warwickshire	134	55,500
Enterprise M3	129	44,000
Greater Birmingham & Solihull	121	92,000
Liverpool City Region	120	49,000
North Eastern Scotland	116	22,500
East Wales	110	63,000
Eastern Scotland	110	62,500
Greater Cambridge and Greater Peterborough	104	85,000
South East	102	107,500
The Marches	101	38,500
South East Midlands	101	92,500
Lancashire	99	87,500
Northern Ireland	99	86,000
West of England	98	36,000
West Central Scotland	97	47,000
London	96	114,500
North East	95	90,500
Humber	95	68,500
New Anglia	94	66,500
West Wales & the Valleys	93	82,500
Leicester & Leicestershire	92	59,500
Southern Scotland	91	34,500
Greater Manchester	91	104,500
Cumbria	90	37,500
Gloucestershire	90	34,500
York, N Yorkshire and E Riding	86	56,000
Dorset	86	29,000
Tees Valley	84	25,000
Greater Lincolnshire	83	67,000
Buckinghamshire Thames Valley	83	17,500
Derby, Derbyshire, Nottingham, Notts	82	126,500
Leeds City Region	80	150,000
Worcestershire	77	34,000
Heart of the South West	76	70,500
Cornwall & Isles of Scilly	76	15,500
Stoke & Staffordshire	71	63,000
Solent	69	45,000
Sheffield City Region	67	92,500
Black Country	51	65,500
All manufacturing	100	2,520,000

Figure 29 – GVA per job (UK Regions) (Beatty & Fothergill, 2020)

The issue, however, is not how manufacturing in Wales compares with the UK, since concerns have already been noted that UK manufacturing appears to be losing its competitiveness (Chapter 4). This provides a perfect segue to the next chapter that looks at the influences of innovation and technology on productivity.

8. Innovation, Technology and the Productivity Link

“You can see the computer age everywhere but in the productivity statistics”.

Robert Solow

To innovate is to create something novel, to implement it and then to create value from it – the Schumpeter theory of innovation (Figure 30). Innovation is a multifaceted phenomenon shaped by various factors including the local economic landscape, historical trajectories, global competition, governmental efficacy, and financial constraints.

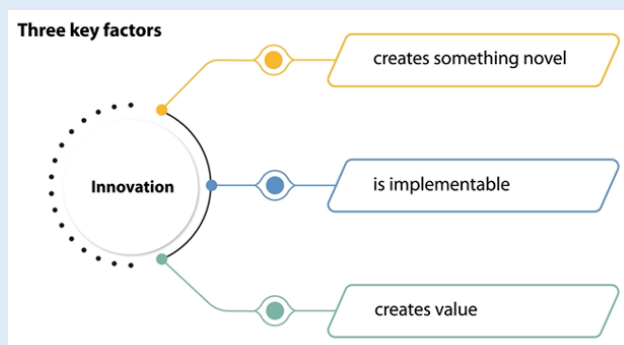


Figure 30 – The Components of Innovation: source (Loch, 2023)

Technology is complementary to innovation. Technology is the application of scientific knowledge to products and new artefacts or procedures to solve problems. Quite often, technology is confused with innovation – technology is not innovation – it is one of many factors that feeds into innovation to impact business performance in different ways – product, manufacturing process, business process etc. (Figure 31).

Firm determinants – control variables	Innovation Inputs	Innovative Output	Firm Performance
Firm Size (sales, turnover, employees, employment growth)	R&D expenditures	Patents	Value-added per employee
Sectoral Affiliation (Pavitt's taxonomy, Schumpeter Mark I, Schumpeter Mark II)	Non-R&D based innovation activities expenditures	Citations	Output per hour worked
Competition – market power, market share, market concentration, market regulation	Purchase of outside services	Licenses	Sales per employee, revenue (sales) per worker
Diversification indexes	Purchase of machinery, equipment for innovation activities	Trademarks	Profit before depreciation
Ownership structure (private, public, foreign,)	Industrial design for new products	Models of use/utility models, copyrights, among others	Profit after depreciation
Managerial ability – managerial practices (subsidiary firms, multi-establishment firm, diversified firm)	Marketing expenditures	Process innovation	Sales margin in level
Human capital (labour quality, type of workers)	Education for innovation activities	Product innovation	Employment growth
Capacity of utilisation	Human capital resources: Highly educated employees	Sales devoted to new products	Exporting activity
Physical capital intensity	Engineers	Qualitative indicators: Sources of innovation	
Industry price indexes	Administrators	Technological changes	
Firm price indexes	Average work experience	User demand	
	Cooperation with outside partners		
	Sources of knowledge		

Figure 31 – Business Innovation, Controls, Inputs and Outputs: source (Ortega-Argiles & McCann, 2021)

We live in an innovation-intensive era, that is considered as the start of the 4th Industrial Revolution. It is an era driven by technology, an era that offers an abundance of rapid prototyping technology for new / existing product development and technologies such as digitalisation, robotics, machine learning, and artificial intelligence (made possible by the recent exponential growth in computing power) that create the potential for the transformation of business sustainability, resilience and efficiency. But, despite the incredible pace of technology advancement, productivity growth has stalled for many countries in the developed world following the financial crash of 2007/8 – a phenomenon referred to as 'The Innovation-Productivity Paradox' (Fragkandreas & et al, 2021).

Emerging research suggests that structural changes brought about by technology adoption are occurring in the global economy that is not well understood. There are a small number of firms at the productivity frontier² who have very high labour productivity growth with a widening gap to the rest (Figure 32).

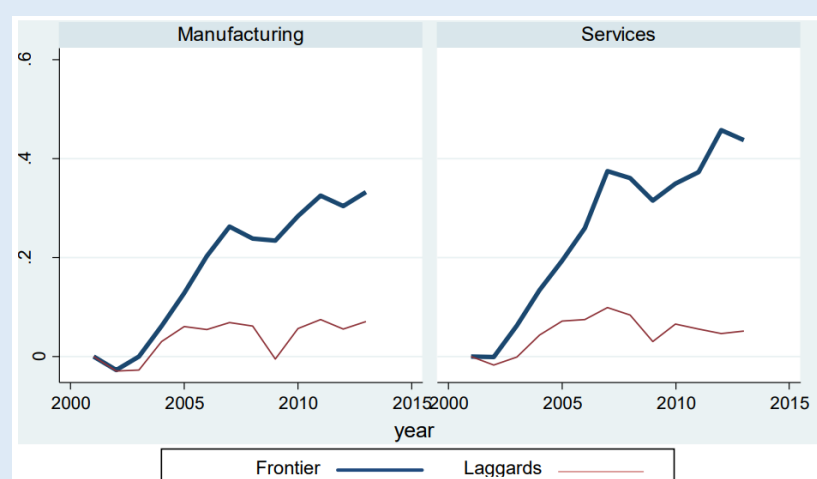


Figure 32 – Frontier Firms and the Rest (The divergence in productivity): source (Andrews, Criscuolo, & Gal, 2016)

This causation for the widening productivity gap appears two-fold. Firstly, the broader global productivity slowdown could stem from a deceleration in the spread of technology. This stagnation might indicate that it's becoming more costly for behind-the-curve firms to transition from traditional production-based economies to ones cantered around innovation. Secondly, ineffective government policies may be impeding the diffusion of technology in OECD economies, contributing to the observed rise in MFP divergence.

innovation through technology adoption diffuses quickly across international boundaries, it does so at a much slower pace across regions within nations. The cause for this slow diffusion appears to be a significant productivity divergence between a small number of 'superstar' organisations and the rest.

² The top 5% of firms (labour productivity) in each 2 digit sector

The superstars are highly productive, while the rest lag. It is here where the productivity battle is being lost.

It takes little digging into technology investment to understand why the UK is losing the productivity war. The countries that are contributing the most to global manufacturing output, China 20%, USA 18%, Japan 10%, Germany 7% and Rep of Korea 4% (Rhodes, 2018) are investing in heavily in industrial robots. In 2021, the UK did not make the 'Top 15' in the 'international league table' for annual installations of Robots (Figure 33) (International Federation of Robotics, 2021).

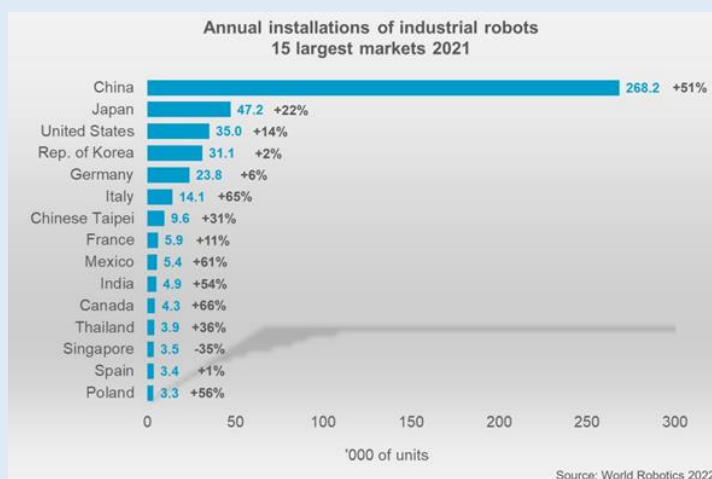


Figure 33 – Global Installations (International Federation of Robotics, 2021)

Furthermore, the UK lags some of its peers in adopting digital technologies, such as Enterprise Resource Planning (ERP) software and Supply Chain Management software, as indicated in Figure 34. Additionally, the UK's investment in next-generation technologies, including the Internet of Things (IoT), advanced artificial intelligence, converged infrastructure, high-performance computing, and virtual/augmented reality, is also behind global standards. This gap highlights a critical area for strategic enhancement to bolster the UK's competitive edge. (McKinsey Global Institute, 2018).

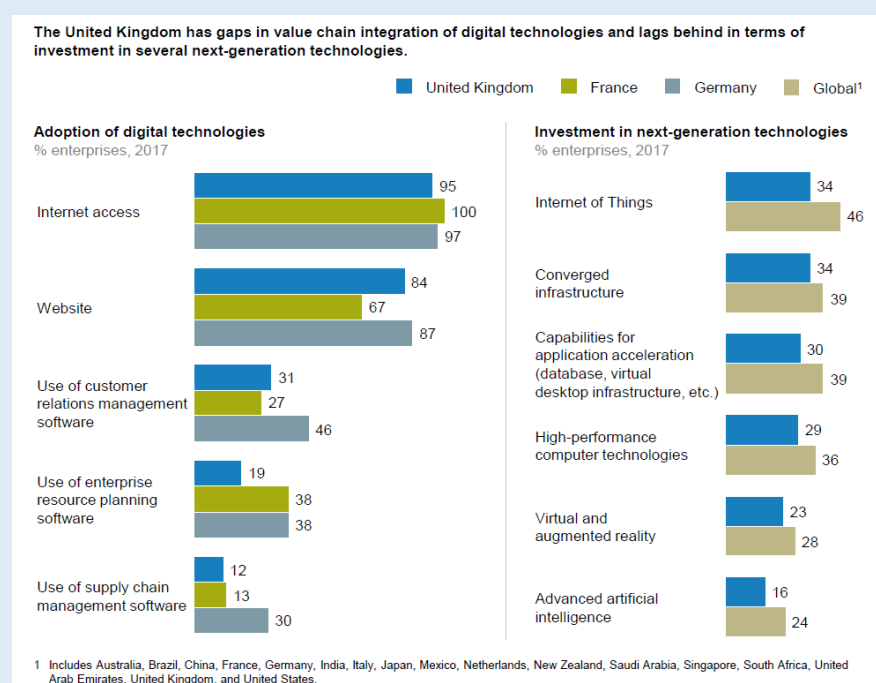


Figure 34 – Value Chain Integration of Digital Tech & Investment in next Generation Tech (McKinsey Global Institute, 2018)

These failings are not going unrecognised. The United Nations Industrial Development Organisation (UNIDO) assess and score the competitiveness of different nations using three dimensions (UNIDO, 2021) – see Figure 35.



Figure 35 – UNIDI Competitive Industrial Performance Dimensions (UNIDO, 2021)

Dimension 1: Production and Export Capacity of Manufactured Goods

- **Manufacturing Gross Value Added (GVA) Per Capita:** Measures the economic output derived from manufacturing per individual within the economy.
- **Manufactured Exports Per Capita:** Assesses the average export value of manufactured goods per individual.

Dimension 2: Technological Advancement and Enhancement

- **Industrialisation Intensity:** Evaluates the complexity involved in the manufacturing processes.
- **Export Quality:** Examines the technological sophistication and the proportion of exported manufactured goods relative to total exports.

Dimension 3: World Impact

- **Manufacturing Value Added (MVA) as a Percentage of Global Manufacturing Value Added:** Indicates the nation's contribution to global manufacturing output.
- **Share in Global Trade of Manufactured Goods:** Measures the country's participation in the international market for manufactured products.

In 2018, the UK ranked 15th – see Figure 36.

Quintile	Rank 2018	Economy	Score	Rank 2017	Rank 2012	Change 2017-2018	Change 2012-2018
Top	1	Germany	0,4709	1	1	0 ↔	0 ↔
Top	2	China	0,3716	2	5	0 ↔	3 ↑
Top	3	Republic of Korea	0,3488	3	4	0 ↔	1 ↑
Top	4	United States of America	0,3454	4	2	0 ↔	-2 ↓
Top	5	Japan	0,3445	5	3	0 ↔	-2 ↓
Top	6	Ireland	0,3304	6	13	0 ↔	7 ↑
Top	7	Switzerland	0,302	7	6	0 ↔	-1 ↓
Top	8	China, Taiwan Province	0,2841	8	8	0 ↔	0 ↔
Top	9	Singapore	0,2591	9	7	0 ↔	-2 ↓
Top	10	Netherlands	0,252	10	9	0 ↔	-1 ↓
Top	11	Italy	0,2443	11	11	0 ↔	0 ↔
Top	12	Belgium	0,2419	12	12	0 ↔	0 ↔
Top	13	France	0,2371	13	10	0 ↔	-3 ↓
Top	14	Austria	0,2051	15	16	1 ↑	2 ↑
Top	15	United Kingdom	0,2049	14	14	-1 ↓	-1 ↓
Top	16	Czechia	0,2019	16	18	0 ↔	2 ↑
Top	17	Sweden	0,1953	17	15	0 ↔	-2 ↓
Top	18	Spain	0,1811	19	19	1 ↑	1 ↑
Top	19	Canada	0,1792	18	17	-1 ↓	-2 ↓
Top	20	Mexico	0,1644	20	20	0 ↔	0 ↔

Industrialized economies

Emerging industrial economies

Figure 36 – Global Competitive Industrial Performance Index – 2018 (UNIDO, 2021)

However, an examination of the UK's rankings across each dimension (Figure 17) reveals significant challenges within the UK manufacturing sector. Notably, the UK is positioned 35th in terms of technological deepening and upgrading—a ranking that aligns with the previously discussed deficiencies in capital investment. Furthermore, the UK holds the 29th position for its capacity to produce and export manufactured goods, underscoring potential areas for improvement.

Regional rank	Economy	Global rank	Rank in the first dimension	Rank in the second dimension	Rank in the third dimension	Absolute change compared to 2012
1	Germany	1	5	6	3	0 ↔
2	Ireland	6	1	3	23	7 ↑
3	Switzerland	7	2	11	16	-1 ↓
4	Netherlands	10	6	28	13	-1 ↓
5	Italy	11	18	21	6	0 ↔
6	Belgium	12	4	24	19	0 ↔
7	France	13	21	22	7	-3 ↓
8	Austria	14	7	18	26	2 ↑
9	United Kingdom	15	29	35	9	-1 ↓

Figure 37 – Europe Competitive Industrial Performance Index - 2018 (UNIDO, 2021)

9. Levers for Economic Growth

There are several levers to support economic growth. One of the most referenced is investment in Research, Development and Innovation (RD&I) as a ratio of GDP. In 2017, the UK government set a goal that: ***“The UK should be the most innovative country in the world”***. The action to deliver on that goal was for the UK to *meet the current OECD average for investment in R&D – that is, 2.4 per cent of GDP – within ten years, with a longer-term goal of three per cent.*

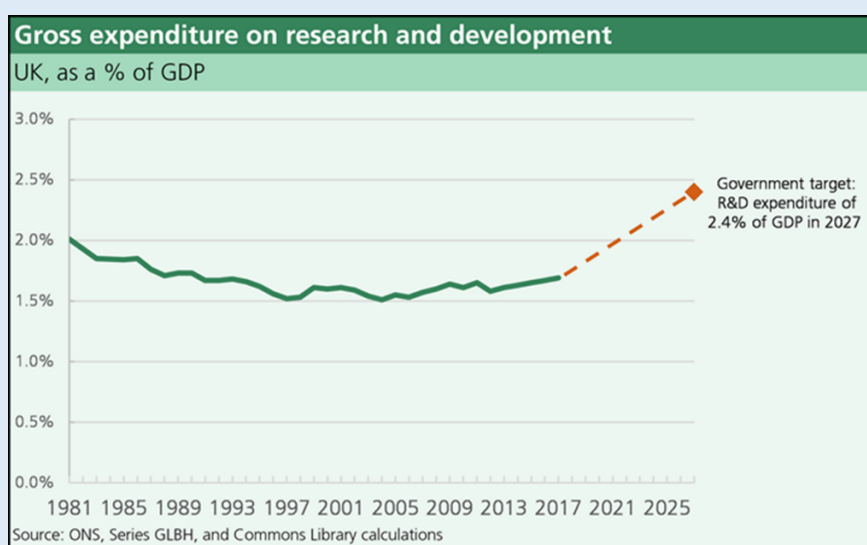


Figure 38 – UK expenditure on R&D as %GDP: source

Wales invests 1% of GDP in research and development. This Investment is funded in numerous ways, which includes research and development tax credits, Welsh Government, EU structural funding (terminated in 2023 following Brexit), Research Councils and Higher Education Funding Council for Wales (HEFCW) – see contributions to RD&I by each sector is shown in Figure 39.

Countries that invest a relatively high proportion of GDP in R&DI are Israel (6%), South Korea (5%), United States (3.6%), Sweden (3.4%) and Germany (3.2%) (Dyvik, 2024)

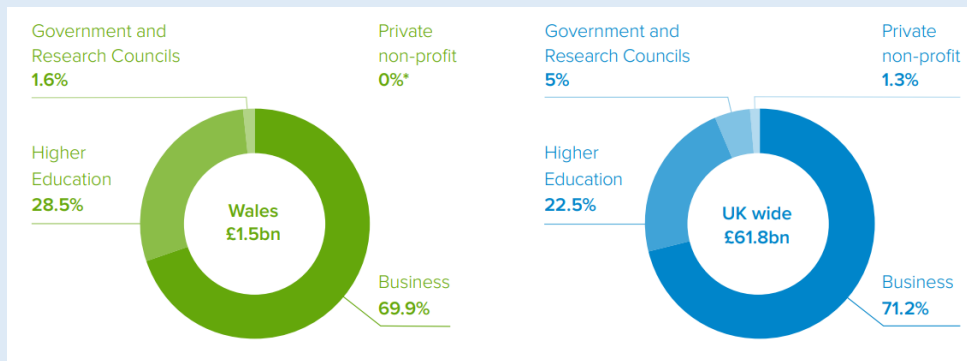


Figure 39 – RD & I expenditure – Wales versus UK average: source: (The Royal Society, 2023)

Some of the funding streams of RD&I activity in Wales are shown in Figure 40.

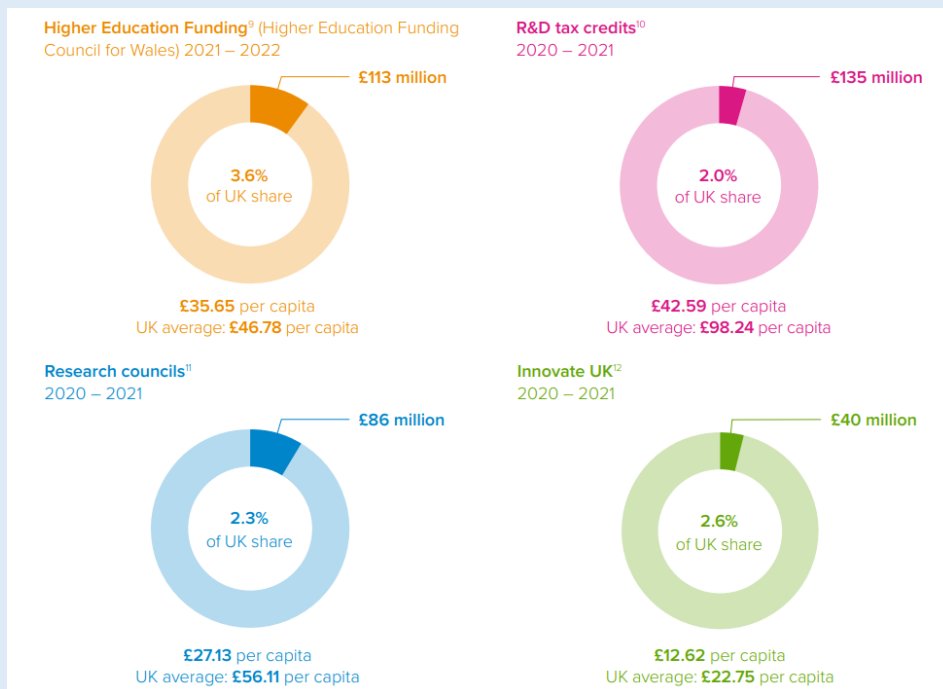


Figure 40 – Some of the Funding Streams for RD&I in Wales 2021-22: source (The Royal Society, 2023)

The comparative funding between Wales and the UK average per capita is both large and concerning.

Wales received the lowest amount of Innovate UK spend in the financial year 2020-21 (Figure 41

ITL1	Innovate UK spend FY2020-21 £M	Innovate UK spend per business £	Innovate UK spend per R&D active business £	Innovate UK spend as a proportion of local GVA	Innovate UK spend by local population £
East Midlands (England)	128	349	23,245	0.12%	26
East of England	117	206	14,461	0.08%	19
London	234	224	13,599	0.06%	26
North East (England)	57	370	20,673	0.11%	19
North West (England)	49	94	5,544	0.03%	7
Northern Ireland	19	150	8,165	0.05%	9
Scotland	62	181	13,502	0.04%	12
South East (England)	315	360	24,744	0.12%	35
South West (England)	139	267	21,596	0.10%	23
Wales	40	191	13,440	0.06%	13
West Midlands (England)	315	707	39,943	0.24%	52
Yorkshire and The Humber	51	123	7,928	0.04%	8
Total	1,526	3,221	206,840	1.0%	251

Figure 41 – Innovate UK Spend UK Regions 2020/21: Source (UKRI, 2021)

Between 2014 and 2020, approximately £340m of EU structural funds was invested in RD&I programs in Wales (almost 20% of the total EU structural funding for Wales) (Welsh Government, 2019) – some of the projects supported by the EU structural funds are shown in Figure 42. During this period, Wales received only 2% (£0.7 bn) of the total UK Government spend on RD&I – one of the lowest allocations across the ITL 1 UK regions.

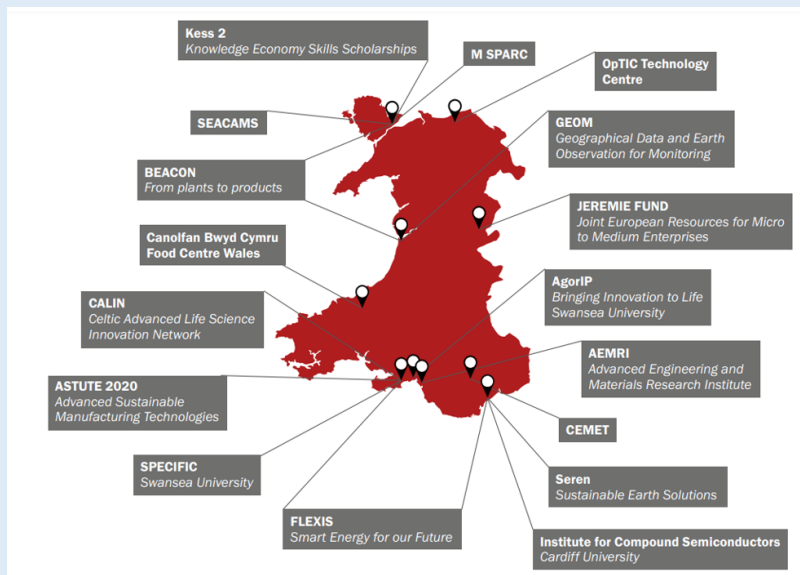


Figure 42 – Projects in Wales Supported by EU structural funds: source (Welsh Government, 2019)

Wales has the lowest R&D spend per capita of all UK nations.



Figure 43 – R&D Spend UK per capita 2021: source (Hutton & et al, 2023)

A second lever for economic growth is gross fixed capital formation as a % of GVA (Figure 44). Investment in fixed capital is an opportunity for businesses to increase productivity through the adoption of technologies incorporated into ICT and machines to that will hopefully improve efficiencies and support the development of better products.

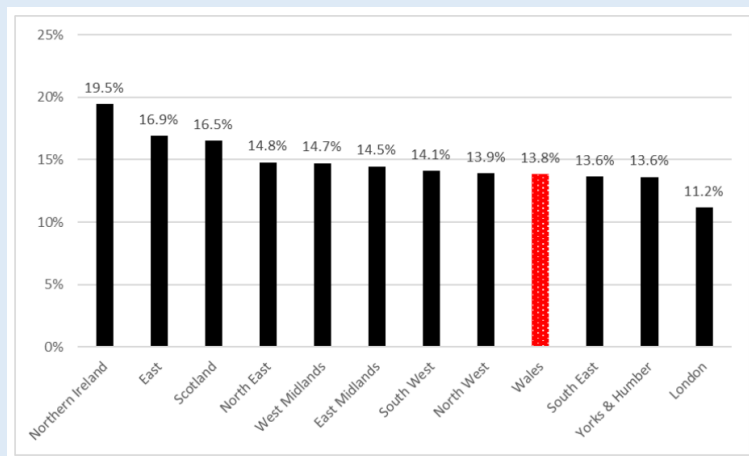


Figure 44 – Investment as a % GVA: source (Chief Economist's Report and Fiscal Prospects, 2023)

10. Funding and the Welsh Public Sector Fiscal Deficit

“Gorau adnabod, d'adnabod dy hun”

(A great sin can enter through a small door) – Welsh proverb.

The Offa's Gap report *'Roots and Remedies of the Welsh Growth Collapse'* (Price & Gwilym, 2012) claimed that Wales is well on the way to becoming the most under-developed nation in the advanced post-industrial world. The report was released by Plaid Cymru as a discussion paper and despite the potential for political point scoring, the report raised some justifiable concerns about the health of the Welsh economy and Welsh Government finances to support the economy.

Over the last two decades, the net fiscal balance³ of Wales has grown considerably. It increased from (-) £6bn in 2000/01 to (-) £15bn in 2019/20 (Office for National Statistics (ONS), 2023). The current budget balance⁴ increased from (-) £4bn to (-) £10bn over the same period.

In the covid pandemic years, the net fiscal deficit ballooned to (-) £26bn in 2020/21, reducing to (-) £20bn in 2021/22, whilst the current budget deficit grew to (-) £20m and (-) £15m respectively. Expenditure increased markedly to support the pandemic recovery whilst revenue remained relatively constant and close to the level generated pre-covid.

Of the 12 UK regions, Wales consistently scores one of the highest fiscal deficits per head (Table 8).

³ Net Fiscal Balance = Total Public Sector Revenue minus Expenditure (**including** capital investment) (Chief_Economist, 2023).

⁴ Current budget balance = Total Public Sector Revenue minus Expenditure (**excluding** capital investment) (Chief_Economist, 2023).

Country or Region	FYE 2020	FYE 2021	FYE 2022
Northern Ireland	5.4	9.2	7.3
Wales	4.6	8.1	6.5
North East	4.1	7.9	5.5
West Midlands	2.9	6.3	4.4
Scotland	2.9	6.7	4.3
North West	3.0	6.5	4.1
Yorkshire and the Humber	2.2	5.7	3.3
East Midlands	1.5	5.1	2.6
South West	1.1	4.9	2.1
United Kingdom	0.8	4.7	1.8
England		4.1	1.1
East of England	-0.6	3.3	0.4
South East	-2.1	1.7	-1.5 ⁵
London	-4.0	0.7	-4.3

Table 8 – Net Fiscal Balance per-head in 2021 and 2022, by country and region, UK, (£ thousands) - (Office for National Statistics (ONS), 2023)

In short, the level of public spending in Wales, far exceeds the total revenue raised (Ifan & et al, 2019). Figure 45 shows that in how the public sector is funded through taxes, block grants and subsidies (non-devolved and devolved). Expenditure exceeded revenue by circa £14bn. The variance between public revenue and expenditure in Wales is picked up by the UK exchequer through a fiscal transfer (subsidy) (Gov, 2023).

⁵ Negative in the table indicates a surplus per head.

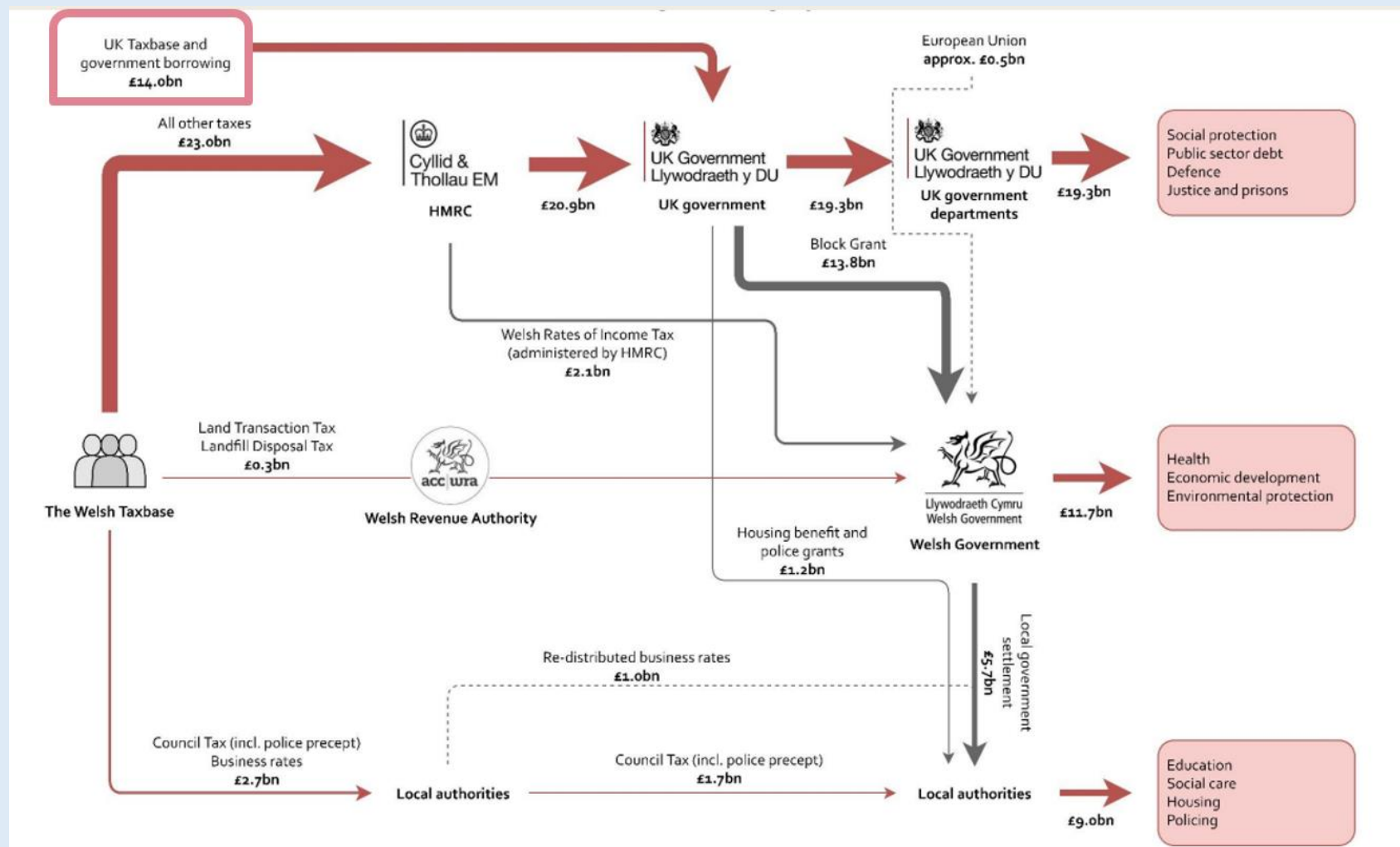


Figure 45 – Public Funding Wales: source (Ifan & et al, 2019)

It is argued that this is the price that one must be pay for keeping the union of Britain together, where wealthier regions carry those that are significantly less prosperous. Parallels are often drawn with the European union where the economic might of Germany and France props up struggling economies like Greece and Portugal.

The Welsh public sector deficit of circa £13,5m that is subsidised by the UK exchequer makes it difficult for Wales to ask for additional funding to support manufacturing – even if that support could lead to higher economic growth and increased taxes that could ultimately reduce subsidy needs.

11. The High Value Manufacturing Catapult Network (HVMC)

11.1 The Original Vision of the HVMC

The Catapults were shaped by two seminal reports:

‘The Current and Future Role of Technology & Innovation Centres in the UK’ - Dr Hermann Hauser

and,

‘Ingenious Britain Making the UK the leading high-tech exporter in Europe’ - James Dyson

It was these reports that persuaded the UK coalition government to invest £200m in a network of technology and innovation centres in 2011. In 2014, Dr Hauser was commissioned by Greg Clark MP and Vince Cable MP to write a review on the performance of the Catapult network following the first 3 years of operation.

11.1.1 Dr Hermann Hauser

In his 2010 report *‘The Current and Future Role of Technology & Innovation Centres in the UK’* report, Dr Hauser reviewed the role of business-focused Technology and Innovation Centres (TICs) that are pivotal in enhancing knowledge transfer by serving as intermediaries between academia and the industrial sector.

Despite a strong research position, the UK had failed to fully leverage this for economic gain, largely due to a gap between research and its commercialization. Hauser’s proposed the establishment of

Technology and Innovation Centres in the UK, designed to bridge this gap by providing a business-focused environment that facilitates the transition from research to market.

Hauser took inspiration from international TICs in Germany (Fraunhofer), Netherlands (TNO), Taiwan (ITRI) and South Korea (ETRI) and highlighted the advantages these countries gain from a national technology strategy that effectively incorporates TICs into their innovation frameworks.

Hauser criticised the UK approach at the time for its lack of national coherence and inadequate attention to business needs and localisation of expertise. He advocated for a new strategy focusing on areas where the UK holds a technical lead and the potential to secure significant portions of the value chain domestically. These fields include regenerative medicine, future internet technologies, renewable energy, and advanced manufacturing.

The bridge between academia and industry is best visualised by considering the Technology Readiness Level (TRL) of innovation, a scale commonly used by entities like the US Department of Defence, the UK Ministry of Defence, and NASA (Figure 46)

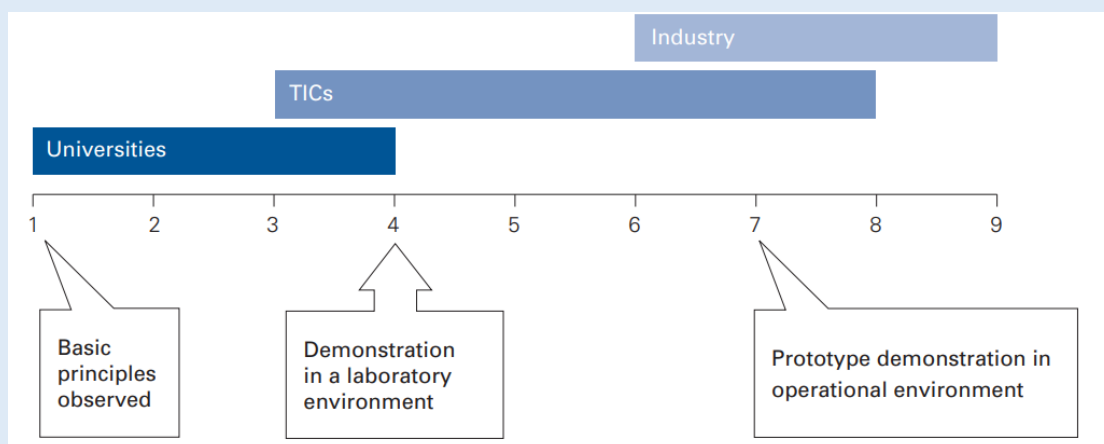


Figure 46 – Technology Readiness Scale: source (Hauser, 2010)

11.1.2 James Dyson

David Cameron and George Osborne identified the need for a UK economy grounded in investment, exports, and savings (Dyson, 2010). They highlighted the importance of high-tech companies in achieving this vision. Dyson was commissioned to give an opinion on how best to create an infrastructure in the UK to encourage the formation and growth of these firms. His report '*Ingenious Britain Making the UK the leading high-tech exporter in Europe*' (Dyson, 2010), focused on several areas:

1. The necessity to foster a culture that values science and engineering, moving away from ineffective initiatives like "Creative Britain" that lack substantive action. In education, it is crucial to improve the image of design and technology, emphasize core science subjects, and promote diverse academic and technical qualifications.
2. Strong public sector policy that facilitates a commitment to major projects like highspeed rail and renewable energy and facilitates growth in high-tech sectors by enhancing financial incentives for R&D (such as R&D tax credits) and increasing procurement from SMEs.
3. Encourage collaboration among universities, companies, and nonprofits to enhance innovation and create a bridge for knowledge transfer between academic research and market application.
4. Enhance financial support for high tech start-ups through initiatives like the Enterprise Investment Scheme and government-backed loans to stimulate innovation and leverage private investment.

These measures, taken together, aim to create a sustainable economic environment that leverages technological innovation and high-tech industries as pivotal elements of economic growth and recovery.

11.2 What is High Value Manufacturing?

Modern manufacturing is not solely concentrated on production. It encompasses the full cycle of activities from research & development, through design, production, logistics and services, to end of life management.

In an attempt to define High Value Manufacturing, the Cambridge University Institute for Manufacturing developed the following matrix of metrics for each stakeholder and type of value (Figure 47)

	Financial	Strategic	Social
Country	• GDP impact payed	• Sustainable employment • Intellectual capital development • Employee capability development	• Minimal environmental impact
Investors	• Return adjusted for risk • Long term growth	• Adaptability, sustainability	• Acts ethically
Employees	• Pay, wages • Funding of retirement	• Lifelong learning • Opportunities for growth	• Personal development • Social interaction • Work-life balance

Figure 47 – Matrix of High Value Manufacturing Metrics for each stakeholder

The challenge facing Wales (and indeed the rest of the UK) is to help businesses to move up the value chain and make high value the standard. The key to this is securing the benefits of high-skilled, knowledge-intensive manufacturing operations whilst competing on unique value and innovation.

Investment in research and development is essential if companies are to climb the value chain and a level of public funding is critical to stimulate the engagement of the private sector and encourage knowledge transfer between academia and industry. According to 'Economic Insight, every £1 spent on public R&D unlocks £1.40 of private R&D investment, together delivering £7 of net economic benefit to the UK. According to the UK Governments Advanced Manufacturing Action Plan, the value

of investing in manufacturing is even more impressive, with £1 of government spend crowding in £5 of private sector money.

Research & Development channelled through applied research councils, is considered to have the greatest impact on private sector productivity growth.

11.3 Governance

There are seven research councils along with Innovate UK and Research England, who report to the UK Research and Innovation Body (UKRI) and ultimately to the UK Governments 'Department for Business, Energy and Industrial Strategy (BEIS) – see *Figure 48*.

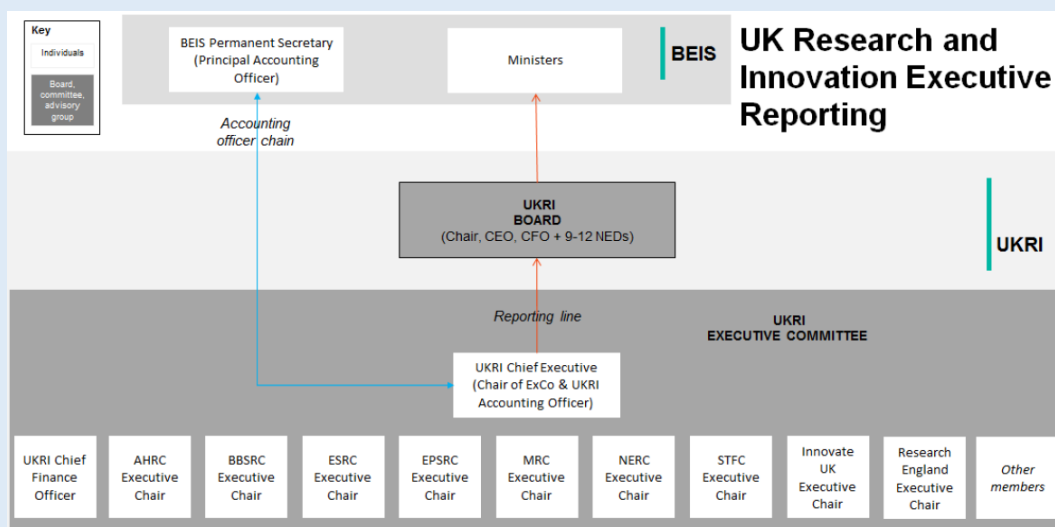


Figure 48 – Reporting structure between BEIS, UKRI and the Research Councils

The Engineering and Physical Sciences Research Council (EPSRC) is the research council responsible for funding university-based research in engineering and the physical sciences.

Innovate UK is the research council that is responsible for working with companies and partner organisations to find and drive the science and technology innovations that will grow the UK economy. EPSRC and Innovate UK are two distinct but complimentary organisations who have a unique and comprehensive understanding of the R&D landscape. For technology-based engineering businesses who struggle to find the right academic or commercial partner, EPSRC and Innovate UK tailor support packages to take the business all the way through the innovation chain – from academic concept to design and prototyping and finally commercialisation.

To support the commercialisation of innovation a coalition government established the ‘Catapults’ with a £200bn investment in 2011. This followed the lead of exemplar technology and innovation organisations such as TNO (Netherlands) and the Fraunhofer Institutes (Germany). The largest catapult created was the High Value Manufacturing (HVM) network of seven centres spanning 27 technologies such as Advanced Assembly, Automation, Biologics, Biotechnology, Digital Manufacturing, Automation and Composites (Figure 49).

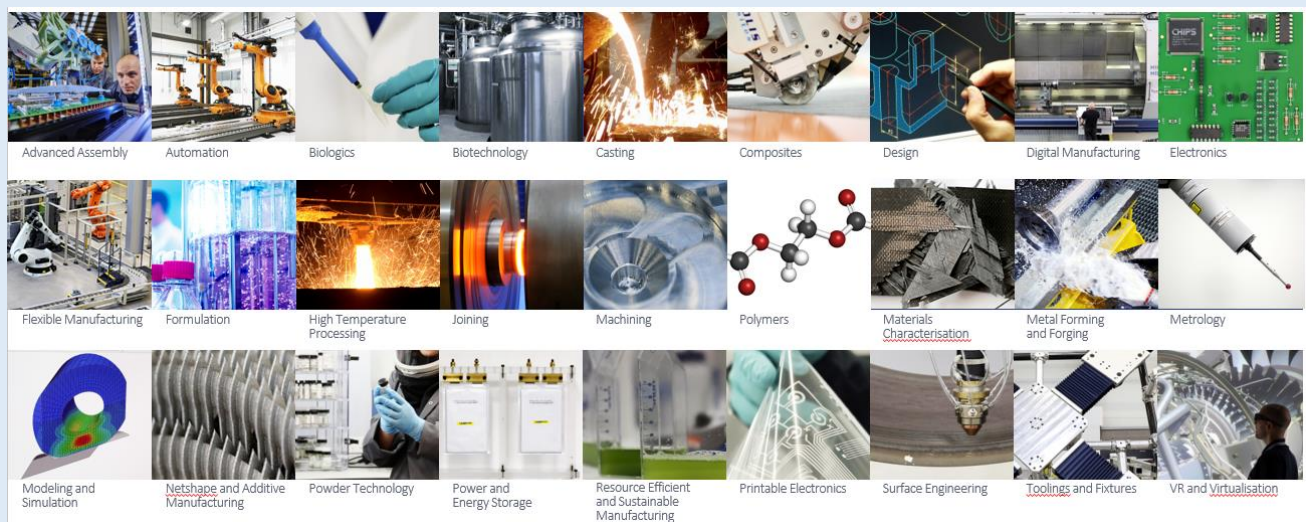


Figure 49 – The 27 Technologies of the HVMC

11.4 Structure

The seven major HVMC centres (Figure 50) are:

- National Manufacturing Institute Scotland (NMIS) – Glasgow
- Centre for Process Innovation (CPI) – Teesside
- Advanced Manufacturing Research (AMRC) – South Yorkshire
- AMRC Nuclear – South Yorkshire
- Manufacturing Technology Centre (MTC) – Midlands
- Warwick Manufacturing Group (WMG) - Midlands
- National Composites Centre (NCC) – Bristol



Figure 50 – High Value Manufacturing Catapult Network

Some of these major centres are University owned or have University governance. For example, AMRC and AMRC Nuclear are departments of the University of Sheffield, Warwick Manufacturing Group

(Warwick University) and NMIS (the University of Strathclyde), whereas NCC, MTC and CPI have University governance but not ownership.

Some of the HVMC centres have satellites i.e., MTC (Liverpool), AMRC Nuclear (Derby), AMRC (North West), AMRC (Cymru) and there are 18 centres in total.

11.5 AMRC Cymru

AMRC Cymru opened in November 2019 and is situated in Bretton (North Wales). It is part of a tri-party legal agreement between the University of Sheffield, Airbus and Welsh Government. A 5000m² facility (Figure 51) was built by the Welsh Government on Airbus land. Airbus (as a tenant) operates in one half of the building, on the Wing Accelerator program – delivering research and development for the next generation wing for single aisle aircraft. AMRC (as a landlord) operates in the other half of the building, supporting the manufacturing sector of Wales with product new design and development and manufacturing intelligence. The legal framework for the relationship between the University of Sheffield, Airbus and the Welsh Government is built into a concession agreement that is reviewed every 5 years. The first review is due in 2025 and the Welsh Government do have the opportunity to terminate the relationship.



Figure 51 – AMRC Site in Bretton (North Wales)

11.6 Funding

The HVMC received £650m between 2018 and 2023. In the Autumn budget, Westminster announced a 35% increase for the following 5 years, taking the annual budget to £180m across the 7 centres.

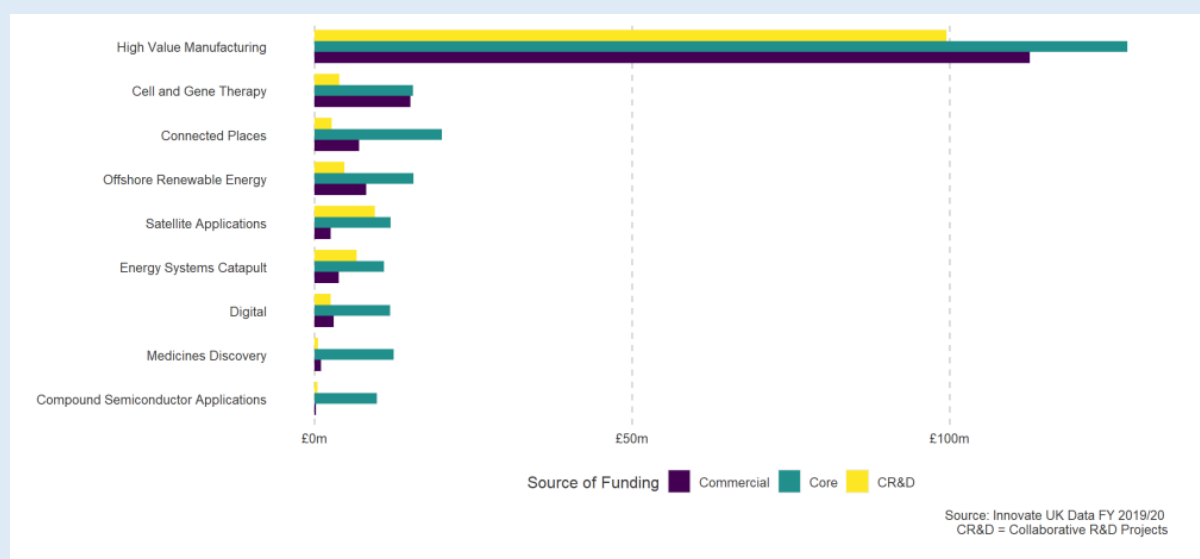


Figure 52 - Catapult revenue budget 2019/20 – source: (BEIS, 2021)

In 2023, the Autumn Statement from Westminster announced a 35% revenue uplift for Catapult centres. Whilst this increase is a strong indication of the value that the UK Government places on manufacturing, it does not appear as though it will be wisely spent. Instead, a significant amount of money is being spent on image, marketing and a duplication of centre resources within the core - rather than manufacturing support.

12. A National Manufacturing Institute for Wales

The manufacturing sector plays a pivotal role in the Welsh economy, contributing a higher percentage to both Gross Value Added (GVA) and employment compared to the broader UK economy. Moreover, productivity levels in Welsh manufacturing are comparable to those across the UK sector.

However, the advent of technology is significantly reshaping the economic landscape, and the UK appears to be lagging. Leading firms that have embraced advanced technologies are gaining a substantial competitive edge due to the tacit knowledge accrued from operating at the technological forefront (Cirera, Comin, & Cruz, Bridging the Technology Divide, 2022).

The UK's engagement with robotics, digital technologies, and investment in future technologies is trailing behind many developed and developing nations (UNIDO, 2021). According to UNIDO, the UK ranks 29th globally in its capacity for manufacturing and exportation, and 35th in technology enhancement and upgrading.

In Wales, the establishment of AMRC/Cymru under the High Value Manufacturing Catapult and the University of Sheffield's Advanced Manufacturing Research Centre is a positive development. However, the initiative currently directs less than 1% of the UK HVMC's annual budget to Wales. The governance by an English university raises concerns about the strategic alignment with Welsh interests, despite the Catapult's intended role as a neutral facilitator among universities, governments, and manufacturing firms for the commercialisation of innovation.

There is growing apprehension that the High Value Manufacturing Catapult is diverging from its mission. No clear strategy has been effectively communicated to its seven centres, and a projected

35% revenue increase (Catapult Network, 2022) over the next five years risks being squandered on unnecessary duplication of roles and a focus on image and marketing at the core. The organisation's key performance indicators lack direct relevance to the economic impact on UK regions and nations.

For Wales to maintain and enhance its competitive edge in manufacturing, it must adopt a distinctive approach. The creation of a dedicated National Manufacturing Institute for Wales is essential. This institute would be a regional asset and should be supported by equitable funding from the UK government through Innovate UK and the HVMC. The current funding model for devolved nations, predominantly based on the Barnett formula (Independent Commission on Funding and Finance for Wales, 2009), should be revised to a needs-based approach, potentially allocating 8% of £135 million annually (£11 million) to reflect the sector's relative importance to Wales.

The geographical concentration of manufacturing businesses in Wales, notably in South East and North East Wales, underscores the strategic necessity of a National Manufacturing Institute in these regions. Proposed centres for the institute include AMRC in Bretton and a new advanced manufacturing centre in Neath Port Talbot for which the local council have capital budget for a building but no revenue for its operation.

Welsh industrial strengths are notably in sectors such as Transportation (Aerospace and Automotive), Food & Drink, Medical/Pharmaceutical, Chemicals/Materials, and Steel/Aluminium, with an emphasis on digitalisation, automation, and cutting-edge technologies. Further analysis is needed to identify leading firms at the productivity frontier, utilising tools such as the Office of National Statistics' 'Productivity Calculator,' detailed further in Appendix F (proposed as a follow-on project).

The remainder of this chapter examines collaborative projects with Airbus, focusing on supply chain enhancements with Granada Cranes and cross-sector knowledge transfer with The Pudding Compartment.

12.1 Flintshire, North Wales - Place-Based Project Examples

Two place-based approaches to supporting the manufacturing sector of Wales are provided in this section (both led by the Author). The examples are not to be judged on the technical content that is presented herein, since the detail is high level and serves only to show how knowledge diffusion and supply chain development around a global ‘superstar’ organisation. In this instance, the place is North East Wales and the global superstar organisation is Airbus. Some of the Airbus impact in Wales is shown in Figure 53.

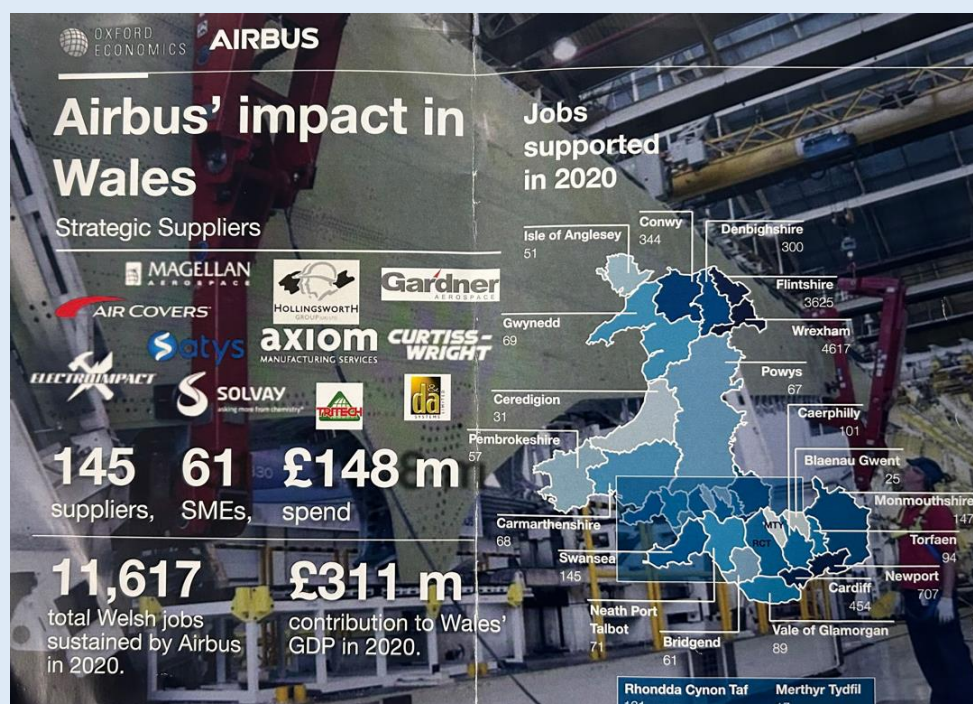


Figure 53 – Airbus Impact in Wales: source Oxford Economics

12.1.1 The Pudding Compartment

The Pudding Compartment (TPC) produces a variety of baked goods, including biscuits and cakes, serving clients such as Avanti Rail, schools, universities, wholesalers, and coffee shops. TPC has 26 employees and reports annual revenues of just over £1 million.

The project was executed by the Advanced Manufacturing Centre of Wales, 'AMRC/Cymru', in collaboration with CAD-IT, EBS Automation Ltd, Siemens, the University of Wales Trinity St David, and the Welsh Government's Innovation and Food & Drink teams. This case study offered a prime example of developing 'best practices in collaboration and technology diffusion. Funded by the Welsh Government, the project aimed at transferring technology and knowledge from the high-tech Aerospace sector to the traditionally lower-tech Food and Drink sector.

The manufacturing operations at TPC are predominantly labour-intensive and feature minimal automation (see *Figure 54* to *Figure 56*). The company primarily uses spreadsheets and manual records to manage manufacturing data and information. TPC has about 20 employees and generates roughly £1 million in turnover. TPC provides baked food products to Avanti Trains and local schools.

The business ambition is to grow turnover to £5m over the next 3 years, investing in industry 4.0 technology and developing the skills of the employees.



Figure 54 – The Pudding Compartment As-Is (1)



Figure 55 – The Pudding Compartment As-Is (2)



Figure 56 – The Pudding Compartment As-Is (3)



Figure 57 – The Pudding Compartment As-Is (4)

Typical activities in the production of 'tray bake' food produce include:

Refrigeration

Mixing

Heating

Decanting

Decorating

Cutting

Packaging

The first step was to produce a process flow for the 'tray bake' product – see *Figure 58*.

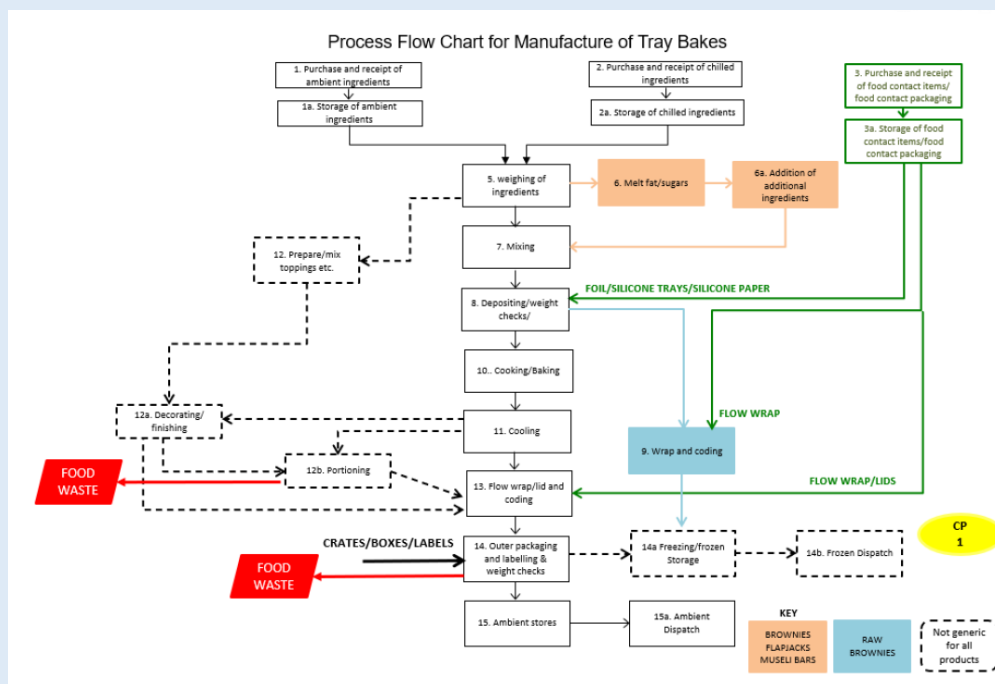


Figure 58 – Process Flow Diagram

The production line at TPC comprised antiquated machinery (mixers, dispensers, manual cutters/guillotines, ovens and flow-wrap machines) and labour-intensive processes.

EBS Automation developed an independent cell containing four robots. The initial robot removes the tray-baked product from a rack, detaches the baked item from the tray, and places it on a conveyor. The second robot then decorates the baked item. A third robot, equipped with an Ultrasonic cutter as an end effector, cuts the baked food into uniformly equal pieces. The final robot arranges these portions on the conveyor leading to the packaging machine, as depicted in – see *Figure 59*.

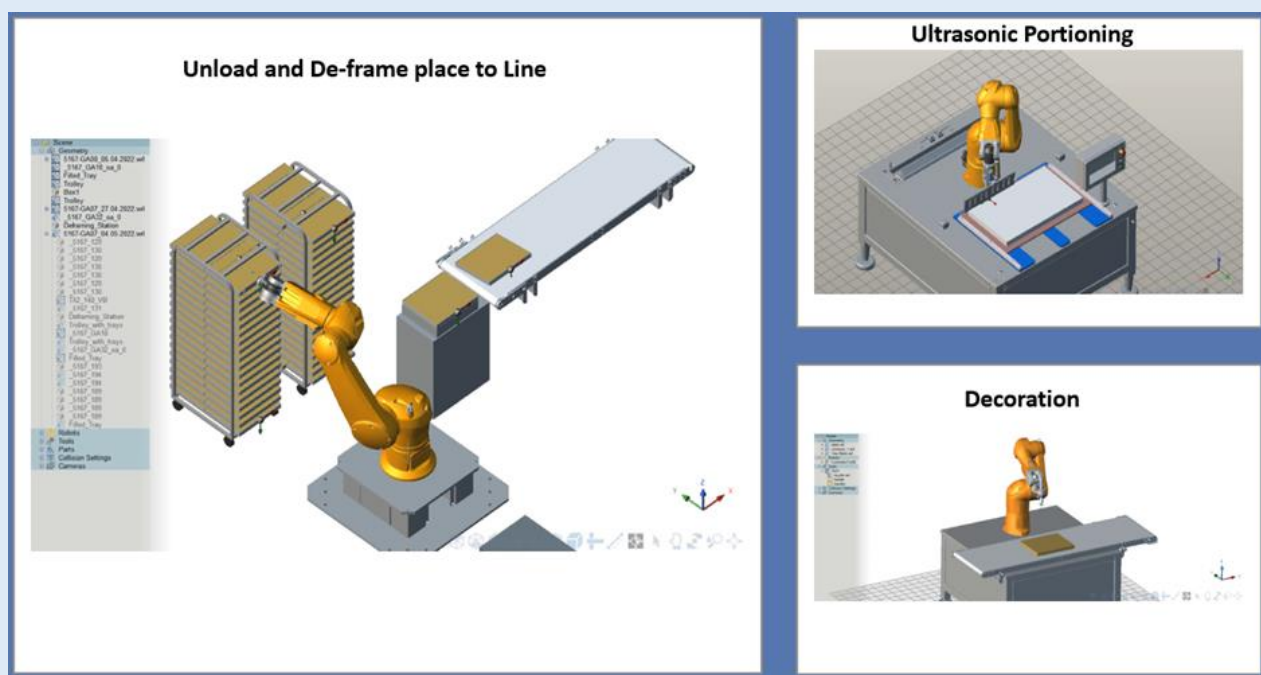


Figure 59 – Robot Cell

The robot cell is completely enclosed with interlocked safety gates – see *Figure 60*

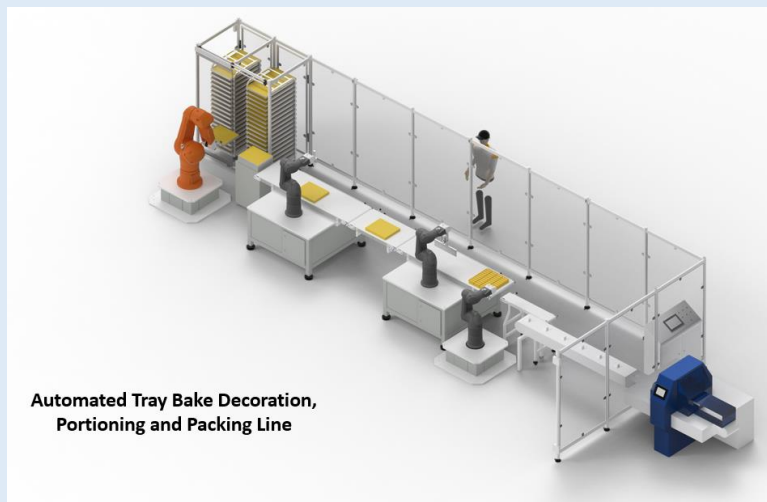


Figure 60 Totally enclosed cell

The robotic cell operates 30% faster than the previous manual process line and only requires one person for supervision, compared to the five operators needed for the manual line. It offers completely repeatable operations and can function continuously without shift breaks. The return on investment was determined using the NPV formula, showing a payback period of two years. Additionally, TPC purchased new equipment, including an Ingredient Dispenser, Mixers, Electric Ovens, etc. (see *Figure 61*), funded by the Welsh Government's Covid Recovery initiative.



Figure 61 – New Equipment

A Data Flow map was produced to look at where IIoT sensors could collect important and useful data for business insights around energy utilisation and overall equipment efficiency – see *Figure 62*).

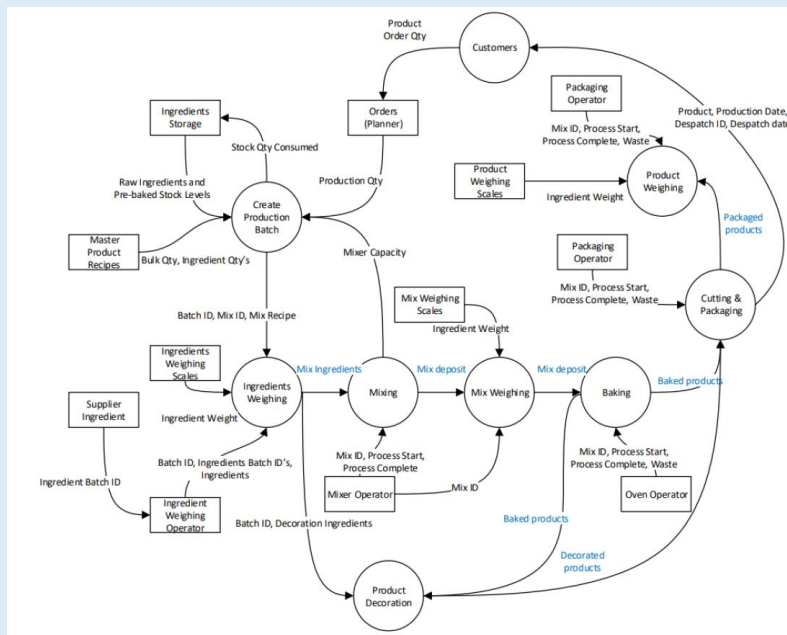


Figure 62 – Data Flow Map

IIoT devices were selected for the fridges, mixers, weighing devices and the robot cell – see Figure 63.

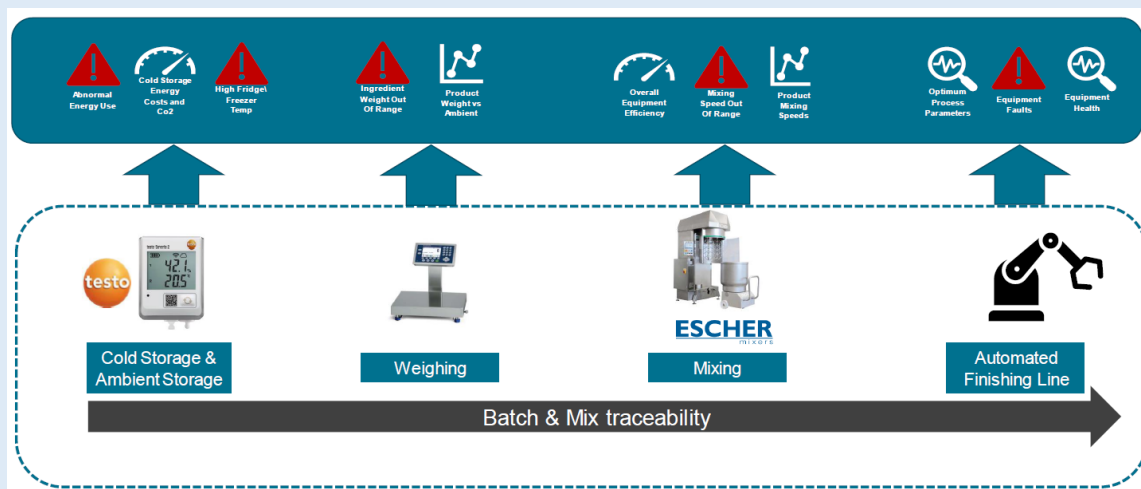


Figure 63 – Different equipment with IIoT fitted

The TPC manufacturing facility was digitally scanned to create a 3D Model – see *Figure 64*. Step files for the individual machinery were obtained from each Original Equipment Manufacturer or from a direct digital scan of the equipment.



Figure 64 – Digital scan of TPC factory

The digital model was transferred into Visual Components software to facilitate the creation of a Virtual Reality model that could be viewed through Microsoft Hololens VR headsets. This proved a powerful tool for allowing management, machine operators and maintenance staff to walk around the facility in the virtual world and examine different equipment layout scenarios.



Figure 65 – 3D Virtual Reality model

12.1.2 Granada Cranes

Granada Cranes (Granada) design and manufacture material handling equipment for the Aerospace sector (Airbus) and the renewable energy sector (fixed and floating offshore wind turbines). Granada have a turnover of approximately £30m and employ 129 people (an increase of 30% over the last 2 years) at their headquarter on the Aerospace Park in Broughton (North Wales)

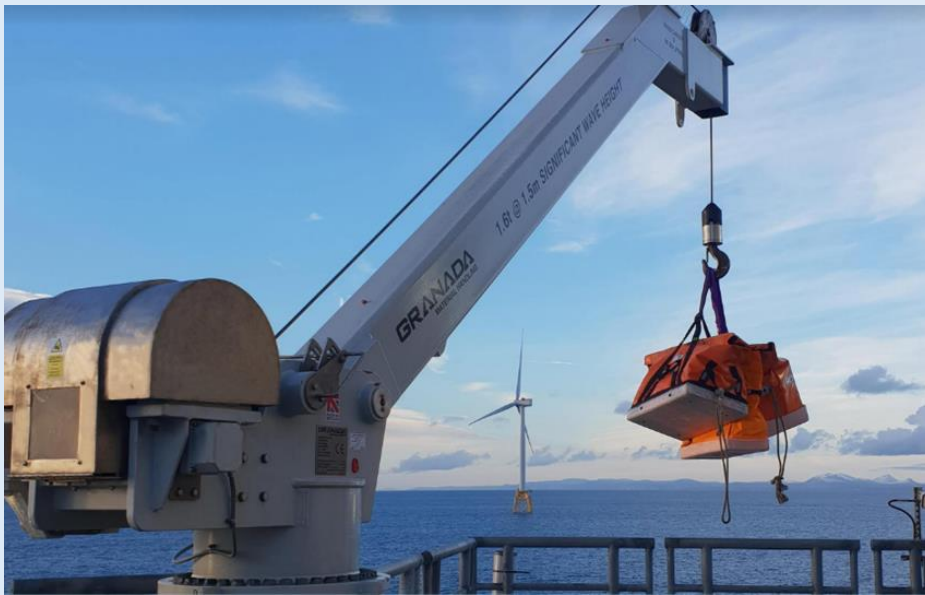


Figure 66 – A Granada Davit of a fixed offshore wind turbine.

Granada approached AMRC/Cymru to look at a new design of Davit to replace their existing product (Figure 66). A new international standard for the design of offshore davits (BSEN 13852) had recently been released and Granada saw this as an opportunity to start afresh with a product that had been developed through incremental innovation over time.

Together, AMRC and Granada started some conceptual development work and Dr James Alum generated some creative designs by looking at nature and architecture for inspiration (Figure 67)

Concept Sketches

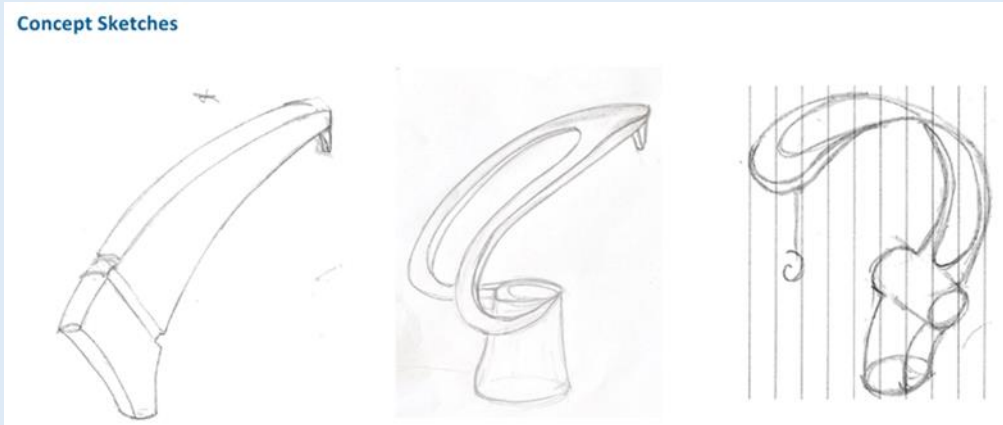


Figure 67 – Concept sketches for a new Davit

After lengthy discussions between Granada and AMRC/Cymru, concerning the practicality of fabricating many of these shapes, the Davit below was designed.

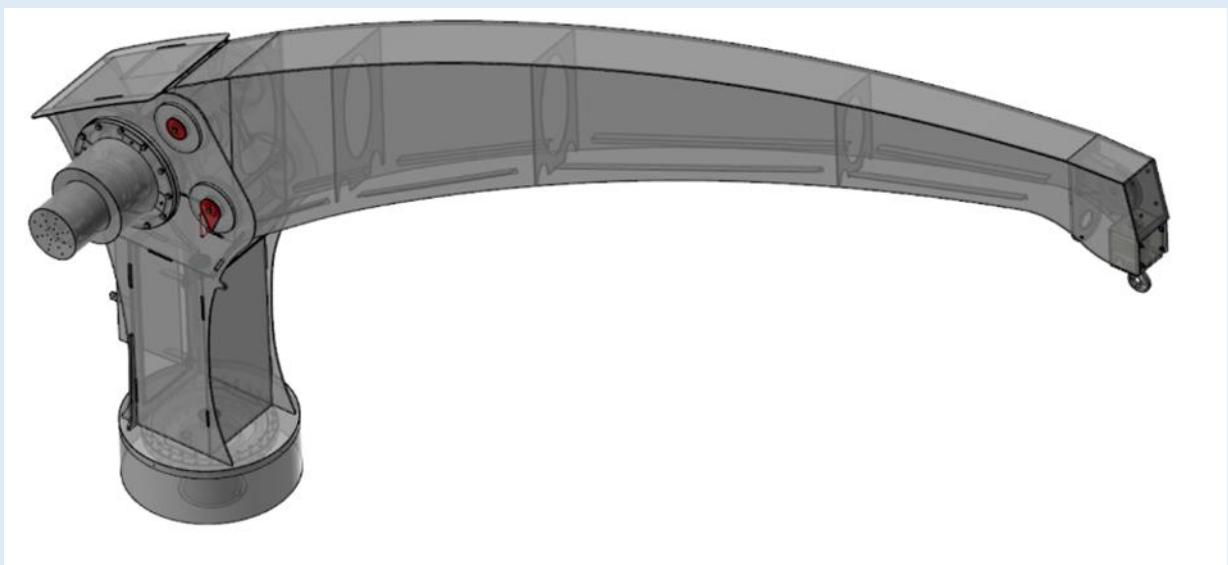


Figure 68 – The Selected Davit Design

The design involved a comprehensive analysis of the load cases and load combinations in accordance with the new BE EN 13582 standard (using Limit State Design) to represent the in-service and out-of-service conditions that the real Davit could experience on a wind turbine at sea that is raising goods from a supply boat (Table 1).

	Ref. 13001-2: 2014	Ref. 13852- 3:2021	yp	A3		yp	B3		yp	C1	C2	C3	C5	C6	C7	C12
Mass of the crane	4.2.2.1 4.3.3 4.3.4	-	1.22	1.10		1.16	1.10		1.10	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mass of the hoist load	4.2.2.2	B.1	1.3400	1.46		1.22	1.46		1.10		1.00	1.00	1.00	1.38	1.25	-0.30
Accelerations from drives	Holisting movements excluded			1.20		1.22	1.20		1.10					1.20		
	All movements	4.2.2.5	-	1.34		1.22			1.10							
Offlead and sidelead	-	B.2	1.34	1.46		1.22	1.46		1.10		1.00	1.00	1.00	1.00	1.25	
Displacements	4.2.2.6	-	1.22	1.00		1.05	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Installation inclination loads	-	C.5	1.34	1.00		1.22	1.00		1.10	1.00	1.00	1.00	1.00	1.00		1.00
Installation acceleration loads, acting on the hoist load	4.2.4.11	C.5	1.22			1.16			1.10		1.00	1.00	1.00	1.00		1.00
Installation acceleration loads, acting on the mass of the crane	4.2.4.11	C.5	1.22	1.00		1.16	1.00		1.10	1.00	1.00	1.00	1.00	1.00		1.00
In-service wind loads acting on hoist load	4.2.3.1	C.4				1.16			1.10		1.00	1.00	1.00	1.00		1.00
In-service wind loads acting on crane structure	4.2.3.1	C.4				1.16	1.00		1.10		1.00	1.00	1.00	1.00		1.00
Loads due to out-of- service wind	4.2.4.2	C.4							1.10	1.00						
Loads due to buffer contact	4.2.4.4	5.5.2.8							1.10		1.25	-				
Emergency stop	4.2.4.6	5.6.5							1.10			1.20				
Additional loads due to testing	4.2.4.3	6.20							1.10							
AOPS loads	-	5.6.2							1.00				1.00			
Emergency lowering loads	-	5.6.3							1.10					1.00		
Sequence of failure loads	-	D							1.00						1.25	
Crane maintenance	-	5.7.14							1.10							
Ice and Snow	4.2.3.2	C.6							1.10	1.00						
Drive forces due to failure of mechanism	4.2.4.10	-							1.10							

Table 9 – Load case and load combinations to BS EN 13852

A Finite Element Analysis was performed to digitally simulate the induced stresses in the structural components of the davit and its deflection due to the imposed loads (Figure 69).

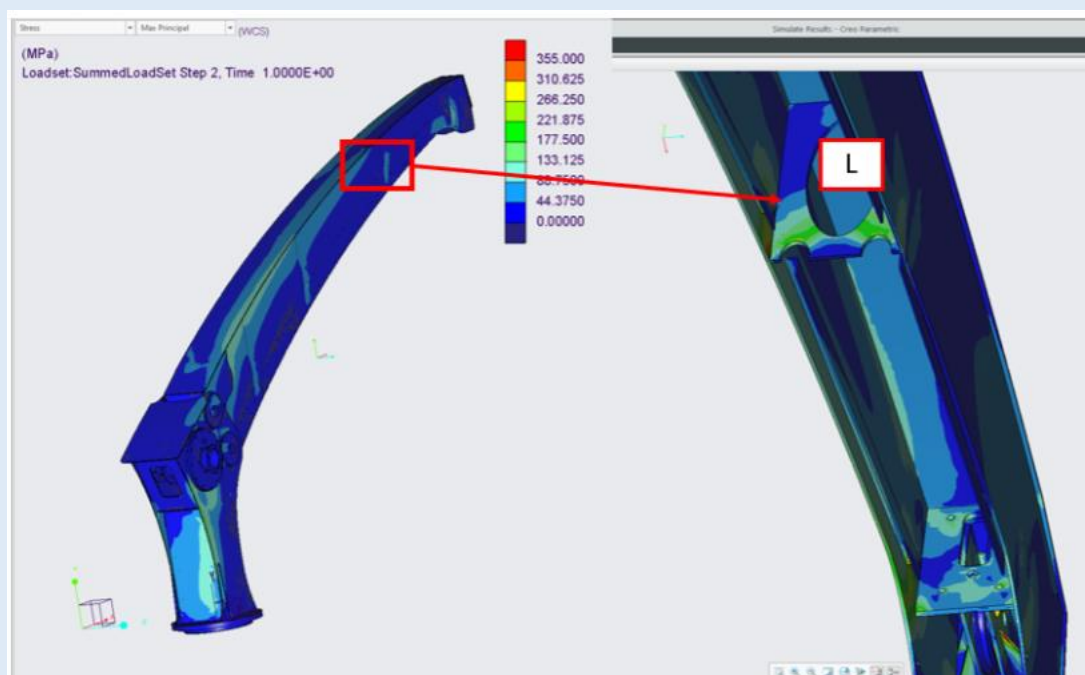


Figure 69 – Finite Element Analysis of the Davit Structure

A prototype davit is currently being manufactured and there are orders already in the pipeline to manufacture 300 off in the next 12 months – representing a turnover contribution to Granada in excess of £20m.

13. Conclusion

Growth of the manufacturing sector in the UK has slowed down more than in many peer countries. Indeed, the sector is considered by many to be uncompetitive. If the manufacturing sector in Wales is to remain relevant in the global market, there must be a radical rethink about how it is supported. Technology is reshaping the performance of firms and economies in a way that is not yet fully understood. A small number of high productivity firms are pulling away from all others and the gap is widening.

A National Manufacturing Institute for Wales that becomes an eighth High Value Manufacturing Catapult, funded by Innovate UK, is a good place to start. The focus for such an institution must be on both regional and national economic impact, such as output (GVA) and productivity (GVA per hour). A logical way to achieve this is through engagement with the high performing businesses (identified in Appendix E) in Wales in the sub-sectors of Transport (Aerospace and Automotive), Life Sciences (Medical and Pharmaceutical), Building Materials, Food and Drink, Chemical, Steel and Aluminium. The technology focus must be digitalization, advanced automation and the investment in next generation technologies.

Policy must support the leading firms in Wales to move (if they are not there already) to the productivity frontier – although where exactly that frontier is must first be determined. Policy must then support the diffusion on knowledge transfer from the tacit knowledge that the leader firms have developed through working at the technology frontier.

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Appendix A – Population of ITL3 Regions in Wales

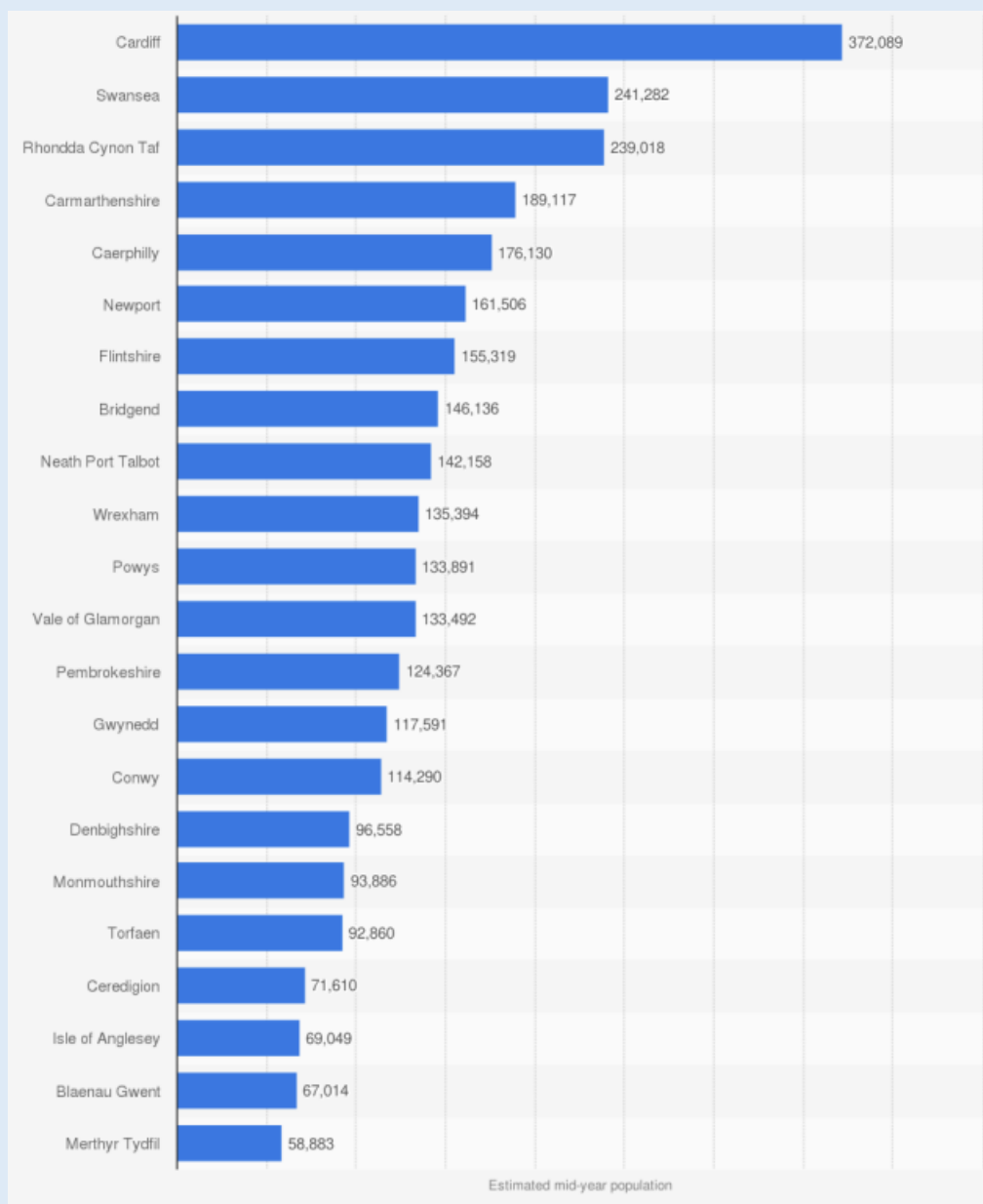


Figure 70 – Population Across Welsh Regions: source (Statistics for Wales, 2020)

Appendix B – GVA per Capita – Wales (2000 to 2021)

Gross value added (balanced) per head of population at current basic prices, pounds [note 1]											
ITL	ITL code	Region name	1998	1999	2000	2001	2002	2003	2004	2005	2006
UK	UK	United Kingdom	15,402	15,968	16,777	17,429	18,061	19,019	19,853	20,870	21,811
ITL1	TLL	Wales	11,254	11,486	11,992	12,359	12,863	13,672	14,357	14,949	15,628
ITL2	TLL1	West Wales and The Valleys	9,891	9,942	10,324	10,628	11,098	11,742	12,464	13,002	13,566
ITL3	TLL11	Isle of Anglesey	8,406	8,455	8,816	9,155	9,463	10,401	11,712	11,857	12,229
ITL3	TLL12	Gwynedd	11,141	11,147	11,468	11,801	12,680	13,674	14,268	15,298	16,316
ITL3	TLL13	Conwy and Denbighshire	9,191	9,285	9,594	9,951	10,596	11,226	11,832	12,328	12,808
ITL3	TLL14	South West Wales	10,028	9,859	10,077	10,646	10,984	11,733	12,930	13,063	13,310
ITL3	TLL15	Central Valleys	8,769	8,917	9,258	9,427	10,062	10,538	11,023	11,718	12,394
ITL3	TLL16	Gwent Valleys	8,863	8,871	9,328	9,454	9,785	10,289	10,772	11,270	11,744
ITL3	TLL17	Bridgend and Neath Port Talbot	11,246	11,409	11,971	11,806	12,141	12,622	12,960	13,544	14,405
ITL3	TLL18	Swansea	11,451	11,663	12,147	12,947	13,438	14,238	15,275	16,163	16,771
ITL2	TLL2	East Wales	13,669	14,214	14,925	15,400	15,959	17,060	17,675	18,349	19,221
ITL3	TLL21	Monmouthshire and Newport	13,473	14,134	15,066	15,377	15,822	16,977	17,799	18,376	19,207
ITL3	TLL22	Cardiff and Vale of Glamorgan	14,609	15,563	16,239	16,967	17,873	19,149	19,609	20,509	21,479
ITL3	TLL23	Flintshire and Wrexham	14,037	13,995	14,648	14,862	15,067	15,914	16,667	17,337	18,336
ITL3	TLL24	Powys	10,015	10,231	10,794	11,302	11,641	12,621	13,071	13,108	13,426

Table 10 – GVA per Capita for Welsh Regions 98-06: source ONS

Gross value added (balanced) per head of population at current basic prices, pounds [note 1]											
ITL	ITL code	Region name	2007	2008	2009	2010	2011	2012	2013	2014	2015
UK	UK	United Kingdom	22,690	23,343	22,699	23,149	23,480	24,035	24,815	25,714	26,316
ITL1	TLL	Wales	16,117	16,157	15,942	16,323	16,839	17,294	17,868	18,267	18,855
ITL2	TLL1	West Wales and The Valleys	13,899	14,117	13,786	14,209	14,609	14,907	15,574	16,026	16,473
ITL3	TLL11	Isle of Anglesey	12,263	12,320	11,448	11,331	12,002	12,277	12,348	12,361	13,100
ITL3	TLL12	Gwynedd	16,614	16,847	16,271	16,002	16,612	17,122	18,060	17,900	18,155
ITL3	TLL13	Conwy and Denbighshire	12,927	13,084	12,635	13,058	13,528	13,603	14,473	14,912	15,342
ITL3	TLL14	South West Wales	13,967	14,040	13,248	13,608	13,819	14,333	15,245	15,386	16,990
ITL3	TLL15	Central Valleys	12,682	13,105	13,572	14,411	14,838	15,168	15,651	16,141	15,999
ITL3	TLL16	Gwent Valleys	11,822	11,843	11,598	11,986	12,587	12,758	13,289	13,460	13,887
ITL3	TLL17	Bridgend and Neath Port Talbot	14,718	15,017	14,352	15,449	15,625	15,848	16,626	17,281	17,482
ITL3	TLL18	Swansea	17,309	17,777	17,842	17,587	17,973	18,244	18,667	20,166	19,810
ITL2	TLL2	East Wales	19,973	19,687	19,654	19,952	20,655	21,371	21,775	22,077	22,901
ITL3	TLL21	Monmouthshire and Newport	19,844	19,322	18,845	19,300	19,724	20,121	20,016	20,294	21,215
ITL3	TLL22	Cardiff and Vale of Glamorgan	22,579	22,095	22,361	22,137	22,623	23,602	23,946	24,516	25,259
ITL3	TLL23	Flintshire and Wrexham	18,758	19,058	18,880	19,881	21,290	21,972	22,826	22,555	23,470
ITL3	TLL24	Powys	13,850	13,362	13,305	13,569	13,959	14,325	14,810	15,385	16,096

Table 11 - GVA per Capita for Welsh Regions 07-15: source ONS

Gross value added (balanced) per head of population at current basic prices, pounds [note 1]								
ITL	ITL code	Region name	2016	2017	2018	2019	2020	2021
UK	UK	United Kingdom	27,147	28,169	28,982	29,944	28,377	30,443
ITL1	TLL	Wales	19,541	20,132	20,763	21,553	20,392	22,380
ITL2	TLL1	West Wales and The Valleys	16,987	17,552	18,039	18,807	17,645	19,585
ITL3	TLL11	Isle of Anglesey	14,013	14,405	15,304	16,278	13,807	15,012
ITL3	TLL12	Gwynedd	18,117	18,918	19,153	19,825	17,697	20,951
ITL3	TLL13	Conwy and Denbighshire	15,975	16,878	17,243	17,509	16,780	17,758
ITL3	TLL14	South West Wales	17,322	17,659	17,785	18,887	17,801	21,218
ITL3	TLL15	Central Valleys	16,789	17,098	17,334	17,623	17,311	18,640
ITL3	TLL16	Gwent Valleys	14,335	14,912	15,551	16,222	15,067	16,720
ITL3	TLL17	Bridgend and Neath Port Talbot	17,775	18,424	19,055	20,424	18,789	20,297
ITL3	TLL18	Swansea	20,646	21,394	22,486	23,158	21,901	23,591
ITL2	TLL2	East Wales	23,869	24,493	25,358	26,181	25,011	27,013
ITL3	TLL21	Monmouthshire and Newport	22,359	22,855	24,532	24,994	23,303	24,597
ITL3	TLL22	Cardiff and Vale of Glamorgan	26,429	27,150	27,570	28,725	27,506	29,724
ITL3	TLL23	Flintshire and Wrexham	24,148	25,015	26,036	26,864	25,973	28,993
ITL3	TLL24	Powys	16,550	16,487	17,116	17,295	16,662	17,296

Table 12 - GVA per Capita for Welsh Regions 16-21: source ONS

Appendix C – Large Manufacturing Businesses in Wales Top 300 of Indigenous Firms

Business	T/O (£M)	Industry	Location	Employees	Profit / Loss (£M)
GE Aircraft Engine Services	£2,378	Provide & Overhaul aircraft engines	Cardiff	1138	£138 (6%)
Calsonic Kansei Europe	£733	Automotive Parts	Llanelli	2237	£30 (4%)
Dow Silicones	£506	Inorganic basic chemicals	Barry	576	£8 (2%)
Celsa (UK Holdings Ltd)	£480	Iron & Steel Alloys	Cardiff	1249	£6 (1%)
The Royal Mint Ltd	£416	Striking of coins	Pontyclun	877	£2 (1%)
Wynnstay Group PLC	£368	Feeds for farm animals	Llansantffraid	1066	
Kronospan Holdings Ltd	£361	Wood based panels	Wrexham	902	£9 (2%)
Kingspan Ltd	£351	Panels & Facades	Holywell	886	£40 (11%)
Finsbury Food Group plc	£314	Bread & Fresh Pastry	Cardiff	3162	
International Greetings Ltd	£328	Gift Packaging	Ystrad Mynach	1954	£20 (6%)
Ipsen Biopharm Ltd	£268	Basic Pharmaceutical Products	Wrexham	475	£53 (20%)
GS Yuasa Battery Europe Ltd	£246	Batteries	Ebbw Vale	528	£11 (4%)
Ortho-Clinical Diagnostics	£246	Basic Pharmaceutical Products	Bridgend	418	£55 (22%)
Panasonic Manufacturing UK Ltd	£236	Home appliances, mobile devices	Cardiff	428	£9 (4%)
Nice-Pak International Ltd	£230	Wet Wipes	Flint	932	£5 (2%)
Liberty Steel Newport Ltd	£214	Steel & Aluminium	Newport	153	£10 (5%)
SPTS Technologies Group Ltd	£222	Electronics Etch & Deposition	Newport	478	£70 (34%)
Zodiak Seats (UK) Ltd	£201	Premium Aircraft Seating	Cwmbran	2060	(-£64) (-32%)
Convatec Ltd	£167	Medical & Dental Instruments	Deeside	844	£43 (26%)
Plastipak	£159	Plastic packaging	Wrexham	321	£2 (1%)
IQE PLC	£154	Semi-conductors	Cardiff	591	£15 (10%)
S.A Brain & Company	£135	Brewery	Cardiff	2437	
Intertissue Ltd	£132	Paper tissue & Paperboard	Neath	411	£2 (1%)
Notemachine UK Ltd	£128	Specialist Purpose Machinery	Crickhowell	298	£20 (16%)
Alcoa Manufacturing	£125	Aluminium	Swansea		
Cequent UK	£120	Vehicle Towing Accessories	Deeside		£6 (5%)
Hexion UK Ltd	£120	Inorganic basic chemicals	Penarth	154	£5 (4%)

<u>Meritor Heavy Vehicle Braking Systems</u>	£120	Heavy Vehicle Braking Systems	Cwmbran	429	(-£5) (-4%)
<u>WEPA Ltd</u>	£120	Household & Sanitary Goods	Maesteg	260	£12 (10%)
<u>Newport Wafer Fab Ltd</u>	£117	Advanced Semi-conductor processing	Newport	391	£15 (13%)
<u>Nidec Industrial Automation UK</u>	£115	Inverter Drives & Motors	Newtown	394	£6 (5%)
<u>Premier Forest Group</u>	£115	Wood, construction, sanitary materials	Newport	300	
<u>Rockwool Ltd</u>	£113	Insulation materials	Bridgend	392	£3 (3%)
<u>Solutia UK Ltd</u>	£101	Organic basic chemicals	Newport	197	£1 (1%)
<u>Biomet UK</u>	£90	Medical and Dental Instruments	Bridgend	564	£6 (7%)
<u>Wockhardt</u>	£90	Pharmaceutical Products	Wrexham	69	£2 (2%)
<u>Seda UK Ltd</u>	88	Food packaging	Blackwood	292	£13 (14%)
<u>Qioptic Ltd</u>	85	Optics & Photonics	St Asaph	584	£13 (15%)
<u>PCI Penn UK Holco Ltd</u>	82	Basic Pharmaceutical Products	Cardiff	734	
<u>Enersys Ltd</u>	81	Batteries and Accumulators	Newport	470	£ -
<u>Bisley Office Equipment Ltd</u>	81	Office & Shop Furniture	Newport	790	£ -
<u>Harris Pye Engineering Group Ltd</u>	73	Marine and offshore structure upgrades	Cowbridge	636	£-8 (-11%)
<u>Brother Industries (UK)Ltd</u>	73	Office Machinery & Equipment	Wrexham	164	£2 (3%)
<u>Mabey Bridge Ltd</u>	73	Bridge Building	Cardiff		
<u>Monument Chemicals UK Ltd</u>	71	Inorganic basic chemicals	Cardiff	102	
<u>Hydro Aluminium Deeside Ltd</u>	67	Aluminium Production	Deeside	46	£2 (3%)
<u>Norgine Ltd</u>	72	Pharmaceutical Products	Hengoed	572	£4 (6%)
<u>Abingdon Flooring Ltd</u>	65	Carpets & Rugs	Blackwood	386	£4 (6%)
<u>Cytec Engineered Materials Ltd</u>	58	Advanced materials, speciality chemicals	Wrexham	233	£8 (14%)
<u>Ledwood Holdings Ltd</u>	64	Heavy Engineering	Pembroke	358	
<u>Northwood Hygiene Products Ltd</u>	63	Household & Sanitary Goods	Penygroes	411	
<u>Sogefi Filtration Ltd</u>	59	Suspension, cooling and filtration (automotive)	Tredegar	322	£4 (8%)
<u>BBi Diagnostics Group</u>	59	Medical diagnostics	Cardiff	516	(-£10) (-18%)
<u>Catalent Cts (Edinburgh) Ltd</u>	55	Pharmaceutical preparations	Deeside	250	

<u>A.Schulman Inc. Ltd</u>	54	Thermoplastics and composites	Blackwood	108	£3 (6%)
<u>Morris Mclellan</u>	53	Industrial electrical services & components	Bridgend	285	£1 (3%)
<u>Freudenberg Oil & Gas Technologies</u>	53	Sealing Technologies	Port Talbot	213	£11 (21%)

Table 13 – List of Large Indigenous Manufacturing/Engineering Companies in Wales

North Wales	
South Wales	

It is noticeable how the majority of large indigenous businesses are concentrated in South Wales.

Large businesses employ approximately 40% of the workforce in the production sector.

Appendix D – Large Manufacturing Businesses in Wales Top 300 of Indigenous Firms

Business	T/O (£M)	Industry	Location	Employees	Profit / Loss (£M)
<u>Quinn Radiators Ltd</u>	45	Domestic Radiators	Newport	267	
<u>Showa UK (Nissan)</u>	45	Automotive parts	Aberdare	76	
<u>Headland Agrochemicals Ltd</u>	44	Pesticides and Agrochemicals	Deeside	88	
<u>Airborne Systems Ltds</u>	43	Airdrop systems by parachute	Bridgend	342	
<u>O.P. Chocolate Ltd</u>	43	Chocolate Wafers and Bars	Merthyr Tydfil	416	
<u>SEI Interconnect Ltd</u>	43	Electronic and Electric Wires	Swansea	80	
<u>Zeon Chemicals</u>	42	Rubber, Latex, Polymers	Cardiff		
<u>Gyrus Medical Ltd (now Olympus)</u>	41	Medical & Dental Instruments	Cardiff	205	
<u>Protherics UK Ltd</u>	41	Interventional medicine	Llandysul	110	
<u>TT Electronics Ltd</u>	40	Electronic Components	Newport	273	
<u>Lawrence Automotive Interiors (VMC) Ltd</u>	39	Automotive Trim	Abergavenny	464	(-£3) (-2%)
<u>Henrob Ltd (Atlas Copco)</u>	38	Fasteners and screw machine parts	Deeside	210	
<u>Reflexallen (UK) Ltd</u>	37	Motor electronics and other	Rhyl	171	
<u>Klockner Pentaplast Ltd</u>	36	Plastic packaging	Crumlin	128	
<u>Continental Teves</u>	36	Automotive solutions (Continental)	Ebbw Vale	102	
<u>IG Doors Ltd</u>	36	Steel & GRP doors	Cwmbran	239	
<u>Euroclad</u>	35	Metal roof & wall cladding	Cardiff		
<u>Coveris Advanced Coatings</u>	35	Specialist coatings	Wrexham	133	
<u>Mollertech Ltd</u>	34	Automotive plastic parts	Newport	270	
<u>Capital Coated Steel Ltd</u>	34	Pre-finished steel	Newport	100	
<u>Mitsui Components Europe Ltd</u>	34	Automotive Door Locks	Ammanford	109	
<u>Radnor Hills Mineral Water Co Ltd</u>	34	Bottles Water	Knighton	126	
<u>Ensinger Group</u>	33	Plastic solutions	Tonyrefail	319	

<u>Fillcare Ltd</u>	32	Cosmetics and Pharmaceutical	Pontyclun	158	
<u>Pd Edenhall Ltd</u>	32	Brick and concrete	Newport	242	
<u>Deeside Cereals Ltd</u>	32	Breakfast Cereals	Deeside	129	
<u>C D T Sidoli</u>	32	Ice Cream	Welshpool	355	
<u>Castalum Ltd</u>	31	Aluminium Die-casting	Welshpool	216	
<u>Altrad NSG</u>	31	Scaffold access solutions	Deeside	433	
<u>Braces Bakery</u>	30	Bread and Pastry	Blackwood	285	
<u>Talis-Uk</u>	30	Water valves and fittings	Bridgend		
<u>TriTech Group</u>	30	Investment castings	Wrexham	414	
<u>Stately-Albion Ltd</u>	30	Park Homes	Newport	236	
<u>Electroimpact (UK) Ltd</u>	29	Aircraft wing automated assembly	Deeside	129	
<u>Amerex Ltd</u>	29	Iron, steel and Ferro-alloys	Llandudno	32	
<u>Sandvik Osprey Ltd</u>	29	Metal products	Neath	141	
<u>Real Alloy Ltd</u>	28	Aluminium recycling and alloy production	Swansea	48	
<u>Blackwood Engineering Ltd</u>	28	Castings and counterweights	Aberbeeg	74	
<u>JTEKT Automotive</u>	28	Power Steering and Axle Components	Neath		
<u>TRB Ltd</u>	28	Automotive switches	St Asaph		
<u>Eftec Ltd</u>	28	Automotive painting	Aberdare	34	
<u>Bemis Swansea</u>	28	Plastic packaging for food	Swansea	227	
<u>Glatfelter Caerphilly</u>	27	High Quality paper	Caerphilly	101	
<u>P B Gelatins UK Ltd</u>	27	Animal bi-product processing	Pontypridd	70	
<u>Wall Colmonoy</u>	27	Surfacing Alloys	Pontardawe		
<u>Pelican Healthcare</u>	27	Medical Instruments	Cardiff		
<u>Volcke Aerosol Connection</u>	27	Aerosol connections	Cardiff	125	
<u>Ksr Electronics</u>	26	Automotive electronics	Swansea		
<u>F Bender</u>	25	Paper Cups	Wrexham		
<u>Lenstec</u>	25	Eyewear	Caerphilly		
<u>Parker Knoll</u>	24	Furniture (sofas)	Cardiff		
<u>Bergstrom (Europe)</u>	23	Automotive climate systems	Ystrad Mynach		
<u>Pure Wafer PLC</u>	22	Silicone Wafers	Bridgend		
<u>Eriez Investments</u>	22	Magnetic separators	Caerphilly		

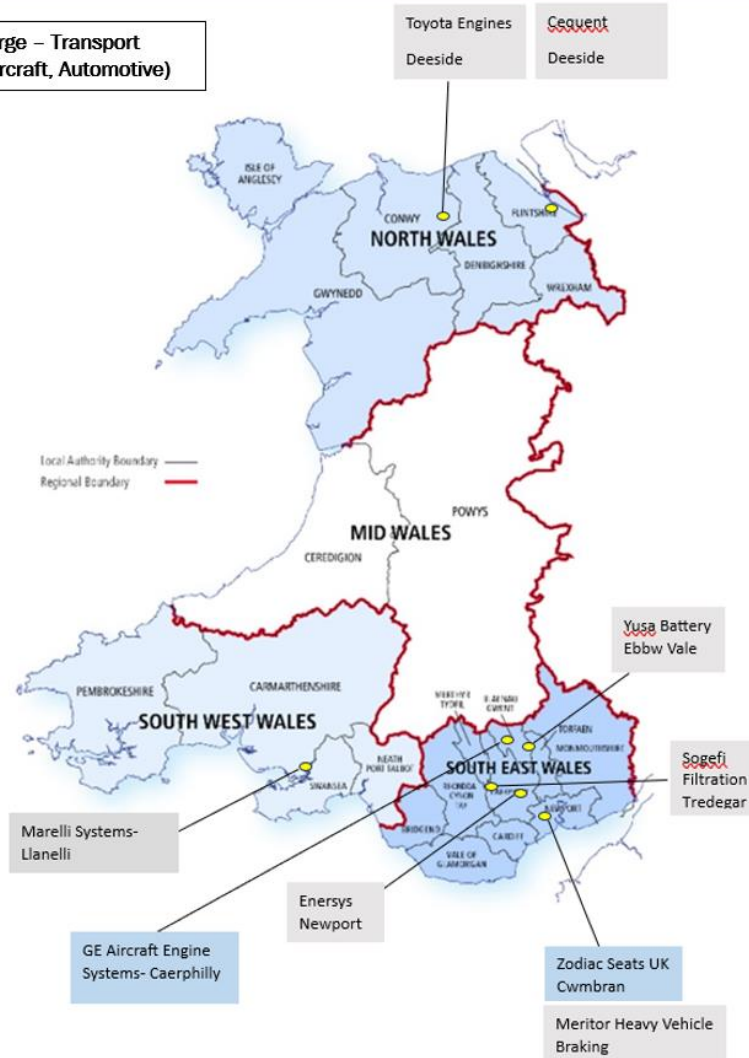
Table 14 – List of SME Indigenous Manufacturing/Engineering Companies in Wales (£50m < t/o > £20m)

North Wales	
South Wales	

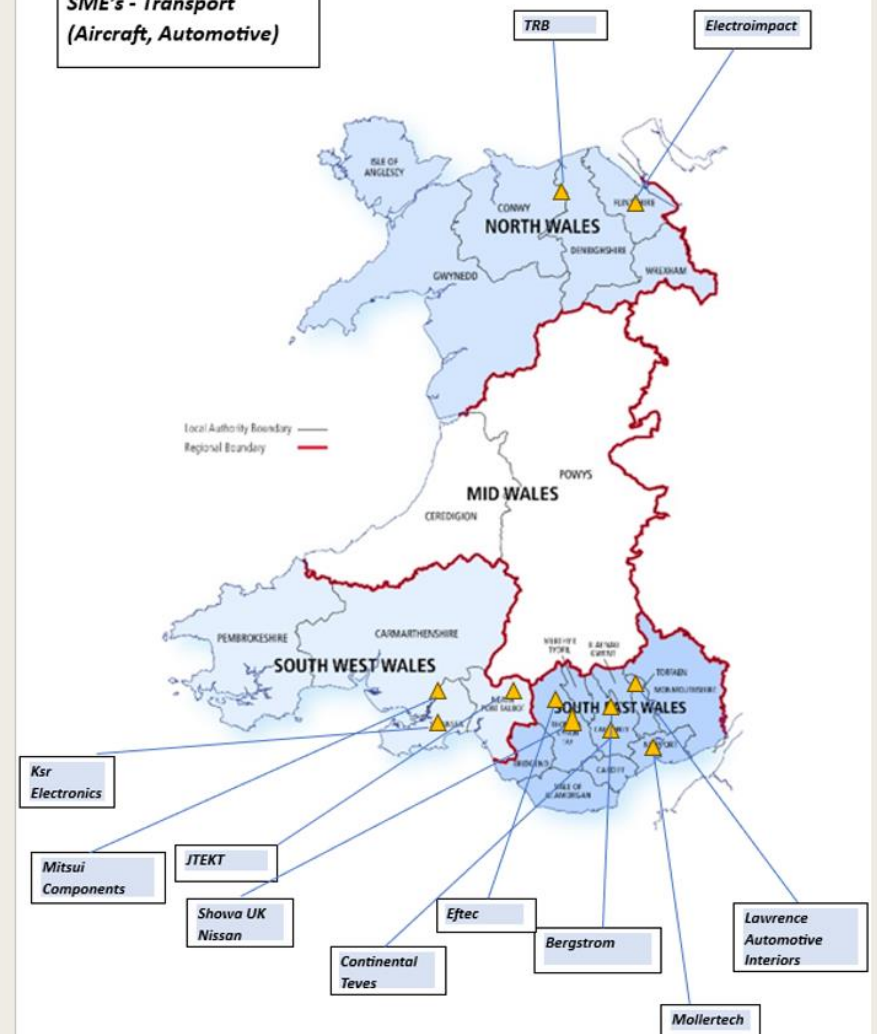
Again, it is noticeable how the majority of the above SME's are concentrated in South Wales.

Appendix E – Manufacturing Sub-Sector and Region Split (Wales top 300)

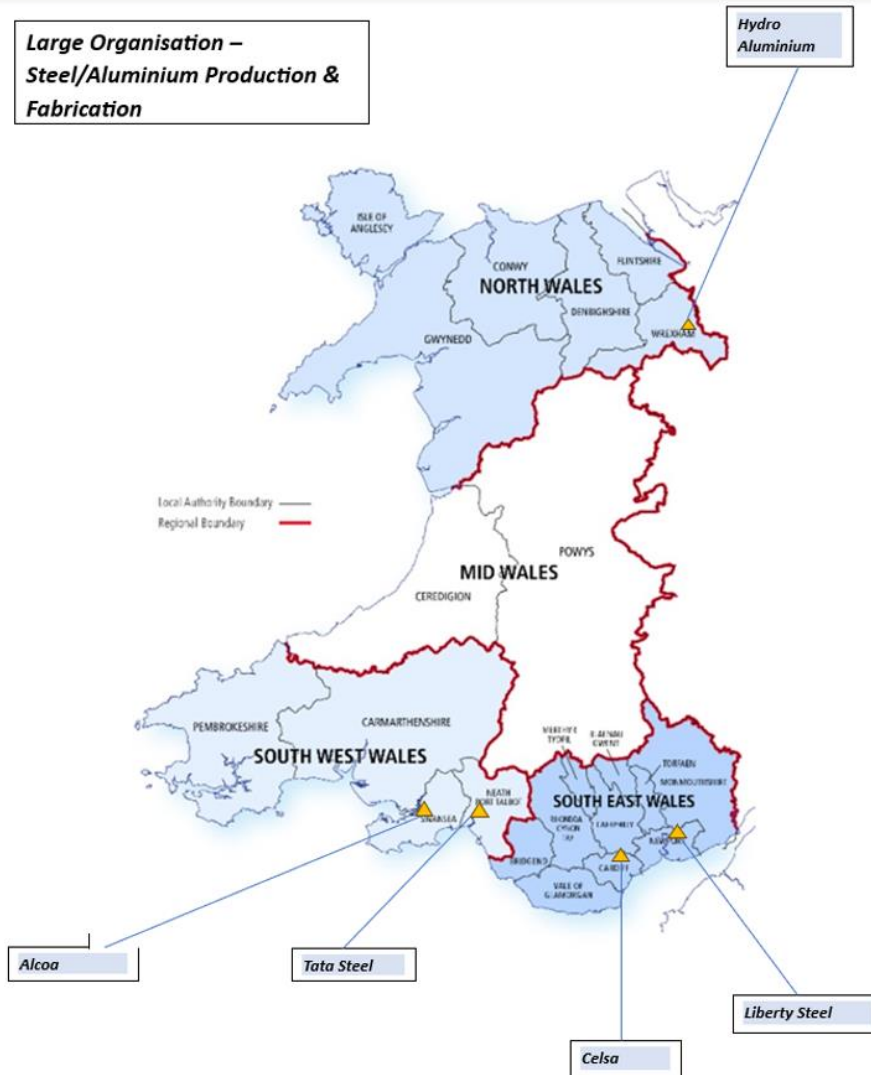
Large – Transport (Aircraft, Automotive)



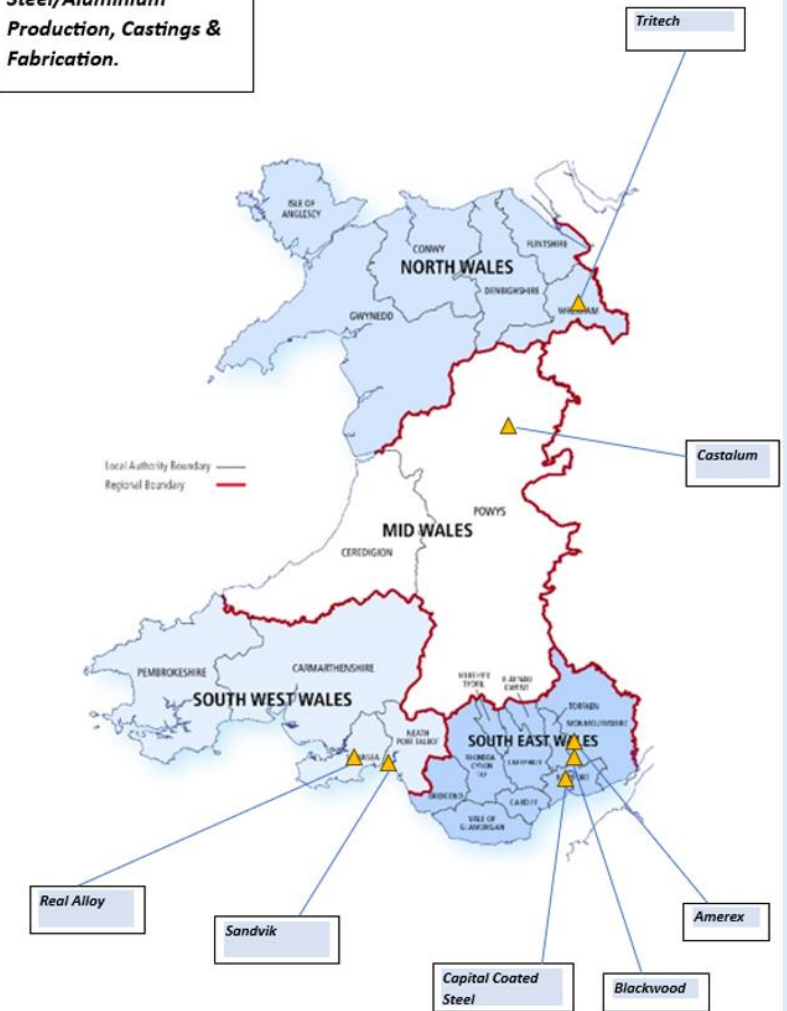
SME's - Transport (Aircraft, Automotive)



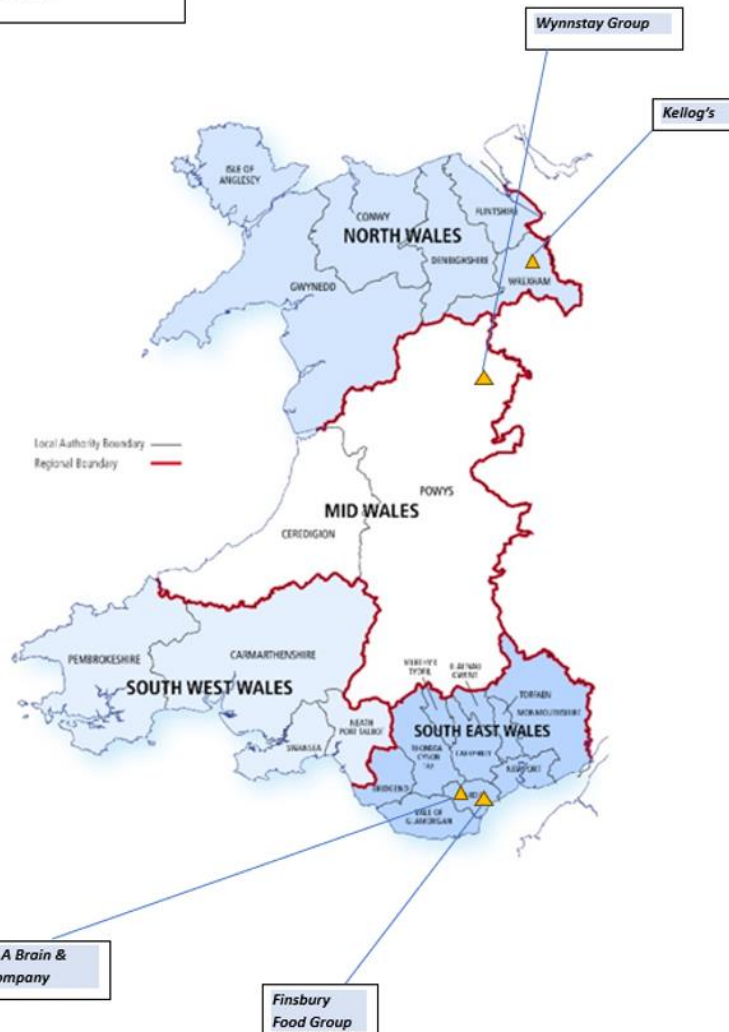
**Large Organisation –
Steel/Aluminium Production &
Fabrication**



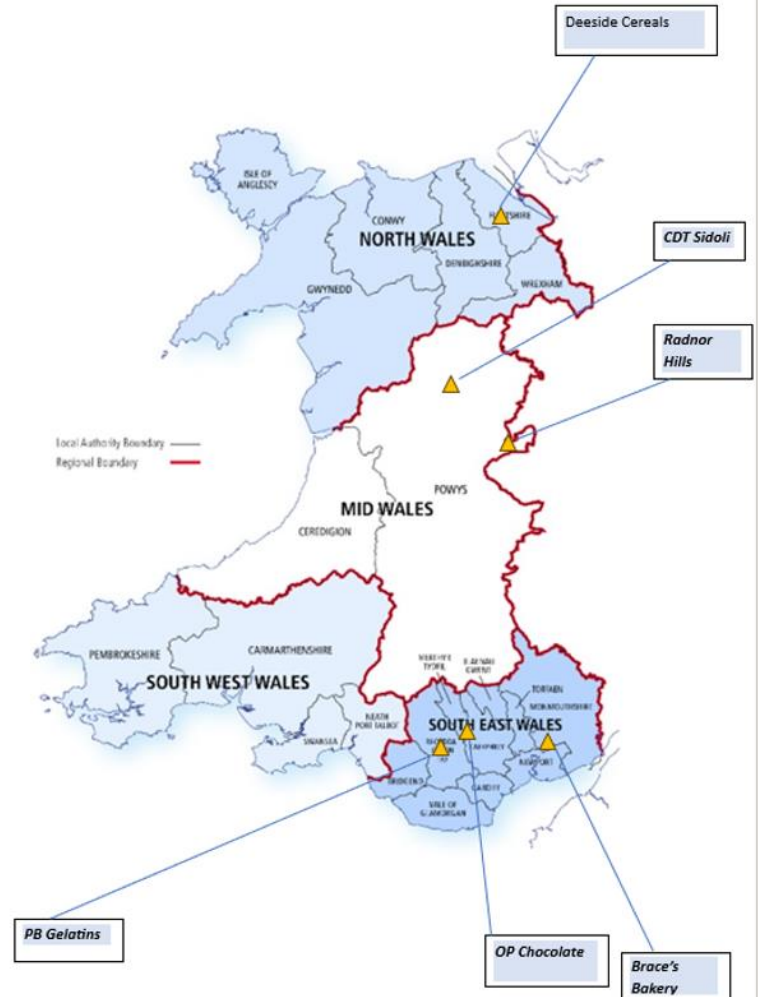
**SME's –
Steel/Aluminium
Production, Castings &
Fabrication.**



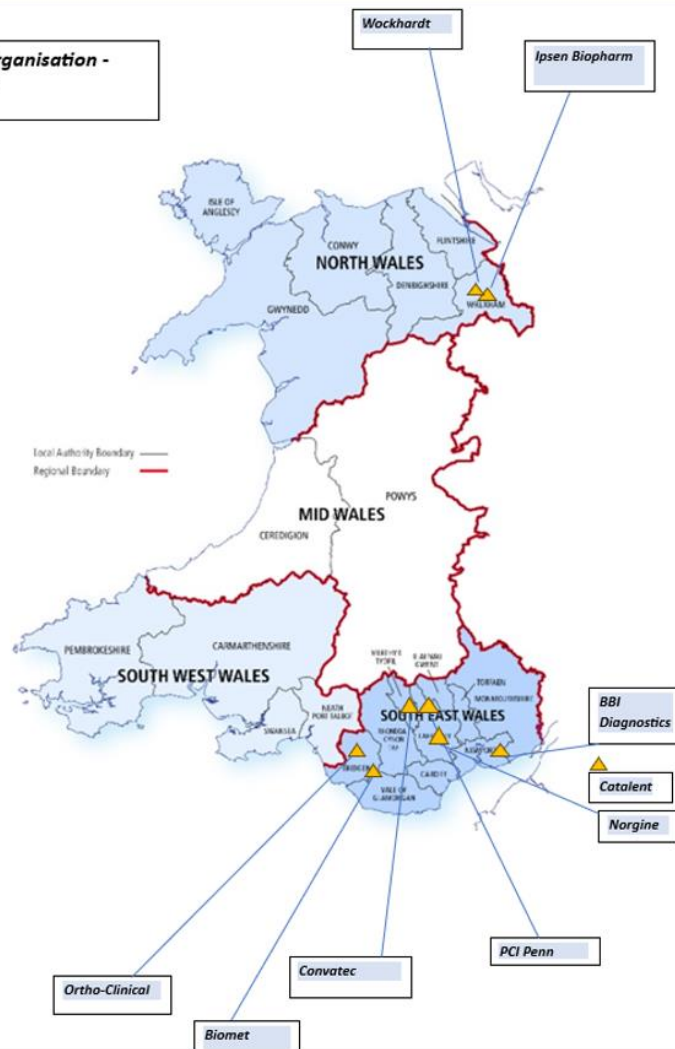
Large Organisations - Food & Drink



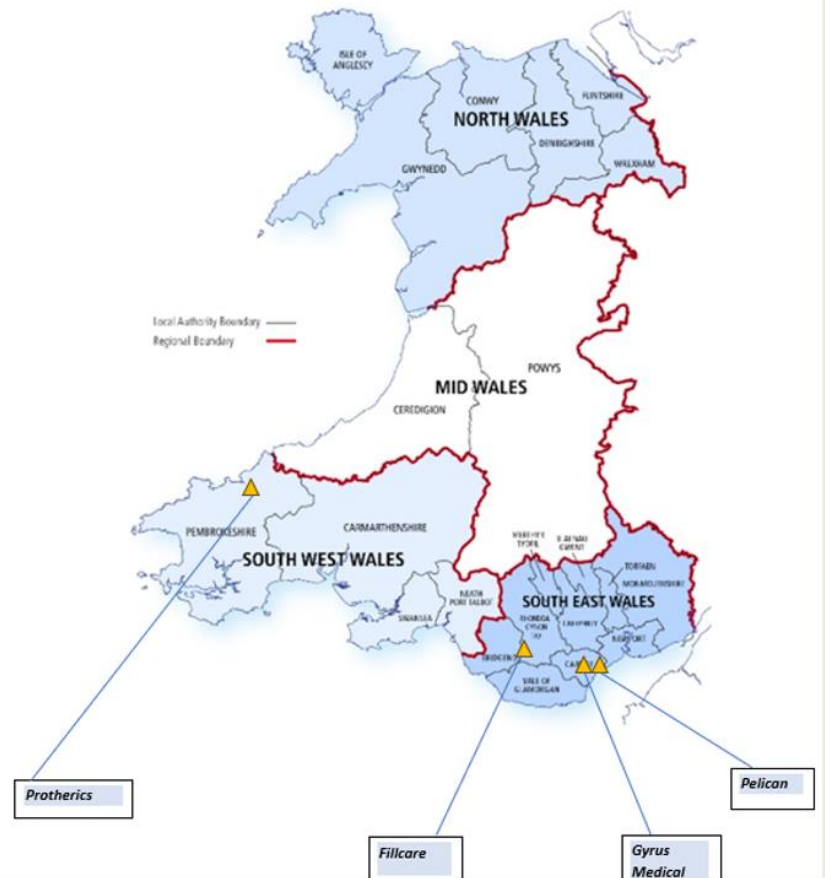
SME's – Food & Drink



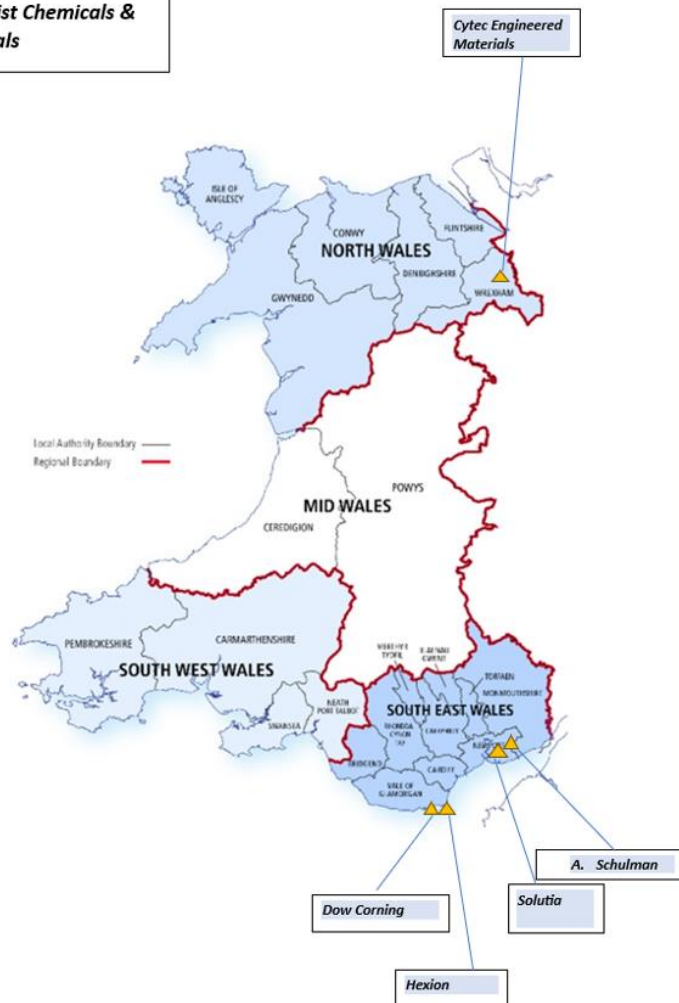
Large Organisation - Medical



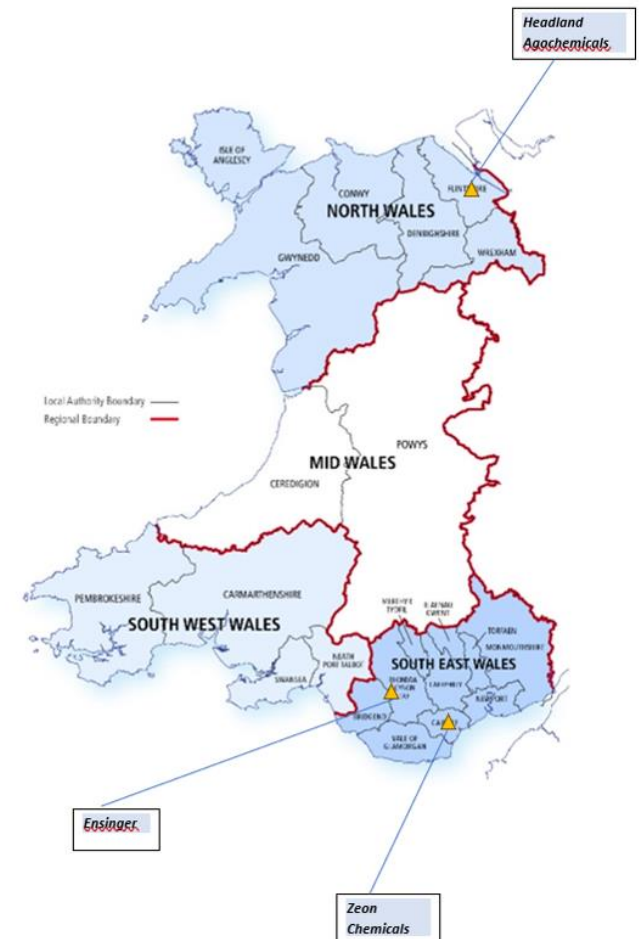
SME's - Medical



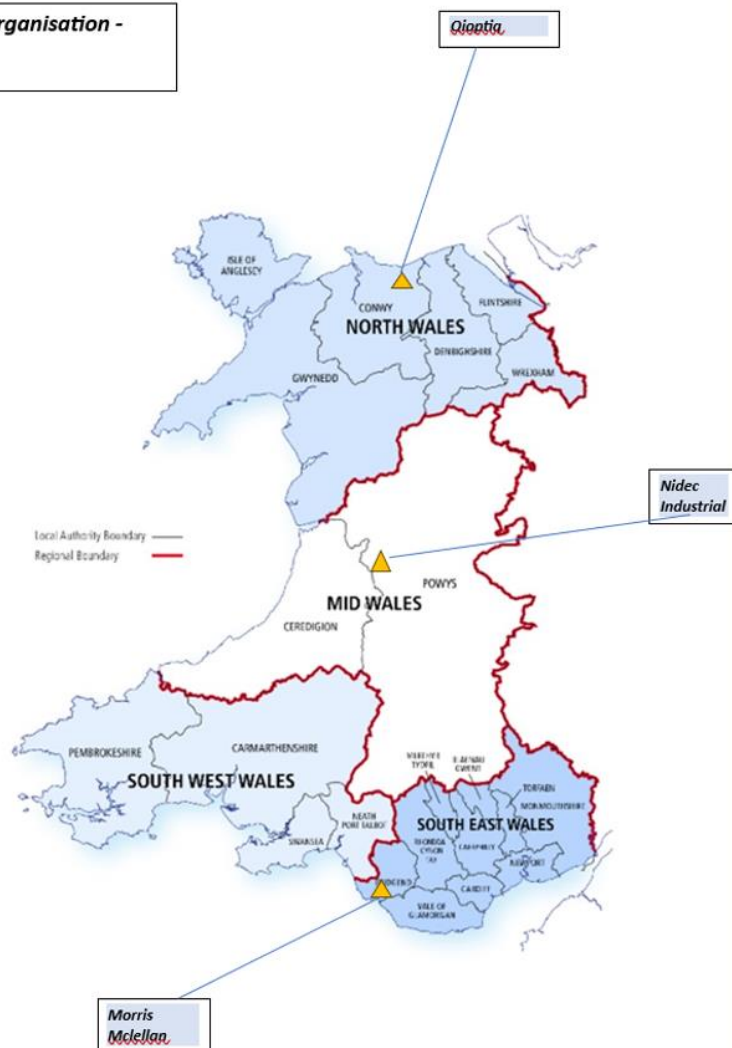
**Large Organisation -
Specialist Chemicals &
Materials**



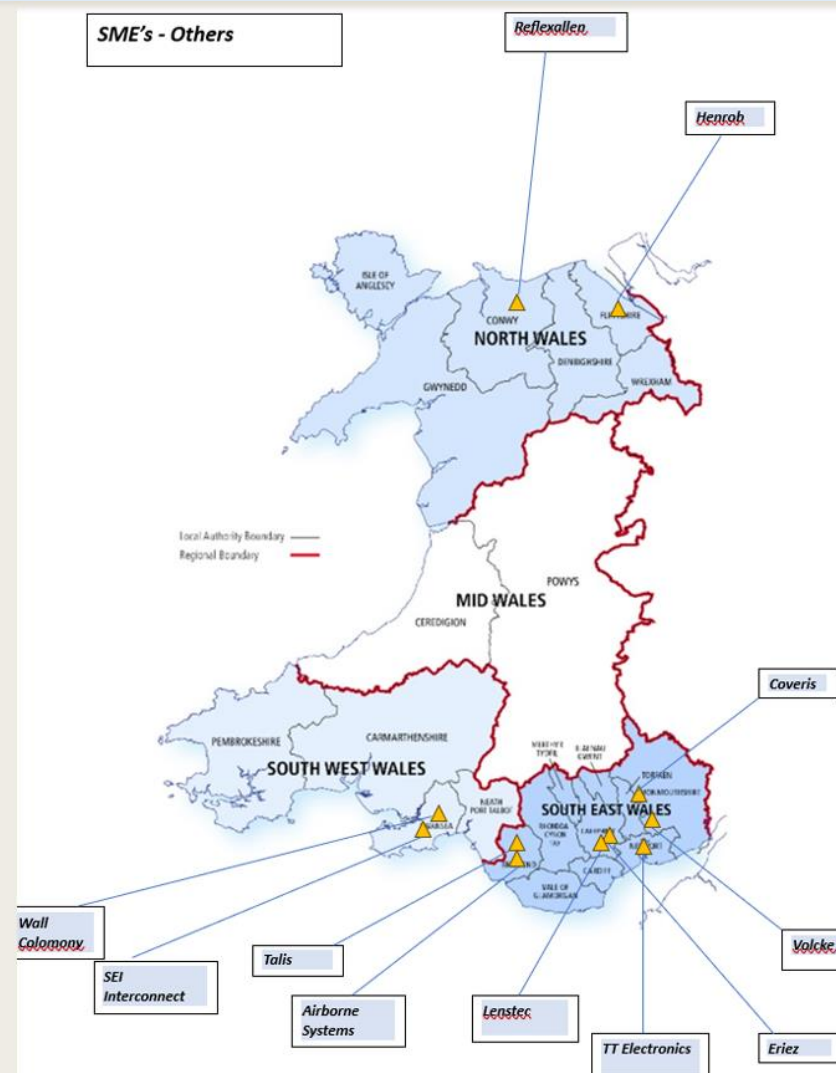
**SME's - Specialist
Chemicals & Materials**



Large Organisation - Other



SME's - Others



Appendix F – Office for National Statistics Productivity Calculator

The Productivity Calculator developed by the Office for National Statistics can be found using the following link - [Productivity Calculator \(ons.gov.uk\)](https://ons.gov.uk/productivity-calculator)

A screenshot of the first page is provided below:

How productive is your business?

Reporting period	Turnover/sales
Select your reporting period ▼	£ 0

Intermediate consumption	Workers
Non-capital purchases	Employees and working proprietors
£ 0	- 0 +

Definitions

Turnover: Turnover consists of total takings or invoiced sales and receipts of the business in connection with the sale of goods and services. Figures should be given gross of indirect taxes, duties and levies (except VAT) invoiced to the customer. Interest and similar income, other operating income and extra-ordinary income should be excluded from the turnover figure as should net proceeds on sales of capital items.

Workers: This includes employees and working proprietors. An employee is anyone aged 16 years or over that your organisation directly pays from its payroll(s), in return for carrying out a full-time or part-time job or being on a training scheme. Working proprietors include all individuals and partners actively engaged in the work of the business. It excludes silent or inactive partners whose main activity is outside of the business.

Intermediate consumption (Expenses): Intermediate consumption is the cost of raw materials and other inputs that are used up in the production process. Please exclude employment costs, stock variation, all interest payments, amounts charged to capital account and capitalised building repairs, but include the following:

Energy and materials for business use:

- Energy used in the running of your business (including petrol, diesel, electricity and gas etc.)
- Water used in the running of your business
- Sewerage charges and other costs of waste disposal
- Goods and all raw materials used in the running of your business (including stationery and consumables)

Goods, energy and services bought for resale:

- Used motor vehicles and motorcycles from all sources (excluding demonstration cars but including motorhomes)
- Parts used solely in repair and servicing activities
- Energy products bought for resale without further processing (e.g. petroleum products, gas, coal)
- Other goods bought for resale without further processing (e.g. new motor vehicles, new motorcycles and accessories for them; new caravans and trailers; food, drink and other goods bought for resale)
- Services bought for resale without further processing

Services for business use. Amounts payable:

- To sub-contractors
- For hiring, leasing or renting plant (including scaffolding) machinery and vehicles
- For commercial insurance premiums
- For contracted road transport services