Discussion Paper

Manufacturing in Gozo

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Manufacturing in Gozo

Ivan Ebejer (Lead Author)

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This Discussion Paper provides an in-depth look at the manufacturing sector in Gozo. It examines the contribution and role of industry in Gozo's economic and social development in the last 50 years, with an emphasis on the period since the turn of the century. The paper evaluates the challenges and weaknesses faced by Gozo and their implications on manufacturing. It does so by focusing on three dimensions that are considered to be critical factors in rendering a territory attractive to manufacturing businesses; logistics, transport and connectivity; energy costs and provision; and human resources and labour costs. This analysis is then set against two trends considered to have the most material impact on the geography of production i.e. changing globalisation dynamics and the deep transformations being caused by the ongoing rapid technological developments. For the latter, the swift advancement towards Industry 4.0, with a specific focus on additive manufacturing as a potential opportunity for attracting innovative industry in Gozo, is assessed.

On the basis of the analysis, the Discussion Paper argues that, while the role of industry in Gozo surely remains and should be bolstered, the future of manufacturing may be at a crossroads. The analysis suggests that, unlike the experience with manufacturing in mainland Malta, Gozo's production basket seems to be missing skill-intensive and high-value added operations. Although the relatively low value-added manufacturing on the Island appears to have weathered past multiple external shocks relatively well, mostly due to the sector's domestic-orientation, without significant policy and firm-level action the upcoming deep shifts may be too strong for some operations to cope with. The EU's regained interest in strengthening its industry, government's 2024 Budget speech announcement of initiatives in support of manufacturing and the identification of additive manufacturing as a target sector in Malta's Smart Specialisation Strategy 2021-2027, present an opportunity for the Island to re-evaluate and strengthen the role of industry in Gozo's future prosperity.

This Discussion Paper is informed by desk research including extensive reviews of both grey and academic literature. In addition, to the extent possible, the analysis is underpinned by key macroeconomic indicators from published statistics. In view of important gaps in official regional-level data, a survey was conducted among manufacturing firms operating in Gozo to complement the published statistics and ensure a more comprehensive and rounded picture of the state of industry on the Island.

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Manufacturing in Gozo

1. A Historical context

Although relatively small, manufacturing has been an important contributor to Gozo's economic and social development. Post-Independence, the Island's nascent industrialisation was largely supported by targeted investment promotion schemes and other assistance aimed at addressing the disadvantages faced by the Island vis-á-vis mainland Malta, while national border tariffs provided protection from foreign imports up until EU accession.

As the manufacturing sector matured, four distinct segments have characterised Gozo's industrial landscape: (i) export-orientated production mostly of textiles, clothing and footwear (TCF) and later electronics, largely marked by low skills and low wages; (ii) higher skilled domestically-oriented manufacturing mostly in furniture; (iii) manufacturing that utilised locally-sourced raw materials, typically food processing; and (iv) cottage/artisanal industry with strong links to tourism.

By the late 1970s, and spurred largely by the labour-intensive TCF production, manufacturing jobs reached a peak of 27% of total employment in Gozo. During this phase, the Island's share of TCF manufacturing jobs in total employment exceeded that in mainland Malta. As a result of this dominance, the global shifts which saw TCF factories in developed countries relocate to cheaper production centres led to a steep contraction of manufacturing in Gozo over the next two decades. By the beginning of the 2000s, manufacturing's share in Gozo's total employment had declined to around 14%. The progressive dismantling of protective levies in the run up to EU accession led to competitive pressures from imports and as a result jobs in manufacturing contracted further to around 10% of total employment in 2004, before stabilising until the end of that decade. In the past decade, manufacturing provided an average of around 1,100 jobs, although the sector's share in total employment continued to decline, reflecting the expanding services sector.

Although this shift to the tertiary sector follows a normal pattern of economic development from agriculture to industry and from industry to services, a further decline of manufacturing could lead to Gozo becoming dependent on a monoculture, as has been the case with the dominance of low value-added tourism on numerous EU islands. Reaching this state could jeopardise the achievement of a balanced economy and heighten the Island's economic, social and environmental vulnerability, especially since some services subsectors are more footloose.

2. The contribution of manufacturing to Gozo's economy

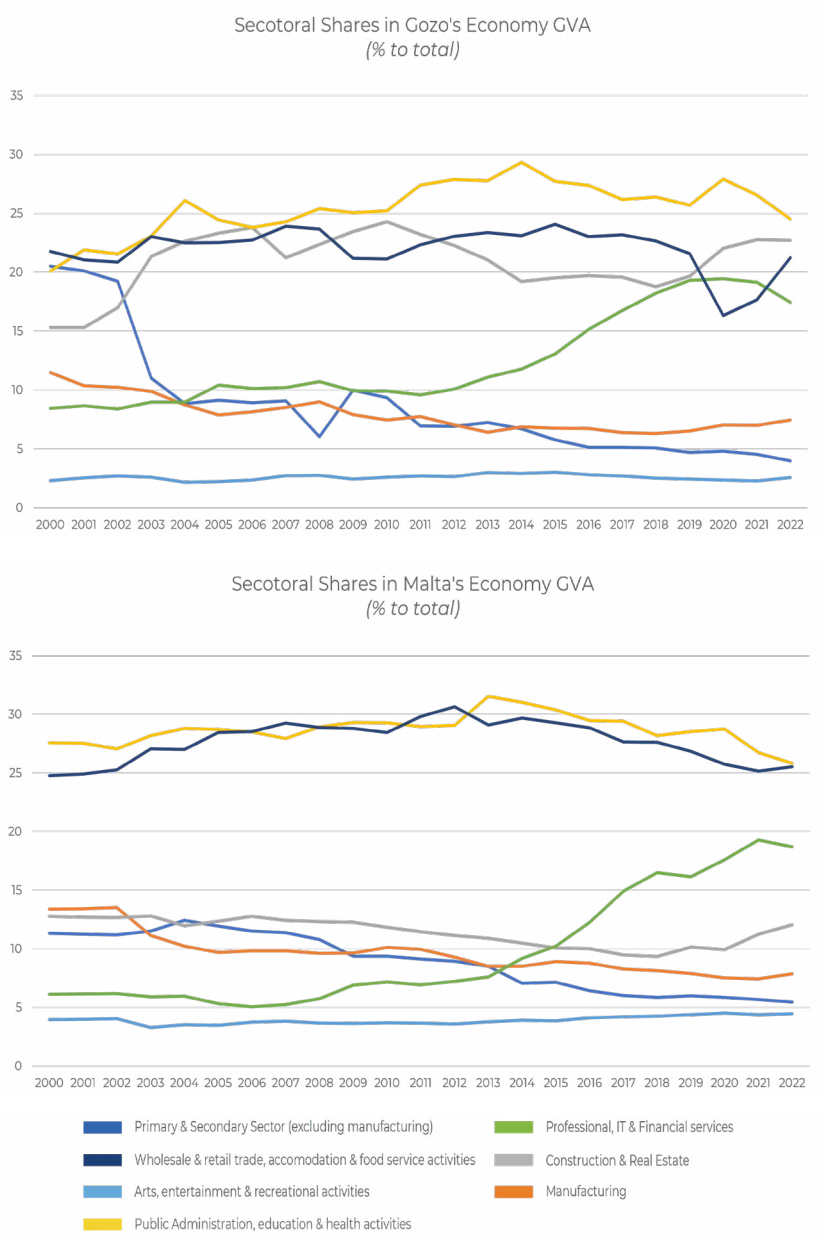
This section provides an overview of manufacturing's contribution to Gozo's economy across a number of dimensions, including value added, employment, productivity, exports, investment

and research and innovation. Where available, the analysis uses data published by the National Statistics Office and other public agencies, taking the latest 10 years as a timeframe. However, since official data for a number of key variables are not published at a regional level, a survey was conducted among manufacturing enterprises in Gozo.[1] Although the two different data sources may limit comparison, together they provide a more holistic picture of the state of manufacturing on the Island. In addition, the survey provides an opportunity to gauge industry's sentiment and outlook, adding an important layer of information to the analysis.

2.1 The role of manufacturing in Gozo's evolving economy

The role of manufacturing in Gozo's economy has been largely re-dimensioned over the past two decades. From having the third highest share in the Island's total gross value added (GVA) in the year 2000, manufacturing gradually but consistently lost ground in subsequent years. Today, industry has the seventh largest share in Gozo's GVA. By 2022, the sector accounted for around 7.5% of total GVA, lower than the share of 11.5% registered twenty years ago. These developments happened against a background of expansion in both traditional and new economic activities, especially in the services sector (Chart 1). Of note is that the declining share of manufacturing in total GVA is relative but not absolute, an indication that services have simply grown faster. In fact, manufacturing's real GVA increased by 2.8% during the period 2000-2022.[2]

Chart 1: Developments of manufacturing in Gozo



Source: Authors' calculations based on NSO data

Most notably, the professional,

[1] See Annex 1 for a description of the methodology used in the survey.

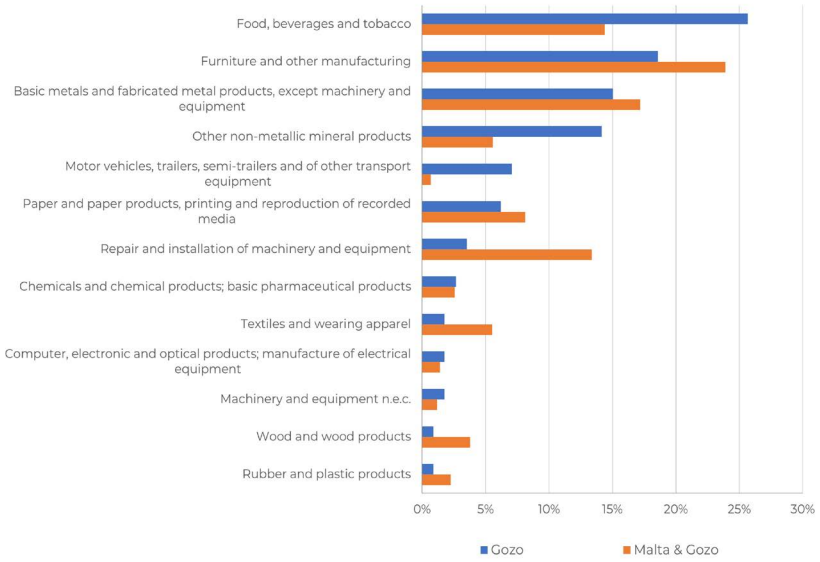
[2] Estimated using the manufacturing GVA deflator for Malta.

scientific and technical services registered strong growth. Public administration and construction also grew at a faster pace than that recorded by manufacturing. A similar picture emerges when considering the evolution of employment in Gozo's labour market. The share of manufacturing in total employment declined in the 2000-2022 period on the back of labour shedding and more jobs generated by most of the remaining economic activities.

2.2 Profile of manufacturing enterprises

A closer look at the profile of manufacturing enterprises operating in Gozo reveals a certain degree of concentration in a few economic activities. Compared to mainland Malta, Gozo is characterised by a high share of manufacturing enterprises in the food and beverages sector, reflecting both traditional developments, persisting complementarities with the local agriculture sector as well as links with an expanding tourism industry (Chart 2).

Chart 2: Manufacturing enterprises by economic activity*
(% of total manufacturing enterprises)



Source: Authors' calculations based on NSO and Malta Enterprise data

**Note - Data for Maltese Islands refer to 2021, except food, beverages & tobacco and chemicals and chemical products which refer to 2020.*

Similarly, the proportion of enterprises engaged in the manufacturing of other non-metallic products, basic metals and furniture is relatively high, mirroring the close ties of these activities with construction and the latter's growth over the years.

In the case of basic metals and furniture, the proportion of enterprises in the total compares favourably with that of mainland Malta, whereas the share of other non-metallic products is significantly higher than the national average.

A better way to determine the concentration or dominance of a particular industry in a region in comparison to a larger benchmark such as the national economy is to determine the so-called location quotient (LQ).[3] LQs are typically used to compare a sector's share of regional employment. However, in the absence of such data for Gozo, it can also be used for other economic variables, such as the number of enterprises as per this Discussion Paper.

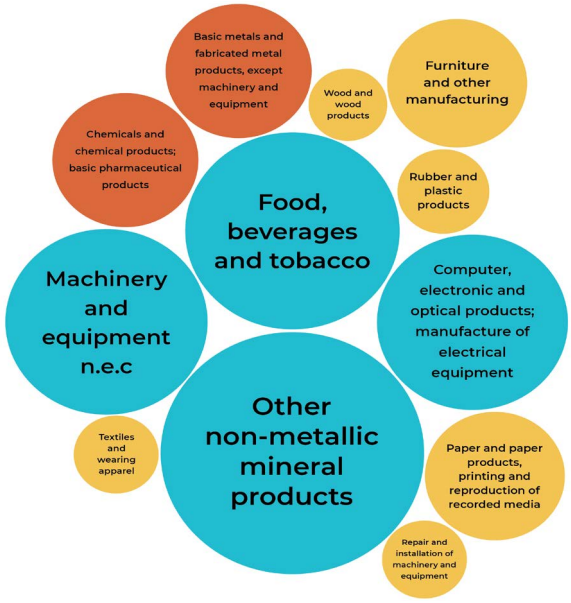
Typically, location quotients higher than 1.2 indicate that a region specialises in a particular activity,

[3] Location quotients, a ratio of ratios, denotes the relative distributions or relative concentrations of a region to the country as a whole and are derived using the following formula:

$$\frac{\text{\% of a region' snumber of manufucturing enterprisies in sector i}}{\text{National \% of number of manufucturing enterprises in sector i}}$$

which in turn shows the presence of localisation economies. In Figure 1, green bubbles represent economic activities within manufacturing in which Gozo shows strong localisation economies (LQ greater than 1.2), whereas yellow bubbles show under-represented economic activities (LQ below 0.8). LQ calculations broadly confirm the dominance of other metallic products and food, beverages and tobacco in Gozo's manufacturing sector. Applying the World Bank[4] classification of manufacturing, which groups subsectors according to five dimensions[5] considered to be conducive to development, places the food, beverages and tobacco and non-metallic mineral products sectors in the "commodity-based regional processing" category. Manufacturing firms in this category are characterised by a low level of tradedness which implies that they benefit less from productivity gains, a high proportion of low-skilled employees and low R&D. This category is also the least exposed to global value chains (GVC), displays the shortest GVC length and the lowest share of production stages located abroad. Therefore, having a specialism in such sectors could represent a disadvantage for a territory in its quest at attracting foreign direct investment and create new potential to boost manufacturing output and leverage them for growth.

Figure 1: Manufacturing location quotients for Gozo
(by number of enterprises compared to national average)



Source: Authors' calculations based on NSO and Malta Enterprise data

**Note - Green bubbles represent subsectors with an LQ>1.2; yellow bubbles denote subsectors with an LQ<0.8; red bubbles indicate subsectors with an LQ value between 0.8 and 1.2. Bubble sizes reflect the respective subsector's relative LQ value.*

The foregoing assessment of LQs based on the number of firms should be viewed with a degree of caution since, at the end, what matters for a region's prosperity is the value added generated by manufacturing units and not the quantity of units, especially in the context of the predominance of micro enterprises on the Island. In addition, in some notable cases the available official data is aggregated at a high level which may mask important developments in key industry subsegments. However, in the absence of disaggregated data, the analysis provides an indicative characterisation of manufacturing in Gozo.

2.3 Value added

Gozo's Gross Value Added (GVA) increased from €270.2 million in 2011 to €659.0 million in 2022. The share of manufacturing output in total GVA declined over the same period from 7.8% to 7.5%. However,

[4] See, Hallward-Driemeier, Mary and Gaurav Nayyar (2018), "Trouble in the Making? The Future of Manufacturing-Led Development." Washington, DC: World Bank.

[5] The five categories are commodity-based regional processing, capital-intensive regional processing, low-skill labour-intensive tradables, medium-skill global innovators, and high-skill global innovators.

the sector's contribution to GVA growth increased from 0.2% in 2011 to 1.6% in 2022. This partly reflects a higher growth in manufacturing GVA in recent years - factory output grew by an average of 8.6% in the years 2019-2021, more than double the yearly average of 4% in the 2012-2018 period.

GVA per enterprise generated by manufacturing in Gozo is lower than the national average. Estimates suggest that GVA per manufacturing enterprise amount to around 86% that of the national average. A breakdown of data by economic activity within Gozo's manufacturing is not available. However, a comparison with national averages shows that the manufacturing sub-sectors in which Gozo displays a dominance, as identified in section 2.2, generate the lowest GVA per enterprise. On the other hand, the sub-sectors with the highest national GVA (and for which data is published) are less prominent on the Island.

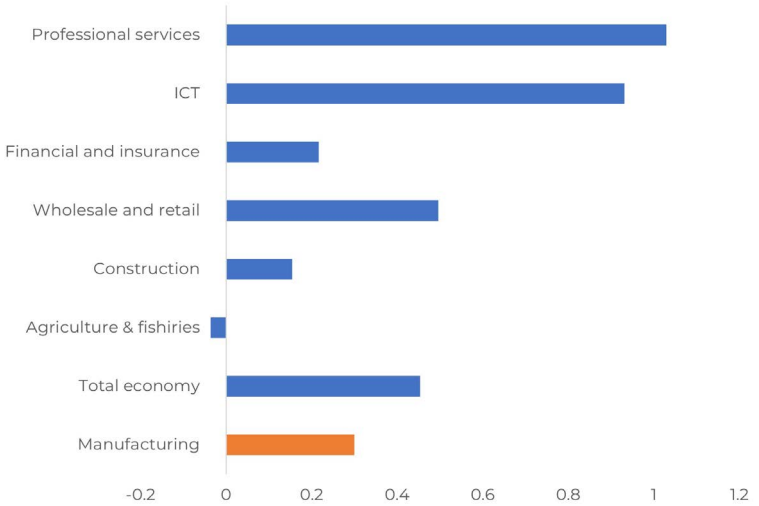
2.4 Employment

Following a sizeable retrenchment in the 1980-2010 period, Gozo's manufacturing workforce stabilised at around 1,100 persons in the past 10 years. However, the sector's share in total employment declined from 10% in 2011 to 7.9% in 2022, as traditional and emerging services sectors expanded at a faster pace. The decline in the share of manufacturing jobs in Gozo was slightly less than that recorded in mainland Malta, which decline by 4.0 percentage points.

In line with the phenomenon observed in other economic sectors, manufacturing attracted foreign employees during the past decade. By the end of 2022, the manufacturing industry employed 388 foreign workers, marking a substantial increase from the 31 individuals employed in 2010. Consequently, the proportion of foreign workers in Gozo's manufacturing workforce rose from 3.2% in 2010 to 31.5% in 2022.

Estimates of the employment intensity of growth or the employment elasticity with respect to output for different economic sectors in Gozo reveals that during the period 2000-2020 responsiveness of manufacturing employment to output growth was rather weak where on average, a 1% growth in GVA resulted in an increase of 0.3% of employment in industry which was below that for the total regional economy (Chart 3). Although the low elasticity of manufacturing signifies fewer jobs created per unit of output growth, as will be discussed in the next section, it coincided with a period of rapid productivity gains by industry which supports its competitiveness and hence its survival. For the same period, the professional services and ICT sectors had a highest employment elasticity.

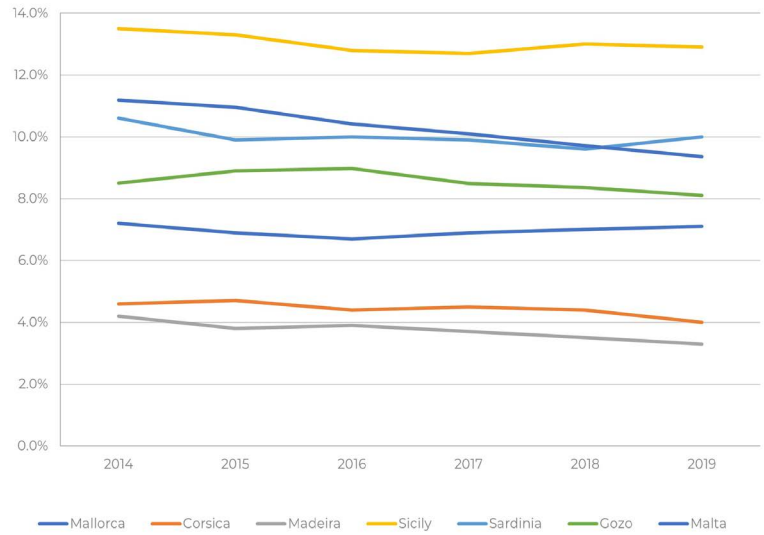
Chart 3: Employment elasticities for key economic sectors in Gozo
(2000-2020)



Source: Authors' calculations based on NSO data

When compared to other EU island economies, Gozo's share of

Chart 4: Share of manufacturing in total employment in selected European island economies



Sources: Eurostat, NSO, ISTAT, INSEE, DREM

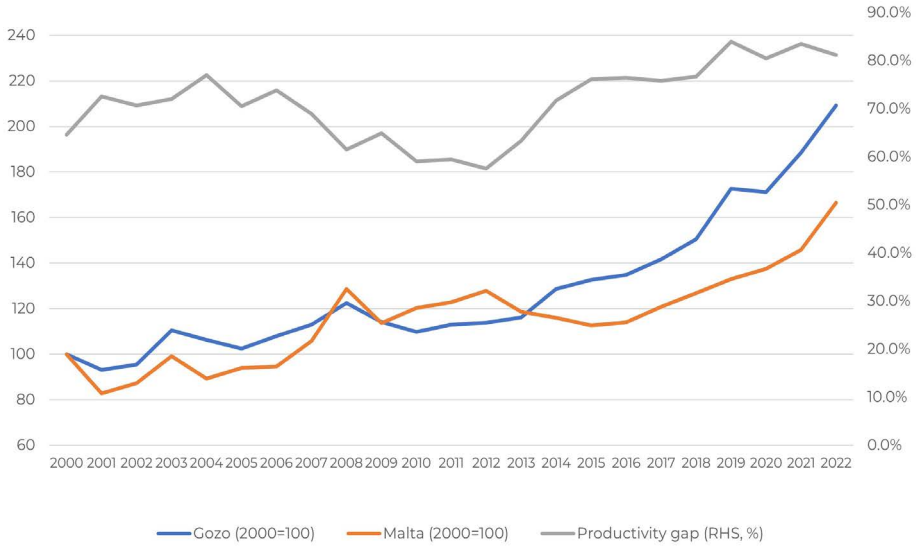
manufacturing in total employment stands between that of Sicily and Mallorca with 13% and 10%, respectively, and the shares of 4% or lower registered in Corsica and Madeira (Chart 4). In all the selected islands, the proportion of factory workforce has declined in recent years.

2.5 Productivity

Productivity improvements form the basis of gains in living standards. An economy can increase output only through higher inputs, innovation or production processes that use inputs more efficiently. Higher productivity allows an economy to produce increasingly more goods and services for the same amount of input and for that purpose is a key driver of growth. Three types of inputs, and therefore productivity, are typically important when analysing drivers of economic growth - labour, capital and total factor productivity (TFP).[6] Given the scope of this Discussion Paper and in view of data limitations, the focus here will be on labour productivity.

However, it is worth noting that both capital productivity and TFP have an important bearing on a region's economic performance, since the extent to which labour inputs can increase output faces constraints especially in the context of the projected ageing population. This renders productivity improvements through technological innovation and more efficient production processes, an important growth channel. Section 2.9 provides some generalised observations on the role and extent of research and innovation in Gozo's manufacturing sector.

Chart 5: Productivity in manufacturing



Source: Authors' calculations based on NSO data

[6] TFP is the residual of output growth that is not accounted for by the growth of a combination of labour and capital inputs. It refers to the joint effects of several factors including new technologies, efficiency gains, economies of scale, managerial skill, and changes in the organisation of production.

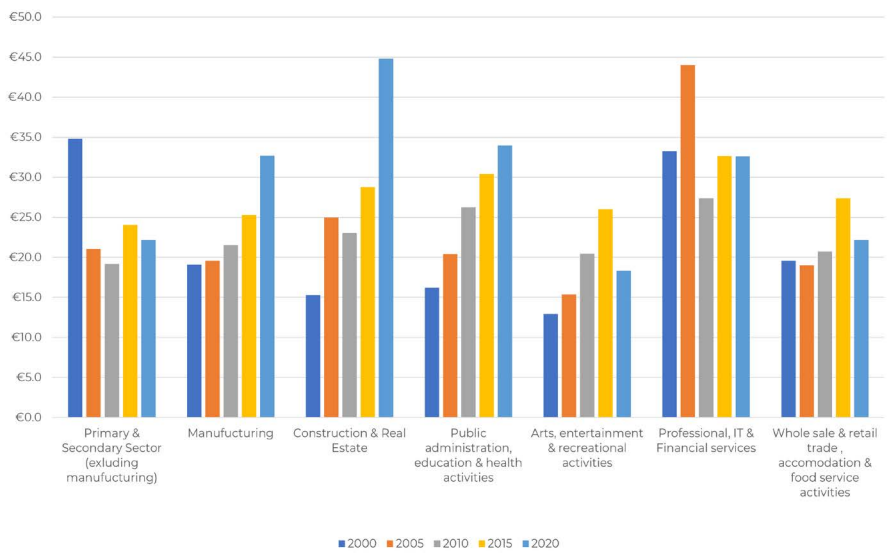
Viewed over a long-term period, Gozo's manufacturing productivity as measured by GVA per worker followed an upward trend, gaining 110% in the years 2000-22. The improvement in productivity seems to have gained traction in the 10 years to 2020 - a period in which only short episodes of productivity reversals are recorded, the most recent being in 2020 as a result of the pandemic shock.

Gozo's manufacturing productivity seems to have performed better than that in mainland Malta which suffered from sharper reversals, especially in 2008 and the 2012-2016 period. This outcome appears to be partly attributable to the higher exposure of Malta's manufacturing sector to the external environment which was reeling from the shocks caused by the financial and sovereign debt crises.

Despite the more favourable performance, the productivity of Gozo's manufacturing sector continues to register an unfavourable gap vis-á-vis mainland Malta. Starting around 2004 and for the next eight years, the productivity gap widened, possibly reflecting the interplay between differences in the manufacturing profiles of the two islands and the impact of restructuring post-EU accession on the respective sectors. For Gozo, this period was characterised by significant declines in both factory output and workforce, while in Malta the same restructuring episode saw manufacturing output increase as the sector shed employment. Over the 2012-2022 period, the gap in manufacturing productivity narrowed progressively to less than 20%.

A comparison across economic sectors in Gozo over five year intervals during the period 2000-2020 (Chart 6), shows that, although recording consistent small gains throughout the period, manufacturing is locked at the lower-end of the productivity spectrum. Only the agriculture and commerce, transport and tourism sectors display a lower productivity performance (in 2020). From a macroeconomic viewpoint, the status quo of manufacturing provides a limited productivity premium to the Gozitan economy. That is to say, a reallocation of a unit of labour input from the agriculture or wholesale and retail to manufacturing will not add significantly to GVA. On the other hand, the Island's GVA will increase significantly if a unit of labour input in manufacturing is reallocated to the higher value-added sectors (assuming skills are transferable). This implies that, with time, the pressure on industry in terms of available labour inputs will tend to increase because of wage premia as employees are attracted to higher paying sectors.

Chart 6: Labour productivity in key economic sectors in Gozo
(thousands)

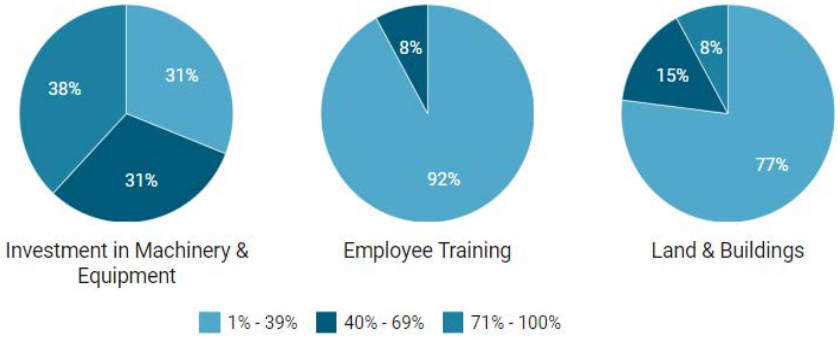


Source: Authors' calculations based on NSO data

2.6 Investment

Investment adds to the stock of capital and the quantity of capital available to a region's economy is a crucial determinant of its productivity. In the absence of disaggregated official statistics, the survey attempted to capture industry's investment decisions. Looking at the manufacturing sector's investment choices among different categories in 2022, the share of investment in machinery and equipment in total investment is broadly equally distributed with 38% of respondents indicating a share of 70% or higher and an approximately one-third each, indicating a share falling between the 40-60% range and 0-30% range (Chart 7). 62% of respondents invested in IT, software and data with the highest number of manufacturing enterprises having a share of 10% of total investment. Almost 60% of the manufacturing companies surveyed invested in employee training in 2022, with nine out of ten respondents indicating a share of 30% or less in total investment for this category. The majority of manufacturing enterprises invested in land and buildings in 2022, with seven out of ten respondents investing up to 30% of total investment.

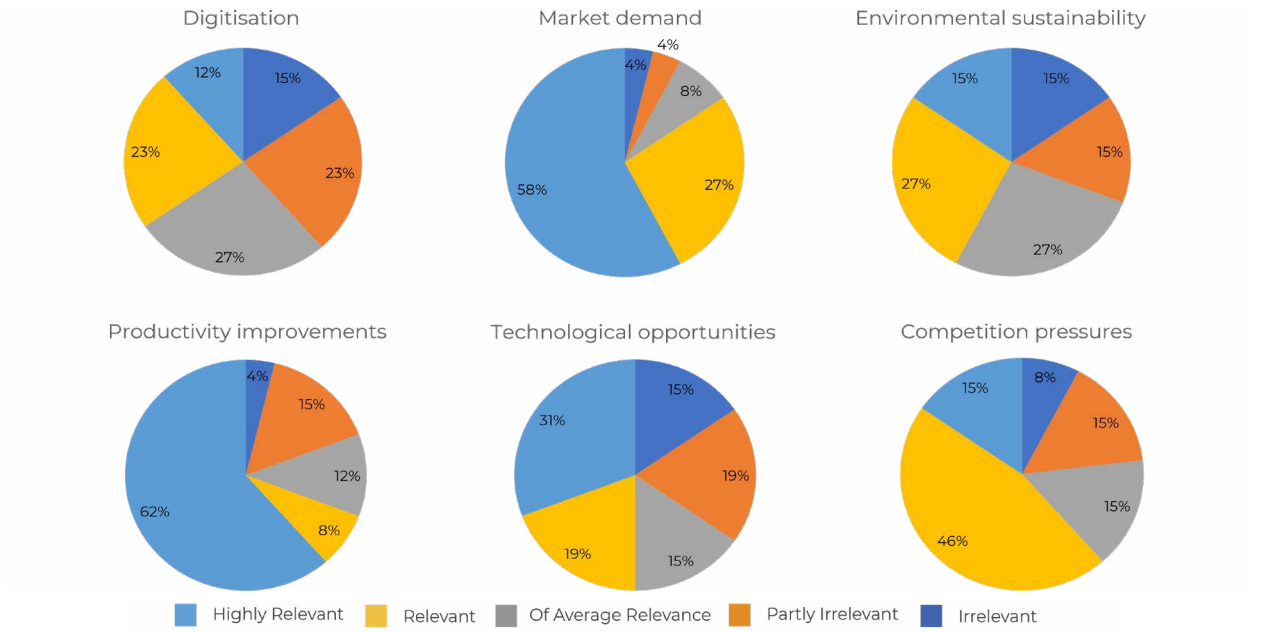
Chart 7: Share in total investment for different investment categories



Source: GRDA manufacturing in Gozo survey

The survey also sought to gauge the manufacturing firms' perceptions about the main drivers underpinning investment decisions in the sector (Chart 8). The majority of respondents place high importance on productivity improvements and market demand as key drivers, followed by competition pressures and technological opportunities. Interestingly, digitalisation and environmental sustainability are perceived to be less important considerations for investment decisions.

Chart 8: Relevance of drivers for manufacturing investment



Source: GRDA manufacturing in Gozo survey

2.7 International orientation

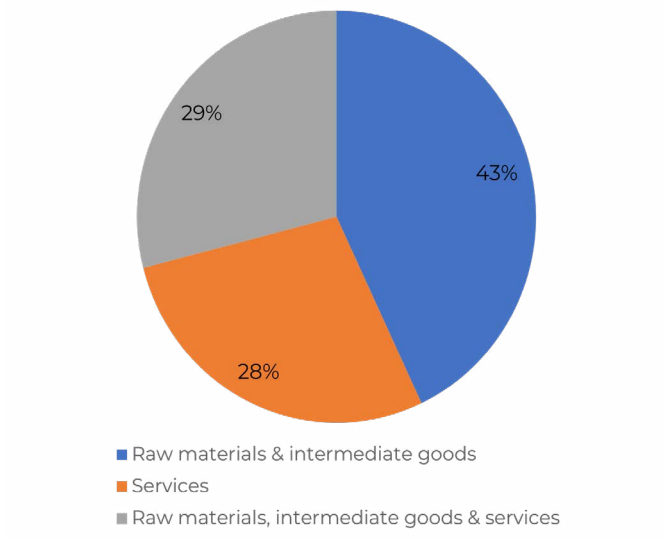
The share of exports to output indicates a sector's extent of internationalisation and its potential for positive spillovers through learning by doing, scale economies, technology diffusion, and greater competition. The survey results show that Gozo's manufacturing sector is characterised by a low degree of internationalisation. Around 31% of respondents indicate they export to foreign markets, with the EU market being the destination of all exporting manufacturing companies. Almost two of five exporting manufacturers also export to non-EU markets. Five out of eight exporting manufacturing enterprises report a share of foreign sales to total turnover of up to 25%, while the proportion of export value of the remaining exporting firms is at least 50% of total sales.

2.8 Local linkages in the value chain

Lower levels of so-called leakages out of the local economy, which occur when internal inputs replace those acquired outside the region, can dramatically increase the value added and hence the economic impact of the sector, in this case manufacturing. The survey also sought to assess the extent of local linkages in Gozo's manufacturing value chain. Respondents were asked if their manufacturing operations sourced raw materials, intermediate goods and service inputs from other Gozitan external providers.

Around 54% of respondents indicated that they acquire inputs from external Gozitan suppliers, suggesting a certain level of integration in the local business ecosystem. Sectors showing the highest degree of interlinkages with the local business ecosystem include agro-processing, wood products and printing. As for the type of inputs sourced from other external providers in Gozo, 43% of respondents mentioned raw materials and intermediate goods whereas, 28% acquire services (Chart 9). Manufacturing enterprises that source both raw materials and intermediate goods as well as services account for 29%. For around three out of five manufacturers, the proportion of inputs sourced externally amounts to 25%, another one fifth of respondents acquire 30% of their inputs externally, while for the remaining fifth outside sources of inputs represent 50% or more.

Chart 9: Value chain local linkages



Source: GRDA manufacturing in Gozo survey

2.9 Research and innovation

Research and innovation (R&I) is crucial for manufacturers to gain competitive advantage, achieve swifter responsiveness to customers' evolving demands, faster turnaround times and a reduction in waste. Evidence suggests that a clear correlation exists between innovation and revenue growth. For example, a recent study[7] finds that highly innovative companies experience revenue growth that is double that of their less innovative peers.

In this light, the survey gauges the extent to which manufacturing firms in Gozo engage in research and innovation. The responses received show that only one-third of enterprises in industry are active in R&I. Innovators are mostly predominant in sectors such as agro-processing, the manufacture of furniture, plastics and machinery and equipment. As expected, almost all manufacturing companies that engage in R&I export their products to foreign markets, further pointing to the importance that innovation plays in withstanding competitive pressures. Interestingly, the majority of those that reported innovative activities are micro enterprises. The proportion of R&I spending to total investments amounted to 5% for two out of five enterprises, while for the remaining three-fifths the proportion of R&I spend ranges between 10% and 20% of total investment. In terms of where R&I activities are carried out, around three-quarters of respondents indicated that innovation happens in-house while the remainder outsource this activity or have a combination of both.

2.10 Public financial support to manufacturing in Gozo

Traditionally, the objective of financial support targeted to manufacturing in Gozo has been to remedy the disadvantages engendered by the additional inter-island transport costs of materials, goods and finished products incurred by operators located on the Island. The Gozo transport grant scheme is the only public support measure that specifically targets manufacturing operators on the Island. The support, in the form of a grant to eligible companies, covers the ferry fare of commercial vehicles and subcontracted haulage and courier expenses. A host of other incentives available to economic operators have a broader scope not exclusive to manufacturing (e.g. Gozo employment refund scheme) or not location-specific (e.g. Rent subsidy scheme).

According to replies received to the manufacturing survey, around 65% of respondents made use of public financial support in 2022. The transport subsidy was used by 75% of manufacturing enterprises, further indicating the importance of this scheme to the competitiveness of Gozo's industry in view of the transport and insularity challenges faced by the Island as will be discussed later. The employment subsidy and company income tax credits were also used significantly by manufacturers (each around 35% of respondents).

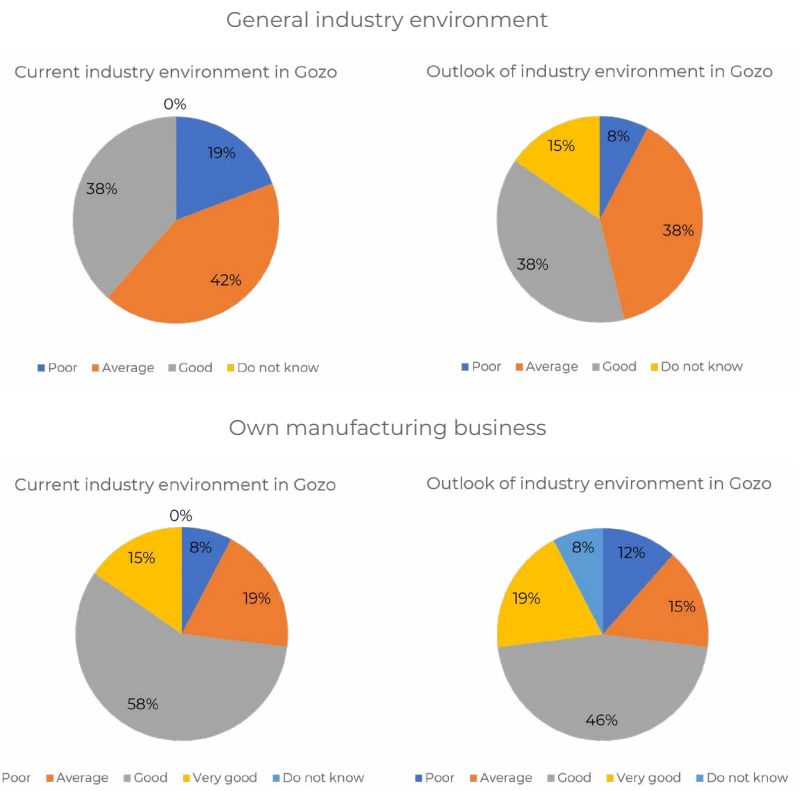
[7] McKinsey Quarterly (2023), "Innovative growers: A view from the top". available online: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/innovative-growers-a-view-from-the-top.

3. Challenges, strengths and weaknesses

3.1 Challenges

The survey also attempted to evaluate the respondent's perception of the challenges currently facing manufacturing in Gozo as well as their sentiment about the short-term future in different aspects that effect the sector (Chart 10).

Chart 10: Perceptions of manufacturing environment in Gozo



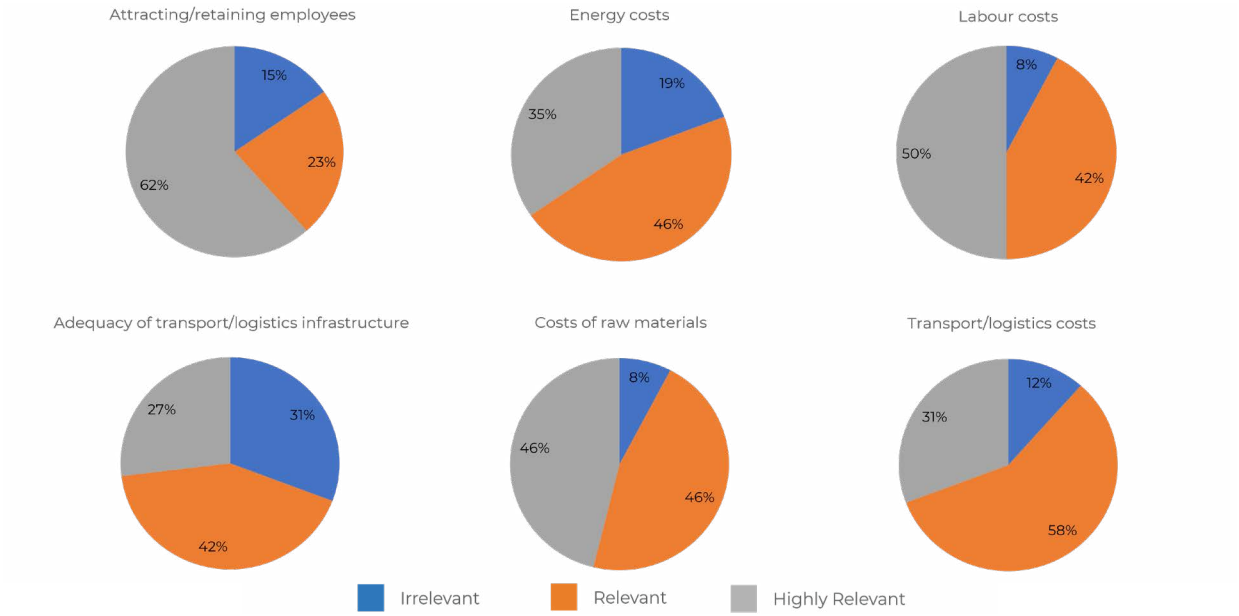
Source: GRDA manufacturing in Gozo survey

Overall, the responses show that manufacturing enterprises consider the current industry environment in Gozo to be satisfactory. Those that perceive the current manufacturing environment to be 'average' amounted to 42%, while 38% of respondents consider the current climate to be good. 19% said that the situation is poor. The sentiment about the outlook seems to weaken slightly. Whereas the percentage of those who perceive the manufacturing environment to be 'good' in the next three years remained unchanged (38%), the share of respondents who anticipate an 'average' situation falls to 38%. Although the share of 'poor' replies is also lower (8%), respondents display a stronger degree of uncertainty about the short-term outlook (15%).

The operators' sentiment is more positive when asked about their own manufacturing business in Gozo. Around 15% of respondents view the current situation as very good, while those that consider it to be 'good' increases to 58%. This positive sentiment seems to be shared across almost all the industry's sub-sectors. The outlook over the next three years from the manufacturing business own perspective remains favourable, although the proportion of the 'good' replies is lower than the current situation, where 19% expect that the situation in the next three years to be very good, whilst 46% of respondents perceive it to be good.

Respondents were asked to evaluate the relevance of a number of major challenges to their own business over the next three years (Chart 11). The challenges with the highest proportion of 'highly relevant' responses include attracting/retaining employees and higher labour costs which mirrors the tight local labour market conditions and the concerns consistently expressed by employers in various other national surveys. Another challenge considered to be highly relevant is the cost of raw materials which may suggest that manufacturers expect the higher input prices recorded

Chart 11: Major challenges to own manufacturing business in Gozo over the next three years



Source: GRDA manufacturing in Gozo survey

in the past months to persist going forward. In the case of challenges perceived to be 'relevant' in the next three years, the highest proportion of respondents indicated transport costs (discussed in section 3.2.1), energy costs and adequacy of transport/logistics infrastructure.

The survey asked if manufacturing enterprises in Gozo expect an increase, decrease or no change in a number of variables over the next three years that effect the performance of their operations. Wage growth and the cost of energy, raw materials and transport reported the clearest and highest proportion of respondents that anticipate an increase going forward. At the same time, a material proportion of manufacturers foresee higher productivity in the next three years. Most respondents also expect higher investment in sustainability and, to a lesser extent, in digitalisation in the short-term. More balanced responses were obtained with respect to the outlook of domestic and export sales, as well as profitability, is in line with the uncertainty mentioned earlier among industry operators especially how these variables would impact their top line and bottom line.

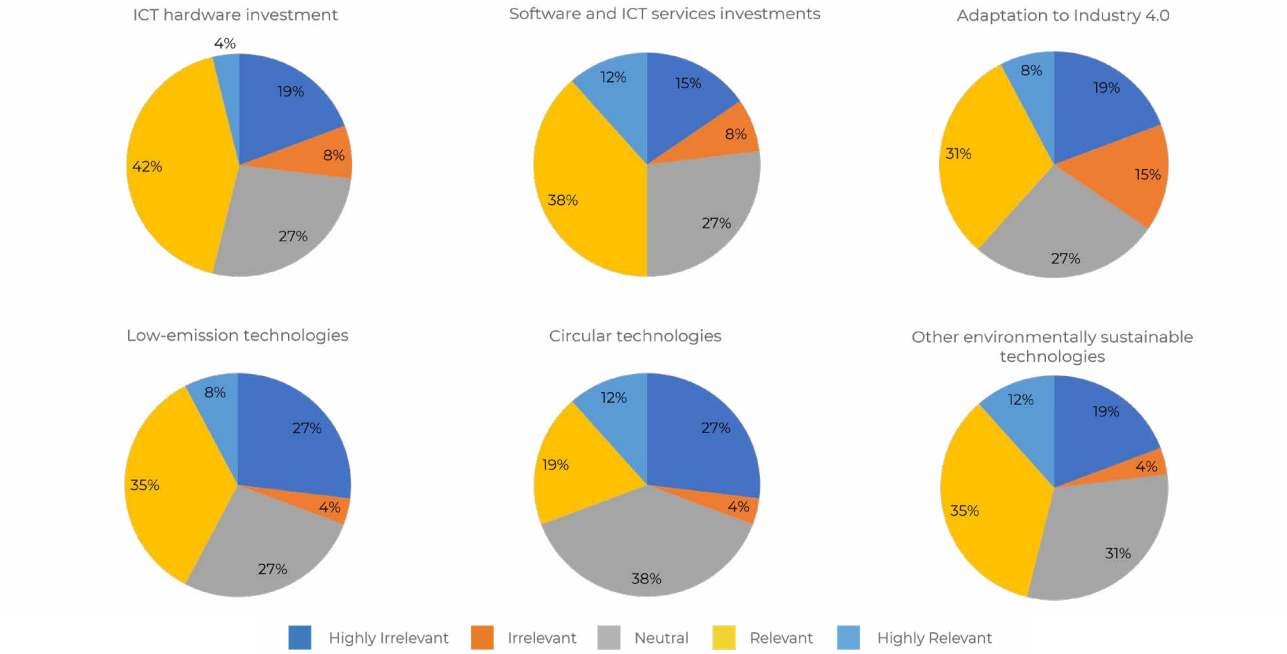
In view of the critical role that investment plays in the long-term success of enterprises, the survey sought to elicit responses on various aspects of industry's short-term investment plans. Asked about their investment priorities over the next three years, the highest proportion of respondents (38%) indicated replacing existing buildings, machinery, equipment and IT and developing or introducing new products or processes to be highly relevant. Around two-fifths of manufacturers also consider the latter as 'relevant'.

Considering both rankings together (highly relevant and relevant) suggests that manufacturers investment goals will most likely focus on investment on new products or processes. For 35% of respondents (the highest proportion) investment to expand capacity for existing products is the least relevant. Overall, these results seem to indicate that the industry prioritises investment in developing or introducing new products or processes which signals an appetite for innovation.

Respondents were also asked to rank capital investment in different technologies from highly relevant to highly irrelevant to their company's competitiveness (Chart 12). Software and ICT

services, circular and other environmentally sustainable technologies scored the highest proportion of 'highly relevant' capital investment. ICT hardware, software and related service were ranked as relevant by the highest proportion of respondents. To a lesser extent, investment in low-emission technologies and other environmentally sustainable technologies are also considered relevant for competitiveness for many respondents. The technologies considered to be irrelevant for competitiveness by the highest proportion of respondents include those for low-emissions.

Chart 12: Relevance of capital investment for own manufacturing business over the next three years



Source: GRDA manufacturing in Gozo survey

In view of the significant impact and transformation brought about by climate change, the survey zoomed in on the investment outlook of manufacturers in Gozo aimed at reducing GHG emissions. The results show a high degree of awareness among industry enterprises about the need to take action to reduce emissions. Around 73% of respondents indicated that they plan to implement some form of investment to lower emissions in the next three years. Of these, 62% intend to invest in energy efficiency interventions, while 53% of enterprises report that they plan to adopt actions that minimise and recycle waste.

3.2 Strengths and weaknesses

In the context of an open and globalised trade regime, economic growth and the generation of wealth typically follows an uneven spatial distribution between the so-called core and periphery. In many instances, economic geography, including territorial attributes, becomes an important determinant of an economy's development path. From a theoretical viewpoint, the decision of firms to operate from a particular location is influenced by the interplay of exogenous forces (i.e. factors firms take as given in a location that influence their location decision) and endogenous forces (i.e. factors that firms can affect, and in doing so influence other firms' choice of location).

According to this theoretical framework, exogenous factors include natural features, border effects and trade barriers. Endogenous factors comprise the quality of local amenities, agglomeration forces such as transport costs, economies of scale and scope, the 'thickness' of the labour market and human capital accumulation, as well as knowledge spillovers, on one hand, and dispersion forces including pressure on infrastructure, cost of production, pollution and security on the other. The push and pull of these exogenous and endogenous forces determine the attractiveness of a location for businesses.

Typically, the attractiveness of a territory is positively related to high accessibility (low logistical costs), economies of scale and favourable agglomeration forces. To achieve this entails access to natural resources and human capital, as well as having an efficient transportation system and proximity to urban agglomerations or core hubs.

Small island economies score low in all of these attributes. Accessibility is hindered by insularity, defined as a permanent phenomenon of physical discontinuity (European Small Islands Federation, 2002) - a key characteristic of islands. In turn, insularity is often accompanied by two main dimensions which are especially critical for manufacturing: (i) small size, in terms of both surface area and population, which necessarily implies limited quantity and variety of natural and human resources as well as a small internal market; and (ii) remoteness and isolation which translate in high set-up and running costs for companies in terms of time (distance/frequency considerations), financial and operating expenses as well as costs related to fragmented and narrow markets. In addition, insularity introduces other economic and environmental vulnerabilities including energy costs and provision.

It is the joint and reinforcing effect of insularity, smallness and remoteness that lead to unfavourable territorial performance of small island economies in contrast to regions that are similar to islands in some attributes (i.e., smallness, peripherality, remoteness) but do not suffer from land discontinuity with the core markets. This combination of factors diminishes production efficiency, a key determinant of competitiveness.

Several studies have explored the variables that have an impact on the attractiveness of a region to businesses. The most common variables that appear in these studies include cost competitive factors such as transport/logistics costs and connectivity, energy costs/supply and public financial incentives, labour input/costs as well as non-price competitiveness parameters including labour quality, research and innovation and governance. As discussed earlier, responses to the survey conducted for this Discussion Paper also suggest that cost competitiveness variables are deemed important. For this purpose, the remainder of this section will focus on a selection of the most critical competitiveness drivers.

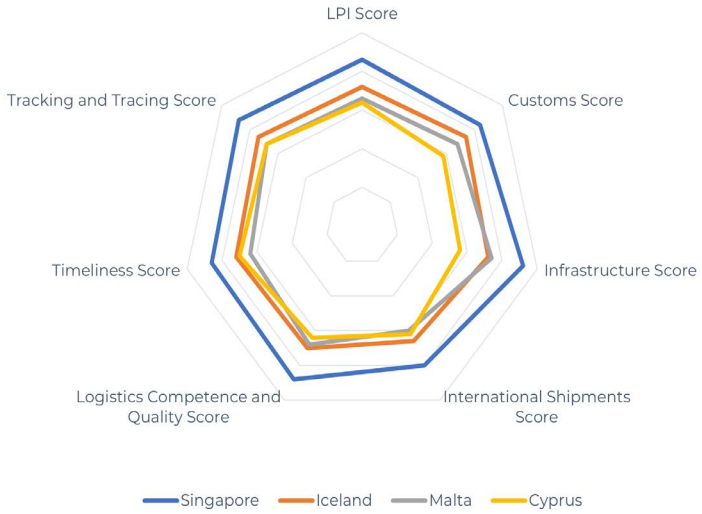
3.2.1 Logistics, transport and connectivity

Connectivity with the outside world constitutes a key determinant of a territory's competitiveness[8] since it represents a link that connects trade, transportation, businesses and territorial

[8] Connectivity encompasses physical facilities, services, and ways to facilitate the movement of goods and people within and across borders regardless of their relative position e.g. central or remote.

development. World Bank data[9] shows that whereas Malta's performance in terms of liner shipping connectivity improved along the years, logistics performance declined (see Chart 13). A comparison with other peripheral island states shows that Malta suffers gaps mainly vis-á-vis international shipments, timeliness and customs.

Chart 13: Logistics performance index for selected island economies, 2023



Source: World Bank

Costs related to logistics and transport are considered to be critical for businesses when choosing where to establish their operations. This variable assumes more importance to manufacturers since, unlike services, the output produced has to be hauled to the buyer. The influence of transport costs on location decisions diminishes the higher the value added generated by the manufacturing activity.

Logistics/transport costs encompass a number of dimensions. Physical distance is perhaps the most recognised parameter; with costs increasing the further the distance between the firm and its customers. Therefore, by definition, manufacturing in peripheral regions faces a permanent weakness. The disadvantage that Gozo faces in terms of distance can be better understood by referring to its virtual distance[10] from the centre of the EU (symbolised by Maastricht). In a study carried out by Eurisles (2002) to determine virtual distances of islands, Gozo's virtual distance is estimated to be equivalent to the physical distance between the EU and northern Chad, which is roughly double the actual physical distance.

Beyond physical distance, the extra costs that burden businesses operating or considering locating on an island stem from other permanent conditionalities, such as the dependence on sea and air transport due to land discontinuity. For Gozo, insularity is double due to a lack of own airport and cargo maritime port which puts manufacturing operators at a higher disadvantage in terms of physical distance, ferry trip frequency and coordinating connections for overseas shipments. These permanent handicaps worsen the increased logistical costs associated with remoteness, making islands strongly dependent on more expensive modes of transport compared to land haulage alternatives.

Another important dimension of logistics/transport costs relates to warehousing expenses for additional inventories (in terms of inputs, finished products and spares for equipment and machinery) that are kept as a buffer. This occurs as manufacturing companies attempt to avoid stoppages in the eventuality of container ships bypassing the Maltese Islands due to adverse weather conditions or

[9] World Bank (2023), Logistics Performance Index, available online: *http://lpi.worldbank.org*.

[10] Virtual distances convert travel time between two locations into kilometres which is then added to actual physical distance. In this exercise, travel time consists of the time taken by a semi-trailer to travel between two points by road, the crossing time by ferry, the waiting time and a frequency coefficient. This total travel time was converted into kilometres on the basis of the average speed of 60 km/h for a truck on the mainland.

other supply chain disruptions. Such contingencies are especially crucial for operations that function on just-in-time processes.

3.2.2 Energy cost and provision

Small island economies face limitations of natural and energy resources that is intrinsic to their territorial discontinuity, distance from the continent and size. Owing to these permanent characteristics, islands are confronted with a major challenge with regard to energy supply as they typically depend on the importation of fossil fuels to meet their power and transport needs, which implies additional logistics costs. As argued in the previous section, since islands pay a premium for transport costs, when energy prices rise, transport costs also rise disproportionally. Moreover, limited economies of scale imply that electricity-generation capacity and fuel inventories are more than is necessary to ensure the availability of a reserve margin (Nuez and Osorio, 2019) needed as contingency and to cover fluctuations in seasonal demand to which islands are prone in part due to extreme climatic conditions as well as population variations arising from the dominance of the tourism industry. In addition, the water scarcity that afflicts most islands means that, so as to generate enough potable water to satisfy the local and visitor needs, they rely on seawater desalination plants, further compounding pressure on energy provision and heightening vulnerability. For all these reasons, energy generation on islands is more expensive than on the mainland.

The different cost components of electricity provide a proxy[11] of the cost of generating 1 KWh.[12] Chart 14 shows a comparison of the electricity cost components for industry in a selection of European countries for 2019.[13] Territories at Europe's periphery show a higher than average proportion for generation and supply costs in total costs, with island economies (Ireland, Iceland, Cyprus and Malta) recording the highest costs in the generation and supply component (which is the most exposed to international price fluctuations and transport costs of fuel). In 2019, Malta had one of the highest proportions of generation and supply costs at 77% of total electricity production costs.

Since energy is a key input for manufacturing, industry's competitiveness is particularly sensitive to energy costs, albeit to varying degrees according to the energy-intensity of the activity. Several studies have shown that energy costs have a material influence on manufacturing expansion and location decisions. For example, Carlton (1983) finds that a 1% change in electricity prices has a greater impact on location decisions than an equal change in wage rates, even for relatively low energy-intensive sectors. Ratti et al. (2011), conclude that a 1% increase in relative energy prices reduced manufacturing investment by 2% in a sample of European countries. Penhans et al. (2017) examined the effects of variations in electricity costs and found that these play a significant role in re-location decisions of European firms.

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[11] Electricity cost components are used here instead of the more appropriate levelized cost of electricity (LCOE) since, to the best of the author's knowledge, they are unavailable for most countries. LCOE is the ratio of initial investment costs, fixed and variable operating costs, and capital costs over the lifetime of a planned plant to the amount of electricity generated over its lifetime.

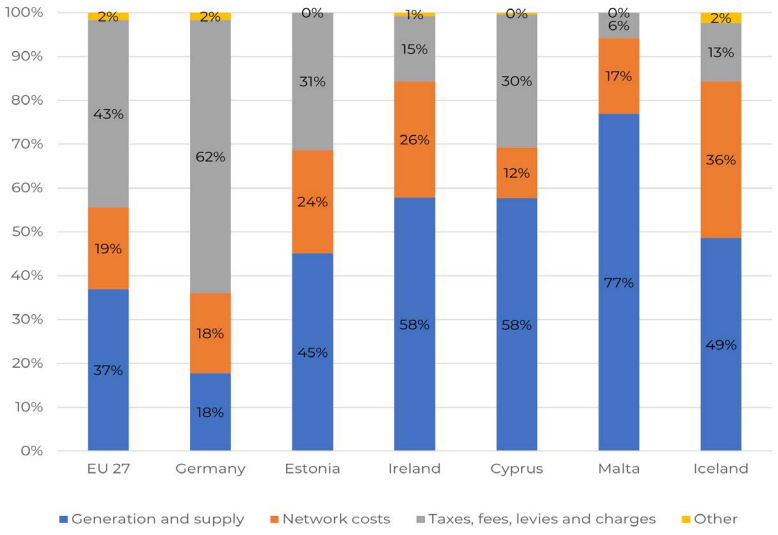
[12] The main components of costs in the electricity value chain are generation and supply, network costs and taxes and service costs.

[13] Data for 2019 were chosen to eliminate the recent effects on prices due to COVID and the war in Ukraine.

Industry's energy consumption in the Maltese islands is relatively low (11% of total) and significantly below the EU average (26%) mainly due to the absence of heavy industry (National Energy and Climate Plan, 2019). Nevertheless, the electricity intensity of manufacturing is greater than its share in the economy: while the share of manufacturing gross value added is 9.1%, it accounted for 11% of final energy demand. Local manufacturing operations mostly consume energy in the form of electricity which means that they are particularly sensitive to changes in electricity prices.

Chart 14: Electricity price components for non-household consumers in selected European countries

(2019, % of total cost)



Source: Eurostat

Table 1 illustrates the share of electricity consumption and electricity intensity for different manufacturing sub-sectors in the Maltese islands for which data is available. Manufacturing of textiles, apparel and leather and chemical and chemical products are the most electricity-intensive sectors of industry followed by fabricated metal products, electronic and optical products, electrical equipment and machinery and equipment.

Table 1: Share of electricity consumption and intensity by manufacturing activity in Gozo

	Share of electricity consumption in total manufacturing	Share of electricity intensity in total manufacturing
Food products; beverages and tobacco products	16.4%	8.0%
Textiles, wearing apparel, leather and related products	6.8%	26.2%
Wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.3%	5.7%
Paper and paper products; printing and reproduction of recorded media	8.8%	3.8%
Chemicals and chemical products	4.6%	26.0%
Basic pharmaceutical products and pharmaceutical preparations	7.8%	4.3%
Rubber, plastic products, furniture and other manufacturing	24.8%	10.4%
Other non-metallic mineral products except glass, glass products, cement, lime and plaster	1.9%	0.0%
Basic metals	0.0%	1.4%
Fabricated metal products, computer, electronic and optical products, electrical equipment, machinery and equipment n.e.c.	24.4%	12.4%
Motor vehicles, trailers, semi-trailers and of other transport equipment	4.2%	2.1%

Note: Electricity intensity is defined as electricity consumption per gross value added

Source: Eurostat

Responses to the survey indicate that energy costs for most manufacturers in Gozo constitutes up to 30% of total costs. In this light and judging by the analysis of location quotients in section 2.2, the sub-sectors in Gozo most sensitive to changes in electricity prices appear to be chemical and chemical products and to a lesser extent electronic and optical products, electrical equipment and machinery and equipment.

Aside from the higher than average costs, insular and remote electricity systems also face the challenge of hedging against risks arising from the lack of grid connections with the continent. For island economies this results in security risks of energy provision, in terms of adequacy, operational security and resilience. Being an important input for production, reliable electricity supply is crucial to the manufacturing industry and is therefore an important factor that has a bearing on the attractiveness of a territory to businesses.

3.2.3 Human resources and labour costs

Intangible assets, such as the availability, knowledge and skills of human resources as well as labour costs are key factors that determine the attractiveness and competitiveness of a territory to businesses.

Availability of labour input is largely dependent on the structure of the local population. During the 2014-2022 period, Gozo's population grew by an annual average of 1.2%, while the working age population (15-64 years) increased by a robust 0.7%, largely due to immigration inflows. The labour participation rate has increased during the same timeframe and is currently estimated at 71%, but remains below the corresponding national level (78.2%). In particular, Gozo's female activity rate, although improving along the years, is estimated at a relatively low 42%, compared to 69.4% at a national level. Such structural labour market bottlenecks contribute to the lack of availability of human resources that is frequently mentioned by businesses as a major obstacle to their growth.

The dependency ratio, which expresses the ratio between the population of non-working age to that of working age, amounts to 1.8, slightly better than in mainland Malta (2.1). In terms of age profile, Gozo's population shows similarities with that of Malta. Gozo's population is in line with the national average for the 0-24 age bracket, while the proportion of the 25-54 years bracket is higher than that for Malta. On the other hand, the proportion of those over the age of 55 years in Gozo's population is lower. According to projections prepared by Oxford Economics, although Gozo's population will continue to grow up to 2040, the composition will shift to older ages. While the number of persons of working age is expected to decline up to 2030 before increasing by around 2.0%, the 65+ age cohort is projected to increase throughout the years to 2040 (see Chart 15).

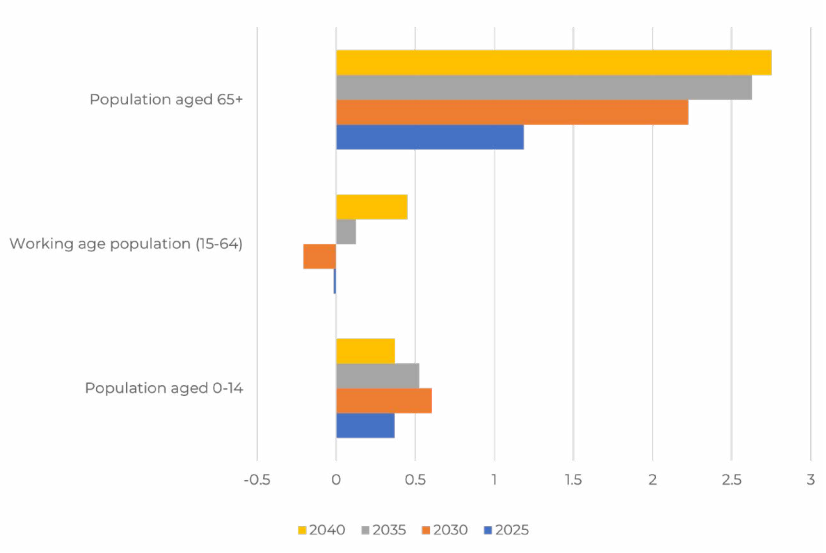
Apart from the quantity of labour inputs, the attractiveness of a territory to business is also related to the quality of human resources. Education and training for skills in demand are key for sustaining a territory's productivity growth and hence competitiveness.

The qualifications profile of the population of working age in Gozo shows that the share of the mid-skilled and high-skilled has steadily increased in recent years with the former almost similar to that in Malta. However, an unfavourable gap persists vis-á-vis mainland Malta with respect to the proportion of high-skilled and low-skilled persons (Chart 16). According to NSO data, in 2021

more than one in three Gozitan employees in the 25-64 years bracket possess low skills. The share of low-qualified adults is significantly high compared to mainland Malta (26%) and the EU average (21%). At the same time, the proportion of high skilled employees in Gozo (39%) is below the national average (47%).

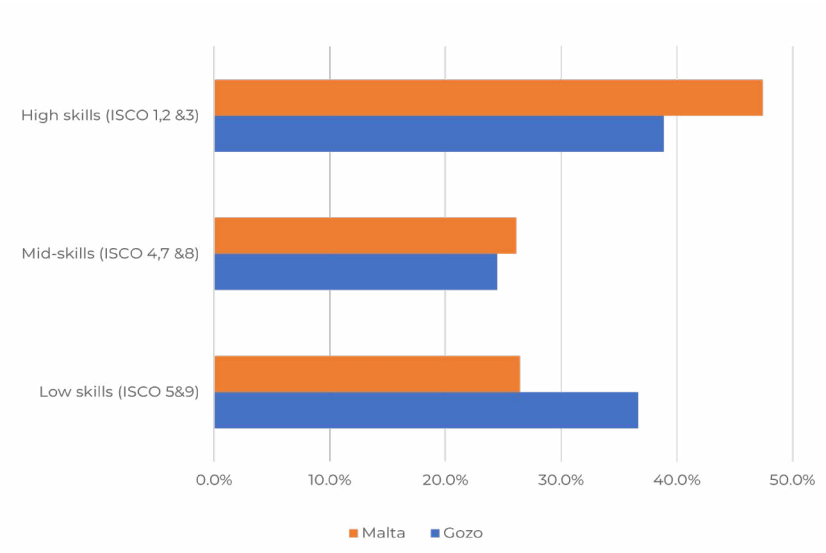
Gozitans face a physical hurdle to access post-secondary education and training. Although the main educational institutions have a presence in in Gozo, the courses they offer on their campuses is limited. As a result, Gozitan students have to commute or relocate to the mainland to further their studies. Private sector learning and training provision Gozo is also weak, which limits accessibility for locals to upskill and reskill. Only one in 10 persons in Gozo's population aged 25-64 participated in adult learning in 2021.

Chart 15: Projected changes in Gozo's population by age bracket
(Level change compared to 2021)



Source: Oxford Economics

Chart 16: Skills distribution of working age population
(%, 2021)



Source: Authors' calculations based on NSO data

In terms of qualifications of the future workforce, participation in vocational education (VET), which is perhaps the most relevant educational path for manufacturing, by Gozitan students lags behind that of their Maltese peers. In 2020, the share of learners enrolled in VET (ISCED 3) out of total learners in upper secondary education stood at around 21% in Gozo, against 27% in mainland Malta. A closer look at the subject areas of apprenticeship offered in all higher education institutes shows that engineering and manufacturing is the second most sought study field among Gozitan learners. Spending on training by manufacturing firms in Gozo seems to be rather low but in line with the national average. The majority of respondents to the manufacturing survey indicated an allocation of up to 10% of total investment for employee training which is around the level indicated at a national level as per the EIB Survey, 2022.

According to the National Employee Skills Survey 2017, manufacturing faces acute skills shortages. Some 56% of the sector's job vacancies are considered hard-to-fill (i.e. persistent unfilled job vacancies), with plant and machine operators being one of the most hard-to-fill occupation. In

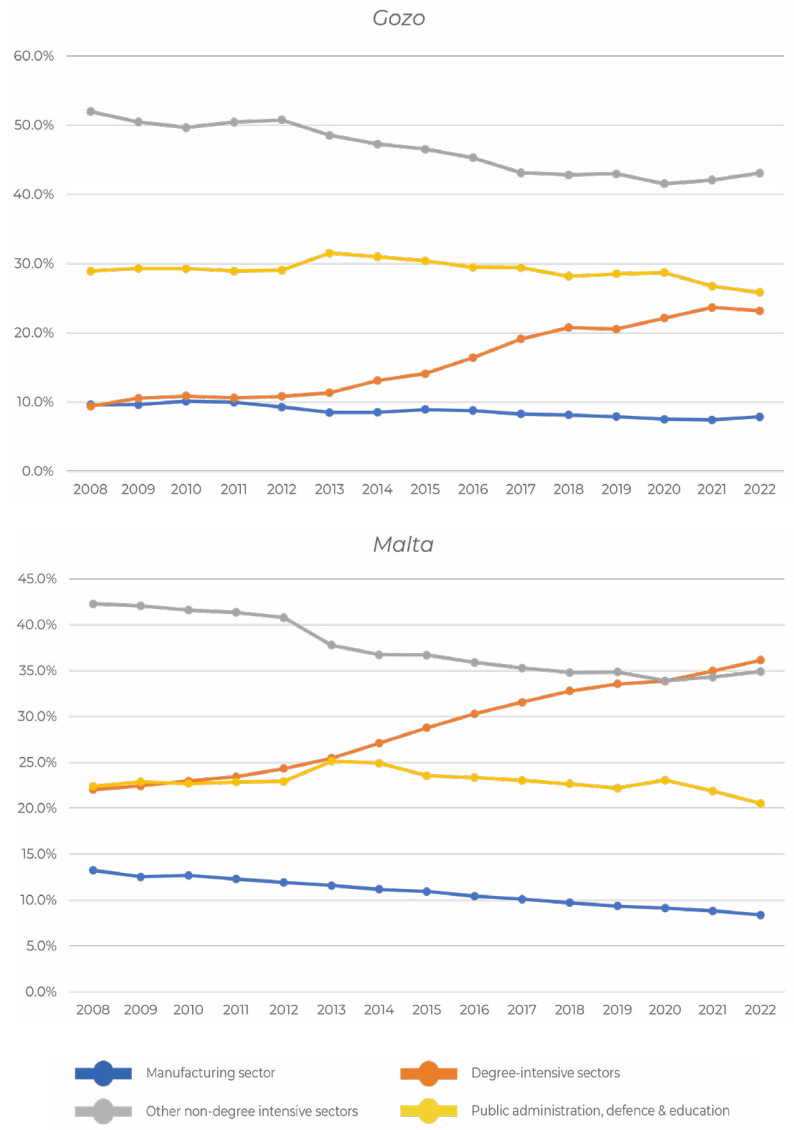
the same survey, manufacturing firms indicated that the most prevalent reason for unfilled job vacancies is the low number of applicants interested in the job rather than deficiencies in skills quality, followed by the low number of applicants in general. This seems to be corroborated by the responses to the survey of manufacturing in Gozo. More than 60% of respondents to the manufacturing survey expect that attracting and retaining employees will be a highly relevant challenge for their manufacturing business in Gozo over the next three years (Chart 11).

For a large portion of industry, the education level required by the workforce is minimal which heightens the economic vulnerability of regions displaying a manufacturing composition dominated by low skills. The vulnerability increases as the development-induced upward pressure on average wages forces labour-intensive manufacturing sub-sectors, such as clothing which are particularly sensitive to labour costs, to shift their operations to locations that offer lower wages or substitute the workforce with capital, such as automation.

This phenomenon is clearly visible in Chart 17 which illustrates a comparison between Malta and Gozo in the share in employment of degree-intensive and non-degree-intensive economic sectors. Manufacturing, a largely non-degree intensive activity of the Maltese economy, is shown separately as is public administration and education[14] given that these account for a significant share of the workforce on both islands.

The proportion in total employment of degree-intensive sectors grew sharply during the same period, with Gozo recording a higher increase than the national average. Although granular data on sectoral wages at a regional level is unavailable, it seems reasonable to conclude that the pressure across the wage spectrum may have effected manufacturing in Gozo less,

Chart 17: Trends in the qualifications-intensity of employment
(% of total employment)



Source: Authors' calculations based on Eurostat and NSO data

[14] In reality, Education should be classified as degree-intensive but in view of limitations in the granularity of data for Gozo it has been grouped with public administration and defence.

since manufacturing in Malta registered a sharper decline during the past 12 years. The fact that Malta's manufacturing base is more internationally oriented and hence more sensitive to changes in labour costs may have been one reason why employment in this sector fell by more in percentage points relative to Gozo. The brunt of these developments seems to have been borne by other non-degree intensive sectors (including wholesale and retail, construction and agriculture) which in Gozo recorded a larger drop in the share in total employment than that registered in Malta during the same period. Still the evolution of unit labour costs, which captures the relationship between nominal wages and productivity, remains an important challenge to the industry's competitiveness, as the results of the survey of manufacturing in Gozo suggest. Nine out of 10 respondents view labour costs to be a highly relevant or relevant challenging factors for their manufacturing business in Gozo in the coming three years (Chart 11).

4. The factory of the future - opportunities for Gozo from emerging technologies and globalisation dynamics

This section outlines the current international context focussing, in particular, on two trends that are expected to directly impact the geography of production in the near future. The objective is to provide a backdrop against which Gozo's manufacturing sector is presently operating and a forward looking perspective of the underlying forces that are anticipated to shape the industry with a view to inform any strategy or policy action that may be adopted in support of this sector in Gozo.

The two trends that will be reviewed here relate to changing globalisation dynamics and emerging technologies. The interaction of these forces is expected to have a direct bearing on where, how and what will be produced. While the focus will be specifically on these two trends, other megatrends such as climate change, shifting demographics and consumer preferences and urbanisation will likely impact the composition and scale of demand for manufactures as well as where production takes place. While the authors recognise that these megatrends will have a bearing on production decisions that merit a deep analysis, they fall outside the scope of this Discussion Paper.

4.1 Changing globalisation dynamics

Globalisation has been a constant feature since the dawn of humankind, albeit moving in different directions and appearing under different guises. In modern history, each cycle of globalisation coincided with the onset of successive rounds of industrial revolutions. The first industrial revolution brought down the cost of transport and created economic agglomeration in large, industrialised nations, while the second extended these gains further through electrification and the establishment of assembly lines that consequently gave rise to standardisation and mass production. Over the first two revolutions, transportation technology breakthroughs made it viable to produce goods in a location and transport them across long distances for consumption in another - wind and animal power was superseded by the steam engine which, in turn, was displaced by internal combustion and air cargo.

Yet, while advancement in transport technology shortened distances thereby enabling trade and innovation to flourish, communication barriers remained relatively high. This meant that coordination among geographically-dispersed production locations was inefficient. It was only after a series of advances in telecommunications, computing power, transmission and software that this communication constraint was overcome. The third, or ICT, revolution made it viable to geographically separate stages of manufacturing. This, together with the significant political changes in the late 1980s brought about by the end of the Cold War which occurred around the same time, ushered in a new wave of global economic integration in subsequent years. Offshoring production abroad contributed to the expansion of globalisation. Companies began extending value chains internationally, while heightened cross-border movement of people, goods, services, capital and data led to a growing interdependence of different economies, people and cultures.

Globalisation started to slow down after the 2007 global financial and debt crisis and failed to regain its previous speed. At the same time, emerging economies that initially participated in global value chains exclusively as assemblers of final goods started to develop more extensive domestic supply chains, thus decreasing their reliance on imported inputs. International trade and investment as a share of GDP started to decline, while supply chains began to shrink. The pace of international cooperation and multilateralism waned. Rising populism in several parts of the world partly fuelled by rising unemployment and income inequalities caused by offshoring heightened the scepticism towards the globalisation ideology giving way to calls for protectionism. In 2020, the coronavirus pandemic dealt a profound shock to global trade, investment and travel and exposed the vulnerabilities of global value chains. The severity of the disruption brought about by the pandemic, which added to the slowdown in world trade and to fragmentation in a number of areas, led some observers to conclude that the world entered an era of deglobalisation or, at a minimum, slower globalisation ('slowbalisation').

The growing international economic tensions as the US and EU push to decouple/de-risk from China within the context of strategic competition not only in trade and investment flows but also in technology, highlight the major geo-economic paradigm shift that is currently unfolding and will continue in the years ahead. Closer to home, this will inevitably lead to a recalibration and reinforcement of the EU's trade policy regarding strategic sectors. To this, one must add the revival of semi-interventionist industrial policies in both the US and EU underpinned by substantial financial incentives aimed at encouraging nearshoring or reshoring[15] of manufacturing production especially in the semiconductor, electric vehicle and clean technology sectors.

The EU's increasingly inward-looking trade and industrial policy through the promotion of reshoring/nearshoring to mitigate concers of security of supply and promote strategic autonomy, coupled with impending climate tariffs partly in response to concerns about the environmental cost of highly fragmented global value chains and just in time production models suggest that regional production structures will occupy a central role in a reordered geopolitical system currently underway. These drivers of change, together with some of the traits of emerging technologies, which will be discussed next, may present new opportunities for Gozo to attract high value-added manufacturing operations and participate in the European value chain.

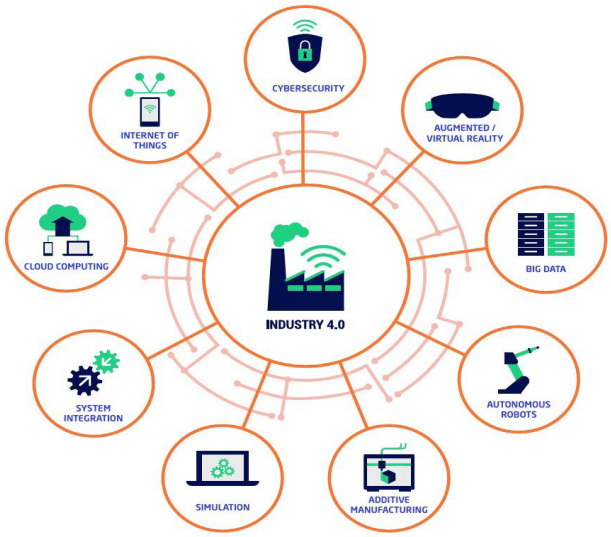
[15] Reshoring and nearshoring involve relocating manufacturing operations closer to the target or home market.

4.2 Emerging technologies

The response of industrialised countries to a loss in competitiveness and the consequent decline in their share in global industrial production as a result of rising labour costs spurred the fourth industrial revolution, otherwise referred to as Industry 4.0. Simply put, Industry 4.0 is the digitisation of manufacturing and represents a significant transformation in the way industries operate and produce goods. Specifically, Industry 4.0 is based on a number of technological drivers and integrates the Internet of Things (IoT) with relevant physical and advanced digital technologies including cloud computing, big data and analytics, AI, robotics and additive manufacturing into various aspects of manufacturing and supply chains (Figure 2), with the customer at the core of production processes. Responses to the survey suggest that there is a relatively high awareness among manufacturers in Gozo about the need to adapt to Industry 4.0.

Industry 4.0 is creating smart factories that are able to optimise the value chain, enhance flexibility and increase productivity. These factories have two salient features: the first is the physical-to-digital technologies embodied in machines and equipment and the goods they produce that enable sensing, monitoring, and control. The second is the communication between the disparate parts of the value chain. While all sectors of industry are expected to be transformed by Industry 4.0, some will be more affected than others. The process technologies (and the increasing pace at which they are being adopted) that are expected to have the largest effect on the production of conventional manufactured goods are: robotics, IoT and additive manufacturing. By changing the relative efficiency in producing traditional goods, these three technologies can have implications for comparative advantage and therefore patterns of globalisation. In addition, according to the World Investment Report (UNCTAD, 2020), these three technologies are also considered to be conducive to reshoring especially for some industries such as automotive, machinery and equipment and electronics.

Figure 2: Key technological pillars of Industry 4.0



Source: Kadir, B., (2020)

To keep the analysis within reasonable bounds, this Discussion Paper will examine additive manufacturing (AM) as a case study.[16] The choice of additive manufacturing among the three above mentioned technologies is based on the most recent literature which seems to indicate that AM possesses attributes that could potentially be the most suitable and adaptable to small island economies. For instance, additive manufacturing holds the potential to align products more closely to customer specifications and could thus be conducive to the regionalisation of production. Although focusing on AM represents only a partial assessment of the potential of

[16] For the purposes of this report, only the industrial application of AM is assessed. Although an important market which can have disruptive effects on manufacturing, desktop-based household 3D printing is beyond the scope of this report.

Industry 4.0, it nonetheless illustrates the possible opportunities that could accrue to Gozo from targeting this manufacturing technique, for instance by becoming and specialising as a regional AM hub.

4.3 Additive manufacturing

Additive manufacturing (AM), also referred to 3D printing, is a process that creates objects by adding layers of material one on top of another, as opposed to subtractive manufacturing methodologies used in traditional machining. The rapid growth in recent years of AM technology usage has largely taken place as part of Industry 4.0. The market for AM is projected to amount to US$35 billion in 2024 and is expected to double in size approximately every three years.[17] AM is facilitating the transition from mass production to mass customisation in several sectors and is considered instrumental in the green and smart transitions. In most cases, AM is used for prototyping purposes followed by the manufacturing of end-use parts. Although a level of uncertainty remains regarding the nature and evolution of the technology, additive manufacturing has clear potential to disrupt the manufacturing landscape since it enables products to be made on demand, at point-of-use and with very efficient use of material.

AM is a technology with many potential applications across a range of specific tasks and sectors. In the past decade, the application of AM was mostly driven by the manufacture of parts and components in the airline and automotive sectors, healthcare and pharmaceutical sector such as prosthetics, dental and medical implants, hearing aids and medical apparatus and instruments. However, use cases are increasingly emerging in other markets, including construction, apparel such as footwear and textiles, furniture and in the food industry using chocolate, dough, sugar and meat. AM is also applied in the production of consumption items such as phone accessories and kitchen utensils. A key advantage of AM is that it is especially well-suited for producing custom designs that would be costly to produce with conventional manufacturing.

Cost advantages of the AM technique include less machines and retooling time during production and reduced material wastage. AM can help limit some of the consequences of value chain disruptions and lower costs of storage and holding buffer stocks of parts while reducing risks associated with production downtime inventory management. It has the potential to limit disruptions in particular products and components since it allows for a swift access to replacements. This represents a clear advantage since, as discussed in section 3.2.1, manufacturers operating in Malta face additional challenges in terms of supply chain disruptions that effect production and necessitate stocking machinery spare parts as contingency which add to their logistics costs. In addition, for a large number of processes, AM can significantly reduce component weight and the number of parts, two dimensions that have a bearing on transport and logistics costs.

Parts can be printed and dispatched within hours or days after they are ordered thereby increasing lead time benefits and reducing bottlenecks in supply chains. AM makes it possible for manufacturers to print a component for a customer and then pivot to make a totally different component for another firm without incurring retooling costs. Further, AM significantly reduces

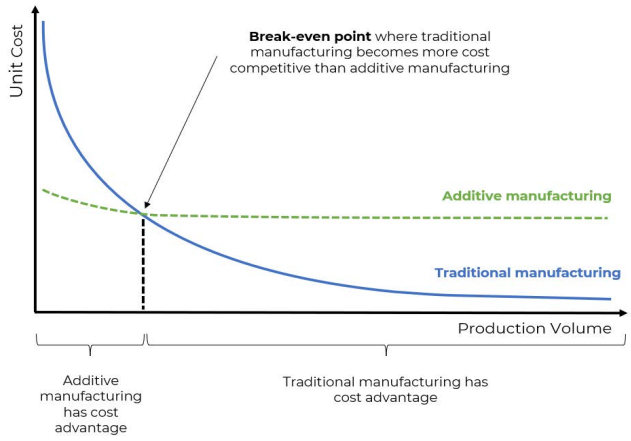
[17] Hubs (2023), "3D Printing Trend Report 2023 - Market insights and forecasts in additive manufacturing".

time-to-market for products which face short product lifecycles due to changing consumer demands. The increased ability to customise production and the reduced need for specialised components together enable personalisation of products.

AM is considered to generate productivity and scope enhancing manufacturing outcomes, allowing firms to increase their competitiveness. Studies comparing the economics of AM to conventional manufacturing suggest that AM is more cost effective for small runs while conventional techniques gain cost advantage at scale (Figure 3). In addition, the more geometrically complex the manufactured items, the further the breakeven point, i.e. where the unit costs of the two techniques equal each other.

Deployment of AM can be either geographically concentrated or dispersed. In the case of concentrated manufacturing, AM happens in central hubs much like traditional industrial estates, with goods shipped to final destination. Distributed manufacturing takes place closer to final destination. Several studies show that the current economics of AM appears to favour concentrated over dispersed manufacturing, for example, in the case of aircraft and medical parts.

Figure 3: Additive and conventional manufacturing cost comparisons



Source: Elaboration based on Ruffo, Tuck and Hague (2006)

Still, AM faces a number of challenges. As a manufacturing technique, it is limited to certain materials which are more malleable and adapted to the technology including plastics, metals, ceramics and paper. Material costs are often identified as a key barrier to broader AM adoption since some equipment is designed to work exclusively with materials developed by the machine vendors, thereby limiting the choice of using third-party materials. Advances in technology could see a wider application of input material broadening the scope and potential of the technology. In addition, the slow manufacturing process means that AM machinery is best suited for low-volume, customisable production rather than for mass production of goods. The initial investment can be high in terms of both equipment and upskilling the workforce, and in some cases specialised raw materials for specific printers can be costly.

4.4 Assessment

The geo-economic fragmentation that could induce reshoring and nearshoring of manufacturing production stages together with technologies that make low labour costs a less important determinant of competitiveness, may strengthen regionally-oriented value chains. The interplay between evolving globalisation dynamics, emerging technological changes and a number of benign attributes of additive manufacturing, the case study of this Discussion Paper, could create favourable conditions for Gozo to attract new opportunities in innovative industry sectors.

In this context, as one of the emerging technologies, AM is shifting the criteria that make locations attractive for production and can change conventional patterns of comparative advantage. With an emphasis on customisation and the time it takes to bring a product to market, it could disrupt scale economies and render the production of more goods in different locations more feasible. The demand for customised, swiftly-delivered goods could favour the establishment of a "micromanufacturing" model, whereby small businesses can access international designs and print them locally.[18]

For instance, AM technologies are suitable for the premium apparel and footwear segments, where customisation, transport costs, reliability and short design-to-production cycles for new models are important considerations. In addition, AM technology may make it feasible for small batch production without the need for scale nor a large ecosystem of suppliers. This may be particularly useful for territories like Gozo that have limited manufacturing bases. Regarding the choice of location, it is expected that AM activity will cluster in hubs especially if the cost of machinery and equipment remains sticky and clear advantages of centralising persist. This would further reinforce the push towards reshoring and favour a concentration of 3D printing activity.

The higher value-added operations that characterise AM also seem to make it suitable and adaptable for Gozo. This is because it eases some of the transport cost disadvantages that effect the attractiveness for businesses operating in insular and remote territories. AM displays favourable characteristics in terms of the manufactured goods high value-to-weight ratios. Designs that require less material to produce make goods lighter. For conventional manufacturing, the process of making a product lighter by removing material renders it more expensive. The opposite is true for AM, because of the materials saved, the lighter a part the cheaper it is to manufacture. This has an obvious advantage in terms of cost and performance of products for which weight matters, such as in the airline and automotive industries. Other sectors with high value-to-weight ratios are related to medium- or high-technology manufactured goods found mostly in electronics, computers, and optical instruments; transportation equipment; other machinery and equipment; or electrical machinery and apparatus.

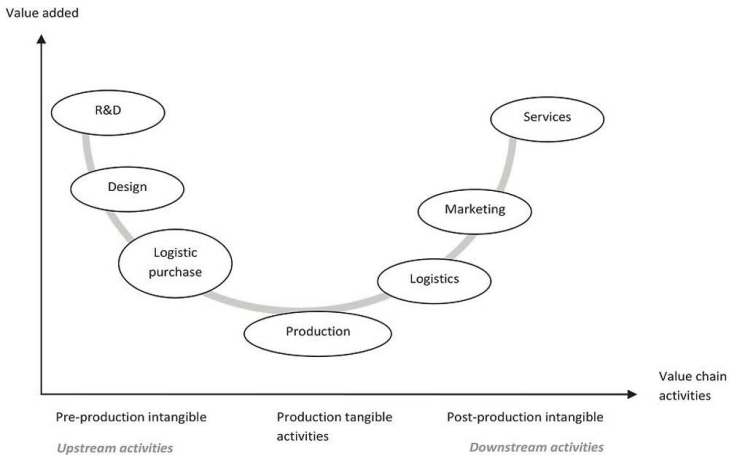
The higher added value of these product categories together with the short delivery time typically required by customers necessitate and allow the goods to travel by air transport, further suggesting that AM could potentially be suitable and adaptable for Gozo. From a macroeconomic perspective, AM could make an economy less dependent on imported inputs since it does not require importation of labour-intensive components and reduces wait time for specific parts. As a result, production is less susceptible to delays and less reliant on transport infrastructure which, as discussed earlier, poses a number of challenges to industry located in the Maltese islands.

Another important consideration is that, in general, manufacturing activities are increasingly dependent on and include services in their offering. 'Servicified' manufacturing refers to the increasing purchase, production and sale of services by manufacturing. In Malta, service inputs account for slightly less than 20% of manufacturing output, while some 35% of manufacturing exports contain services value added (National Board of Trade of Sweden, 2016), indicating a relatively high level of servicification in local industry. Increasingly, the productivity of services matters for manufacturing competitiveness. Industry 4.0 technologies including additive

[18] For example, an Australian manufacturer that currently exports to the EU could reduce transport costs and potentially avoid duties by using an AM hub within the EU, which would receive the digital designs then deliver the printed goods to all EU member states.

manufacturing emphasise the increasing servicification of manufacturing largely driven by the use of data in production processes. Since designs and data are delivered digitally from a product designer in an exporting country for printing in a target market, AM puts a premium on data flows as part of the manufacturing process. Gozo can leverage the high quality of local services, including ICT services specifically enabling technologies such as IoT, big data and cloud computing, to attract AM operators on the Island. In line with the growing servicification of industry as shown in the deeper 'smiling curve' in Figure 4, other complimentary high value-added service inputs, including design and R&D, could be targeted to support and build an AM value chain and increase the local content of output.

Figure 4: The smiling curve: Value added along the global value chain



Source: OECD (2013)

Technological change raises the requirements for high-quality education to meet changing demands for skills. As argued in section 3.2.3, Gozo has an unfavourable gap with regards to high skills and faces a labour shortage reflecting the general situation in mainland Malta. For this reason, attracting AM operations to Gozo might be constrained by the scarcity of trained technicians and engineers. Expanding Gozo's capacity to attract AM operations necessitates building the right capabilities by supporting the creation of specialist additive manufacturing inclusive education programmes, at all levels. These include apprenticeships, vocational training, online training courses, further education and in-work reskilling programmes as well as raising awareness on the capabilities of additive manufacturing.

5. Conclusion

Resource limitations in terms of both variety and quantity means that Gozo struggles to reap the gains of economies of scale and scope. This incurs a premium on logistics/transport and energy costs and can only expect to realise partial benefits from agglomeration spill-overs, where all elements that characterise the dominant development models based on mass market production. Due to insularity (small size, small market, low accessibility), Gozo cannot hope to be competitive with a strategy of mass production, low production costs and low value-added manufacturing activities. Instead, other alternatives which rely on characteristics such as quality and diversification with the specific aim of targeting niche markets are far more preferable.

While the role of industry in Gozo should be bolstered to ensure a balanced economy and reduce vulnerabilities, the future of manufacturing may be at a crossroads. The analysis in this Discussion Paper shows that Gozo's production basket seems to be missing skill-intensive and high-value added operations. At a broader level, this Discussion Paper documents the ongoing push towards

regional production structures brought about by changes in geopolitical dynamics and the deep technological disruptions that are transforming the global manufacturing sector as we have known it until now and that will spare no sector. In this light, the Discussion Paper provocatively and tentatively identifies additive manufacturing - a segment within this technological shift that shows traits that appear to fit Gozo's attributes and that largely overcome the structural disadvantages of insularity; high value-added, small operations, favourable scale economies and low input requirements. However, leapfrogging into manufacturing activities that use new technologies necessitates solving skills gaps and skills shortages through strong investment in the supply of high-skilled human resources.

Although the relatively low value-added manufacturing activities on the Island appear to have weathered multiple external shocks relatively well mostly due to the sector's domesticorientation, the deep shifts currently underway may be too strong for some enterprises to handle, without significant policy and firm-level action. The EU's regained interest in strengthening its industry, government's 2024 Budget speech announcement of initiatives in support of manufacturing and the identification of additive manufacturing as a target sector in Malta's Smart Specialisation Strategy 2021-2027, present an opportunity for the Island to build on its strengths and past achievements by repositioning and renewing the industry to ensure that it contributes to Gozo's future prosperity.

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Annex - Manufacturing in Gozo survey methodology

Overview

This Discussion Paper was partially informed by the analysis of the responses to an ad hoc questionnaire among manufacturing enterprises in Gozo. The objective of the questionnaire was to collect information and therefore obtain a more comprehensive picture of the state of industry in Gozo, in view of the gaps in key disaggregated official regional statistics. In addition, the questionnaire provided an opportunity to measure the sector's sentiment and outlook on a number of critical dimensions, adding an important layer of information to the analysis.

Sampling design

The target population of the questionnaire consisted of manufacturing firms belonging to NACE category C and currently operating in Gozo. Statistical theory suggests that, for population sizes less than 300, the "sample" should include the entire population. In this light, and due to the relatively small number of operators in Gozo, the entire industry population received the questionnaire. The sampling frame was drawn out from a list of manufacturing units provided by Malta Enterprise. In total, the questionnaire was sent to 114 manufacturing firms.

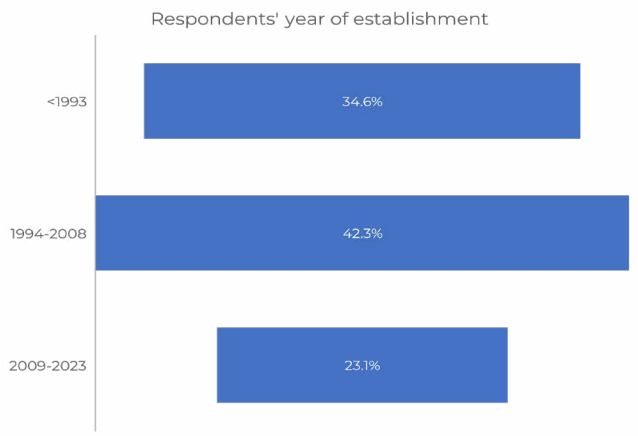
Questionnaire design and field examination

The field examination was based on a self-administered questionnaire consisting of 32, mostly closed-ended, questions. The first draft of the questions was designed by the author and covered areas of interest of the report for which official data was missing. Following a review - which included pre-field quality testing with individuals outside the sample and validation by the GRDA, the electronic questionnaire was distributed to participants through GRDA's official email address.

Invitations for voluntary participation, which included a link to a Google Form questionnaire, were sent to all participants in the first week of September 2023. The invitation sought the respondents' consent to participate, provided assurance that the survey was bona fide, stressed the anonymous and confidential nature of the study, outlined the topics covered and aimed to achieve high participation in the survey. Respondents were initially given a four week window to reply. Since the initial response rate was considered low, email reminders were sent followed by phone calls to non-respondents to maximise response rates to the e-mail survey. As a result, the final data collection deadline was extended to the end of October 2023.

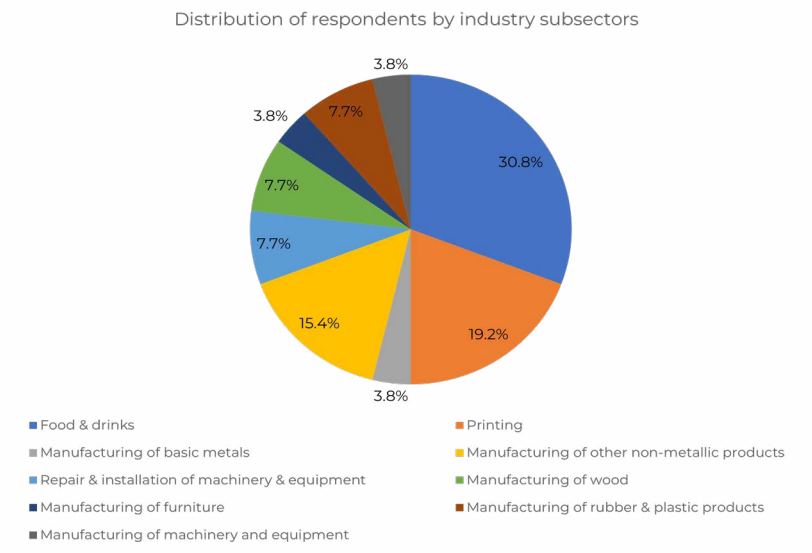
Data processing and profile of respondents

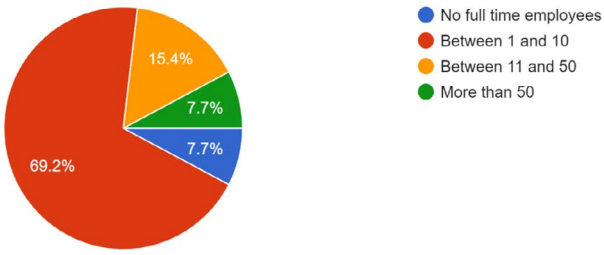
There were 26 completed survey responses. Following a data quality check to detect incomplete and inconsistent responses, all submissions except one were deemed admissible for the data set and considered suitable to be used for the analysis. This represents a response rate of 23% of the eligible subjects in the sample and, as a result, may increase the likelihood of response bias or nonresponse error. However, following Cook et al. (2000), that response representativeness

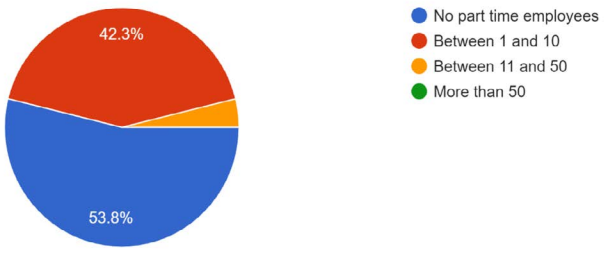


is more important than response rate in survey research, the participation of the most significant manufacturing operators in Gozo in the survey assures the relevance of the results. Nevertheless, in view of the response rate, the survey data should not be interpreted as facts but as respondents' perceptions.

Around 42% of the respondents represented manufacturing firms established in the period 1994-2008, whereas more than a third were established before 1993. In terms of the sectoral distribution of respondents, the highest proportion (28%) represented the food subsector, followed by printing and other metallic products (16% each) and furniture (12%), which is broadly in line with the sectoral distribution of the sector. The majority of respondents (almost 70%) are micro enterprises employing between one and ten workers, while 15% of respondents employ between 11 and 50 persons, representing small manufacturing firms. This broadly aligns with the proportion of micro and small manufacturing enterprises in Gozo (80% and 17%, respectively). The majority of respondents indicated that they do not employ part-time workers, whilst the 42% have between one and ten persons in part-time jobs.







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