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HIGH-QUALIFIED LABOUR AND SKILLS: THE DEMAND SIDE

In this chapter, we analyse the demand side of Penang's labour market focusing on high-qualified employees in both quantitative and qualitative aspects. We discuss current drivers in the forms of upgrading and new directions in Penang's pathway to a higher-income economy. Next, we elaborate on current development of, and shifts in, demand for high-qualified labour in relation to investment trends, job vacancies, and firm recruitment patterns. The specifications of job vacancies and recruitment provide insight into the labour skill demand trend according to major occupations and industries in Penang. While the main emphasis of this study lies on the current situation and the immediate years ahead, it also prompts a brief consideration of debates on the future of work/jobs, and what that may imply for Penang³⁰.

³⁰ Earlier versions of parts of this chapter are included in the project inception report, and Terhorst, J. and T. Verbraeken (2016). *Making the Transition into a High-Income Economy: The Penang Case*. Master Thesis, Department of Human Geography and Planning, Faculty of Geosciences, Utrecht University, The Netherlands.

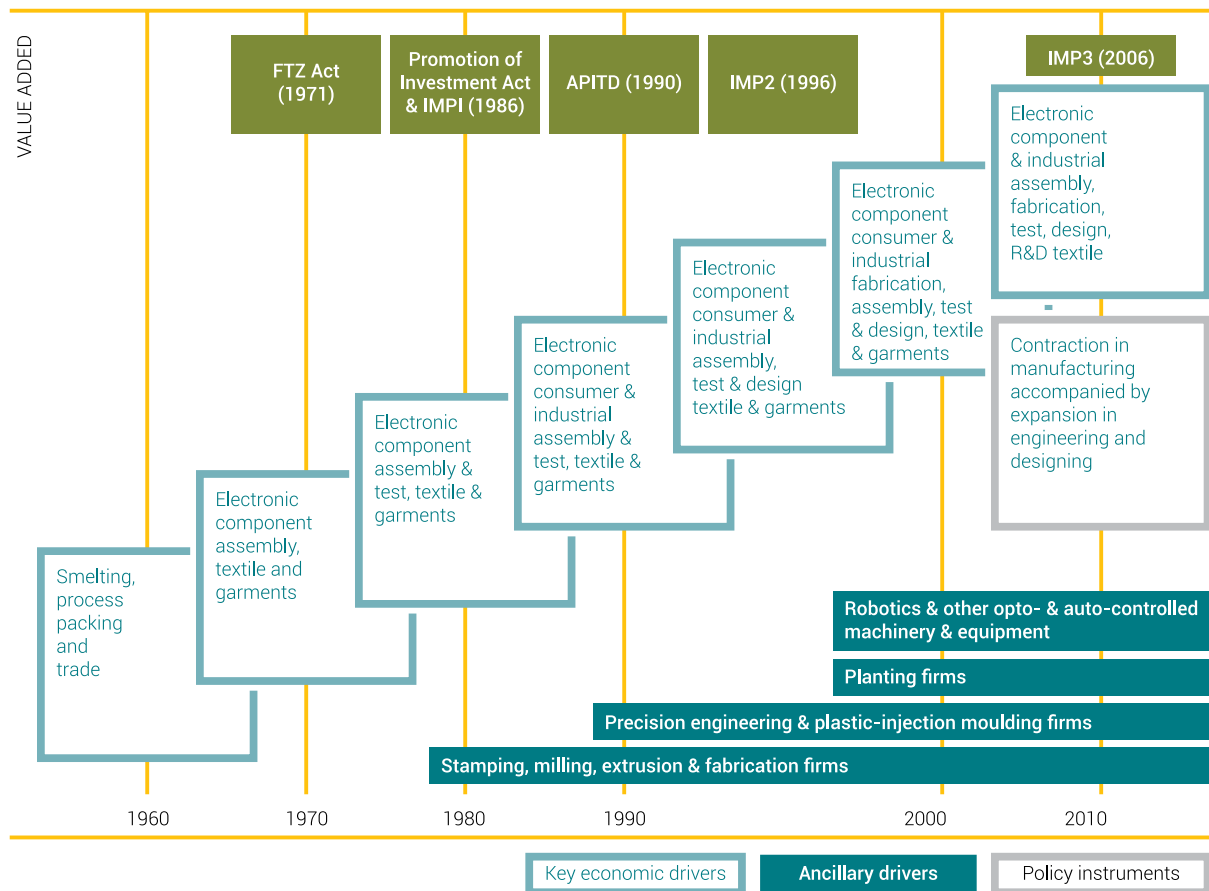
4.1 Penang's next economy and skill demand

Penang's pathway of development into the 2000s has continued to privilege industrial development for some time. It is attributed to the gradual technological deepening of manufacturing in the MNC-led and SME-led segments. This is illustrated in change of the value-

added profile (Figures 4.1 and 4.2).

In the process of upgrading – segments of – industries have started to dwindle as low-value assembly operations have moved out, substituted by higher value operations (e.g. semiconductor and computer storage), or have even ceased to exist (e.g. consumer electronics). At the same time, new industries have started to expand (e.g. medical devices).

Figure 4.1: Industrial development in Penang, 1960–2010



Source: Kharas et al. (2010) p. 34

More recently, these trends have been reinforced with the following developments: first, a further maturing of Penang as a production platform offset by MNCs moving operations along the value chain, or selecting Penang as a location for non-production operations (e.g. research and development, design, shared services). Second, cluster development resulting in integrated chains in a number of industries. Clusters have also been labelled as eco-systems, by any considered a strategic advantage of Penang in the competition for investments. Third, there is a further industrial diversification within manufacturing. Fourth, eco-systems have been influenced as SME-dominated industries have begun to move from incipient stage of being linked to MNCs to gradual delinking and towards either more sophistication (e.g. successful firms in automation) or stagnation. Fifth, there is an emerging and deepening services sector.

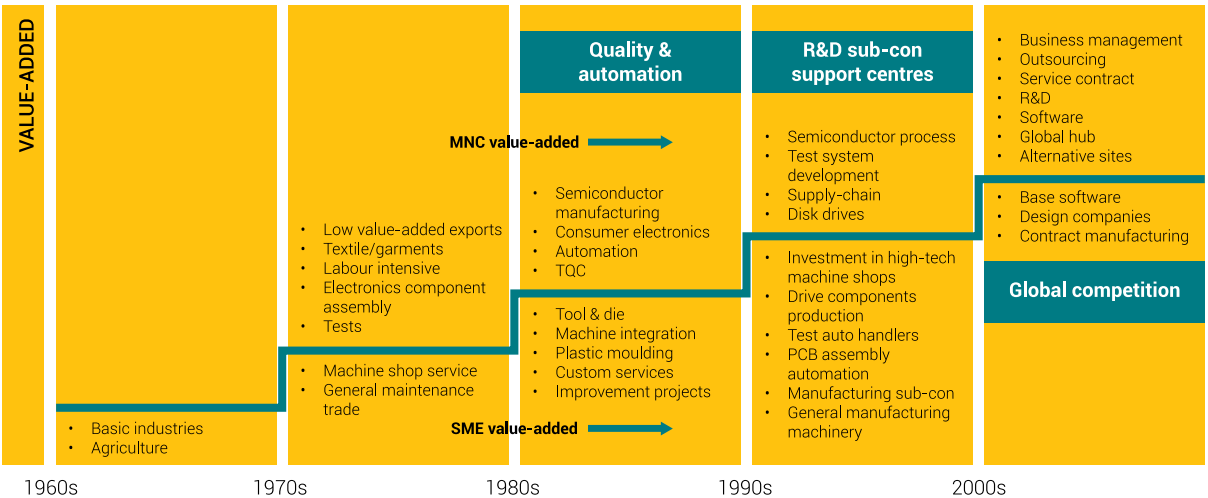
Positive growth linked to some of these developments has resulted in part from active local government policy intervention to counteract the gradual stalling of other developments. The latter has not been unique to Penang as Malaysia as a whole has been confronted with the middle-income trap. Kharas et al. (2010)

offered a useful discussion of the stalling trend³¹. To a certain extent, the national strategy to counter the middle-income trap – the Economic Transformation Programme (ETP), elaborated in the Key National Economic Areas (NKEAs) and the Northern Corridor Development Plan³² are also in place to facilitate growth in the region.

MNCs in a number of industries have frequently integrated R&D, high technologies activities (application development and the design of electronics), and shared global business services into Penang-based business processes. As a case of diversification within manufacturing, the medical devices industry has grown rapidly; at the same time, new industries such as LED, Aerospace and Renewable energy have started to emerge by the mid-2010s at the incipient stage.

Meanwhile, the situation of local SMEs in some industry branches has become critical with low-tech manufacturing activities of MNCs moving to lower-cost locations such as China and Vietnam. With a decrease in demand, local SMEs started to sell their low-end products overseas to MNCs in China. However, due to strong competition from Chinese SMEs (costs and

Figure 4.2: Value-added roadmap – the Penang story



Source: Kharas et al. (2010) p.36

³¹ Kharas et al. (2010)

³² See the Economic Planning Unit (2010, 2015) and Koridor Utara (2007)

geographical proximity), it has become increasingly harder to continue business in China. Many local SMEs have been slow to invest in manufacturing upgrades. Overall, one can say that local SMEs have had difficulties adapting to structural market changes. Mismatch between MNCs and local SMEs today exists³³.

The strategy was to further diversify by expanding the services sector. Besides professional and business services, shared services has been targeted within the scope of this sector (although formally speaking, Global Business Services (GBS) operations are more appropriately designated as 'moving up' in terms of the value chain of both foreign and domestic companies).

In 2006, the manufacturing sector represented 56.3% of Gross Regional Product (GRP). This has dropped to 44.6% in 2016 (still substantially higher than in Malaysia as a whole). In contrast, the services sector has grown from 39.5% in the share of GRP in 2006 to 49.2% in 2016 (Table 4.1) with a slightly higher annual growth rate compared with manufacturing sector.

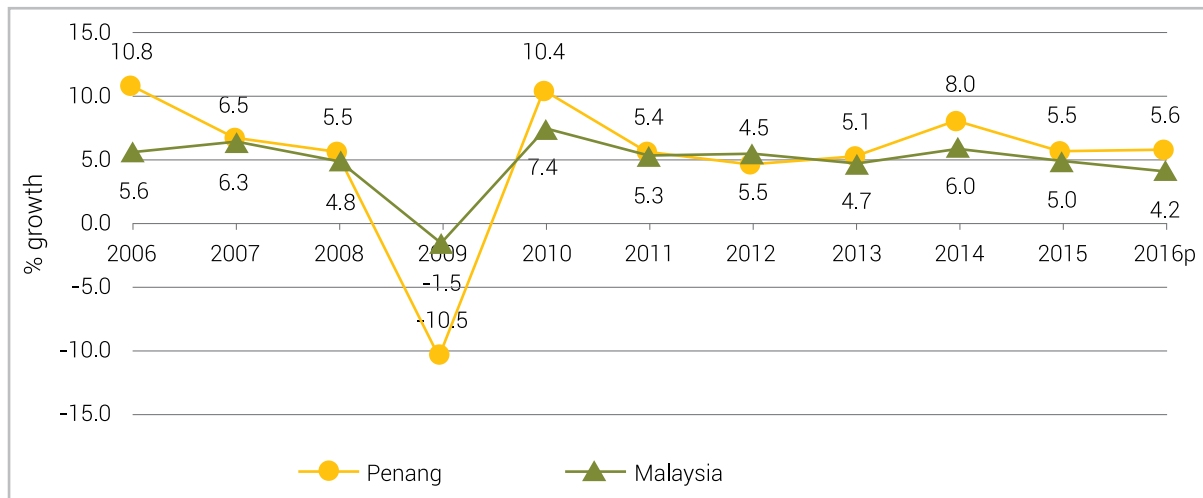
This trend will be reinforced as the next phase in economic strategy that commenced in 2013–2015 started to produce results. According to an unpublished internal study conducted by Penang Institute, the background and objective of the strategy is to provide a push to – some argue, or restore – dynamism to Penang's economy in addressing the middle-income trap. Since the global financial crisis, Penang's economic growth – while still comparable – has outpaced the national economic growth, while prior to the crisis, this was actually the case (see Figure 4.3). Paralleled with the 11th Malaysia Plan (2016–2020), and the still evolving 'Northern Corridor Development Strategy' (2007–2025), it is important to focus on continued restructuring, expanding new growth areas, and addressing constraints to these.

Table 4.1: Malaysia GDP and Penang's GRP growth and share percentage, 2006 and 2016

Economic activity	Malaysia				Penang			
	% growth		% share*		% growth		% share*	
	2006	2016	2006	2016	2006	2016	2006	2016
Agriculture	5.8	-5.1	8.3	8.1	10.4	-2.8	1.6	2.0
Mining	-1.2	2.2	12.4	8.8	0.0	8.7	0.0	0.1
Construction	-0.5	7.4	2.8	4.5	-3.7	10.4	1.9	3.1
Manufacturing	7.4	4.4	28.0	23.0	15.0	5.4	56.3	44.6
Services	7.2	5.6	47.5	54.3	6.3	5.6	39.5	49.2
GDP growth/share	5.6	4.2	99.0	98.6	10.8	5.6	99.3	99.0

* The share does not add to 100% due to import duties.
Source: Department of Statistics Malaysia (DOSM)

Figure 4.3: Growth rates of national GDP and Penang's GRP, 2006–2015*(%)



*Data from 2006–2010 are at constant 2005 prices while 2011–2016 are at 2010 constant prices.

p Preliminary

Source: Department of Statistics Malaysia (DOSM)

Positioning Penang

The 2010 Khazanah's 'Positioning Penang' report³⁴ provides not only an insightful overview of trends, opportunities, and constraints in the development of the Penang's economy, but also indicates areas that can drive growth in the decade(s) ahead. These concern three major areas and six focus areas. The main areas include MNCs further moving up the value chain, new variety in manufacturing and services industries, and growing SMEs. In terms of industries and level of sophistication, the six focus areas are: -

- Technology-based manufacturing including more sophisticated electrical and electronics manufacturing, medical devices and automation;
- Bio-technology and life sciences;
- Business Process Outsourcing (BPO);
- Logistics;
- Tourism (with niches in medical tourism and meetings, international conventions and exhibitions-MICE); and;
- Agribusiness.

These six branches share three characteristics that when combined, increase the likelihood of which can be successfully developed in Penang: scale economies, linkage with regional and global demand through cross-border supply chains, and the possibility to exploit Penang's existing strengths. The latter is a function of 'proximity' to existing products in the Penang product space; stated otherwise, it constitutes related variety.

An internal study from Penang Institute found that most of the focus areas listed above outlines a vision on, and a roadmap for, reinvigorating Penang's economy. Building on Penang's strengths and opportunities, the roadmap includes the following elements.

- Technological upgrading and moving up the value chain in manufacturing and services;
- Building modern services;
 - Tourism;
 - Medical Services/Healthcare;
 - Regional Education Hub;
 - Shared Services Outsourcing (SSO);
 - Creative Industry;
- Growing SMEs; and
- Innovation through Science and Technology.

³⁴ See Kharas et al. (2010)

Table 4.2 summarises Penang's strengths and opportunities with respect to the key economic areas. Many new skill requirements follow from these ideas and determine the possibility to further exploit and

expand the existing innovation initiatives. Meanwhile, Tables 4.3 and 4.4 list the key industries, activities and initiatives constituting the core of the economy.

Table 4.2: Key economic areas

Economic area	Penang's strengths	Penang's opportunities/focus
Technological upgrading; further moving up the value chain	The presence of MNCs and their well-established eco-system; competent SMEs.	E&E industry (including automation/machinery/ precision tooling, fabricated metal products, plastics, transport equipment) readiness to move up the value chain by setting up R&D, service centres, and spur innovation. Further growth and diversification of high-tech manufacturing (such as life sciences, including medical devices and bio-pharmaceuticals) and high-tech bio-agro sector.
Modern Services		
Healthcare	High quality healthcare providers in public and private sectors and well-trained personnel.	Shifting demographic composition hence readiness for Remote Healthcare, existing regional demand and ageing population.
Tourism	UNESCO world heritage site, nature, well established hospitality industry, top medical tourism destination in the country, and world-class home-grown athletes.	Middle and high income groups, growth of international tourism, changing demography linkage tourism and heritage, medical services and eco-initiatives.
Business Services	Quality human capital and facilities.	Positioned to be the Northern hub with strong MNC presence and future well-built SSO/BPO hub. High-end SSO; linkage with ICT sector.
Education Hub	Well established tertiary institutions such as USM and supporting facilities.	Becoming an education hub, attracting foreign talents and opportunities to establish a research university.
Creative industry	Talent, technology, and tolerance	Visual arts, crafts, film and TV production, performing arts, human capital development, music, digital and multimedia content, as well as marketing, sales, and distribution.
SMEs	Niche competences; SMART centre, SME villages, SME centre.	Growing beyond supplier role into independent exporters.
Innovation	The presence of MNCs and their well-established eco-system.	Harnessing Penang Science Cluster and existing innovation initiatives.

Source: An unpublished internal document by Penang Institute

Table 4.3: Key industries for which Penang has the competencies to further develop

High value-added engineering		Modern services
High-tech manufacturing	Life sciences & food processing	
<ul style="list-style-type: none"> • Light Emitting Diodes (LED) • Radio Frequency Identification (RFID) • Integrated Circuits (IC) • Automation and precision machinery • Automotive • Broadband equipment • Renewable energy • Oil & Gas (O&G) facilities 	<ul style="list-style-type: none"> • Medical devices • Bio-pharmaceuticals • Food processing • Halal industry • Agriculture & Agro Life Sciences • Aquaculture 	<ul style="list-style-type: none"> • Tourism • Education • Shared Services Outsourcing (SSO) • Information Communications Technology (ICT) • Creative hub

Source: An unpublished internal document by Penang Institute

Table 4.4: Existing innovation initiatives in Penang (excluding corporate R&D)

Initiative name	Main stakeholders	Activities
Collaborative Research in Engineering, Science & Technology (CREST)	TalentCorp, Northern Corridor Implementation Authority (NCIA), Khazanah, MIDA, USM, MNCs such as Avago, Altera, AMD, Agilent, National Instruments, Motorola, Intel, Siltera, Osram, Western Digital, and Seagate	R&D, talent development & commercialisation on E&D, focus on: <ul style="list-style-type: none"> • Integrated Circuits (IC) & Embedded Systems • Optoelectronics • Radio Frequency (RF)
Centre of Excellence for Electrical & Electronics	Penang Tech-dome	Hub for technology learning and exchange of ideas. Vehicle for improving scientific literacy and technology ability in Penang.
PSDC Shared Services Centre	Penang Skills Development Centre (PSDC)	Laboratories for Design & Development (D&D) include: <ul style="list-style-type: none"> • Electromagnetic Compatibility Lab • RF Lab • Embedded Systems Lab
Techmentor programme	Penang Science Cluster (that runs the Penang Science Café)	<ol style="list-style-type: none"> 1. Promoting Effective Schools through Enhanced Education Management (ESTEEM) teaching environment that includes: <ul style="list-style-type: none"> • Engagement • Science • Technology • English • Engineering • Mathematics 2. Conducting TechMentor to recruit and train engineers from the industries, undergraduates and parents of students to be mentors for the school. National Instruments, B. Braun, and Keysight are among the companies that have participated in the programme.
Karpal Singh Penang Learning Centre	Penang Youth Development Corporations (PYDC)	Teach Engagement, Science, Technology, Engineering, English and Mathematics (ESTEEM) by exposing children to real world lessons and hands-on experiences.

Source: An unpublished internal document by Penang Institute

To remain globally competitive, Penang seeks to continue diversifying into high value-added industries within the manufacturing and services sector by building on its niche strengths and opportunities. After four decades of industrialisation, the state government recognises that besides foreign direct investment-based (FDI-based) MNCs, SMEs are important key players in the economy. A significant share operates in automation, machinery & precision, tooling, plastic moulding and fabricated metal products. It has been noted that the suppliers' role in MNCs has been dwindling, growth and innovation of SMEs have been lagged in keeping a parallel pace with MNCs. The state government should encourage SMEs to invest in R&D and innovation to upgrade their activities, as well as knowledge spillovers through cluster effect. This has been one of the driving forces behind the establishment of the Penang SME centre, the SME Market Advisory and SME villages³⁵. However, the effectiveness of these driving forces is very much contingent on the access to sufficient and suitable human capital.

4.2 Labour demand shifts

The shift in labour demand can be induced by internal and external drivers, which could fundamentally change the human capital landscape from both quantitative and qualitative aspects. The internal drivers include company expansion and replacement of employees who have left the positions. Hiring activity will be heightened, thus vertically expanding the recruitment of labour demand in the market. Meanwhile, the external factor takes into account of the new establishments, which spur hiring activities where employees are likely to move into the new establishments. This is especially evident when skill requirements involve those that are highly transferable between different industries. In essence, this phenomenon may predominate quantitative constraints with regard to the available supply of workers, and it also reflects qualitative constraints when most vacancies require certain types of skills.

4.2.1 Quantitative demand

Investment and employment creation

Investment is an indicator to measure the number of

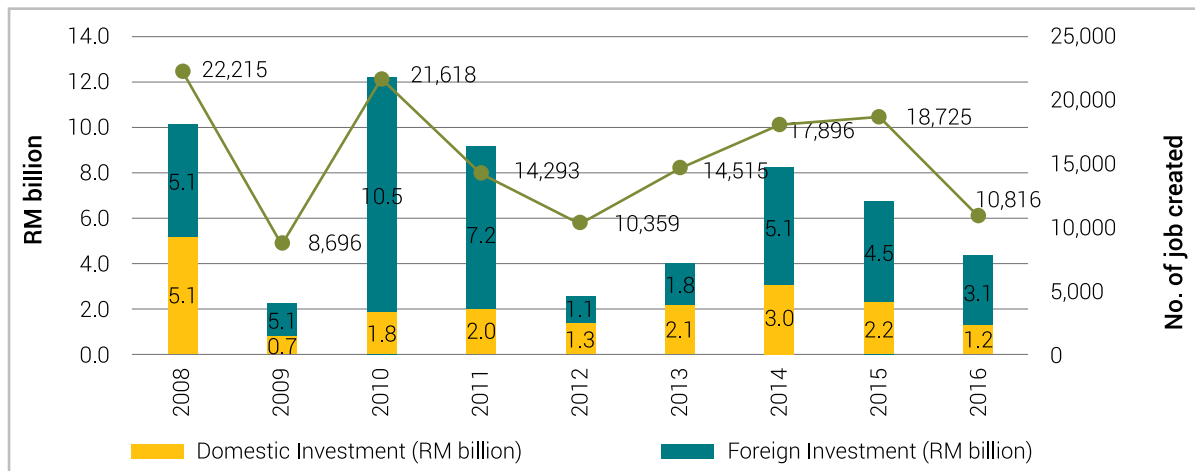
jobs to be created within a period, depending on the type of investments. Domestic and foreign investments, which are approved today, will take an average of about one to three years to complete their physical facilities regardless of the expansion of existing premises or the establishment of new premises and recruitment of employees. In Penang, the new development in Batu Kawan Industrial Park (BKIP) is projected to allure more investments into the state and hence creating more job opportunities, and attracting new workforce within the region. However, these job opportunities would be made available if investors identify the availability of relevant types of skilled labour.

Penang has been considerably receiving steady investments in manufacturing and services sectors. Since Penang is an open economy where it is highly affected by the global economic events, investments would peak in some years, and lacklustre in other years. In the manufacturing sector, as can be seen in Figure 4.4, foreign investment has consistently made up the largest share of total investments in Penang. Although the investments recorded were low in 2009, 2012 and 2013, the number of jobs created remained relatively high.

In tandem with Malaysia's aspiration to achieve year-on-year growth of 5% towards 2020, jobs across all skills spectrum need to be created, as emphasised by The World Bank (2014). In this relation, capital investment per employee ratio (CIPE) is used to measure the level of capital intensity of investment along with the GDP growth rate in Penang. Figure 4.5 illustrates the amount of capital invested in each employment created. As can be seen, with the exception of year 2011, higher CIPE ratio was exhibited in years where higher GDP growth rate was recorded. It is interesting to note that while Penang saw a lower investment in 2011, the capital intensity was relatively higher in 2011 where it produced RM637,400 worth of capital investment for every job created. This means that more capital was invested in automating industry where more investment could probably be devoted on fixed assets such as physical machinery, land and buildings with the expectation of higher productivity and efficiency.

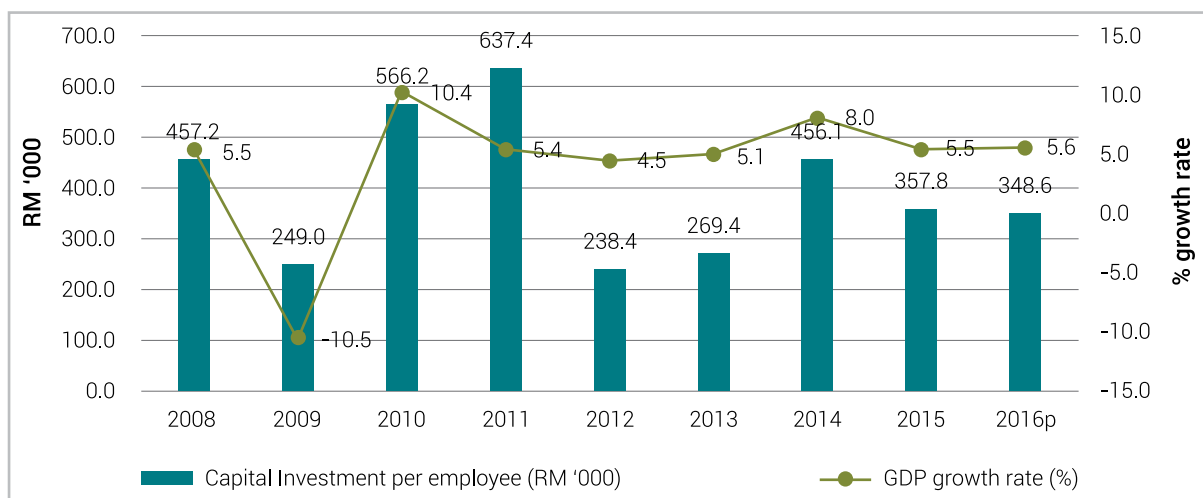
³⁵ See Tan (2016)

Figure 4.4: Approved manufacturing investments and employment created in Penang, 2008-2016



Source: Malaysia Investment Development Authority (MIDA), Penang

Figure 4.5: Capital investment per employee (ratio RM '000) and GDP growth rate (%) in Penang, 2008-2016



Source: Own calculations based on DoSM's and MIDA's Figures

The skills spectrum required by each investment project is not publicly made available at subnational level. According to MIDA's 2016 Malaysia Investment Performance Report, two investments in the form of expansion made by Keysight Technologies and Jinko Solar Technology highlighted the requirements of additional 400 to 2,552 employees to be hired respectively across all skills range, comprising engineers, professional personnel, management personnel, technicians, skilled workers and operators. This is further supported by the General Manager of Invest Penang, Loo Lee Lian, who opines that "the nature

of the approved capital investment ranges from mid- to high-end manufacturing operations in which R&D will come hand in hand with the operation, especially in the new capital investment". Whether these investment projects are of high quality with focus on R&D, it is difficult to conclude specific skill profiles and skill characteristics needed by each investor. However, we can make an assertion that high-qualified workforce with at least a certificate in educational qualifications would be needed to support the mid- and high-level of manufacturing activities.

Looking at the capital investment by industry, it gives an overview of the broad skills demanded by investors. Over the past six years, Electronics & Electrical (E&E) products poised as the key investment sector, accounting for about 61% of the total approved manufacturing investment and 57.1% of the total job creation (Table 4.5). This investment has largely created employment opportunities in high-tech manufacturing industries, including industrial electronics, semiconductors and optoelectronics. This was followed by precision engineering, tooling, machining and automation clusters where over 20% of investment and jobs were collectively created from Machinery & Equipment, Basic Metal Products, Scientific & Measuring Equipment and Transport Equipment.

Every approved manufacturing investment project is estimated to take about three years to commence. The spillover benefit on employment creation will only be reflected in a later period. For the past two years, a number of local and MNC companies have started their operations in BKIP, namely Hewlett-Packard (HP), SanDisk, Haemonetics and Boon Siew Honda. Others such as Boston Scientific, Aemulus Holdings and Scandinavian Industrial Building Systems (IBS) are expected to be completely set up in the next three years. Presently, new investments are projected to generate a total of 4,815 jobs. Table 4.6 shows the number of jobs that will be created until year 2021. Over 12,000 new jobs are to be created by the existing companies and newly established companies. About 49.3% are to be offered by existing companies and the remaining 50.7% are to be created by new establishments. Industry-wise, semiconductors, medical devices, automation and renewable energy have been reported to record the top job creation industries in Penang. This coincides

with MIDA's figures where majority of the capital investments are produced from E&E product-related companies.

Apart from employment requirements in the manufacturing sector, Penang's approved investment in services projects has tremendously increased in the past three years. The investment swelled by about 58% in 2015 to RM369 million, and it steeply escalated by more than ten-fold to RM4.1 billion in 2016. Penang ranked 2nd in Malaysia's approved investment in the services sector in 2016. No specific information about the type of employment created is available. Nevertheless, many MNC manufacturing firms choose Penang as their preferred destination in setting up their global business operation hub owing to the fact that the English-speaking community is relatively large, with most of them able to converse in more than one languages. Global business establishments require a workforce that is relevant in skill-set and capable in performing the job scope, and also able to communicate in foreign languages.

It is worth mentioning that workforce has to be made sufficiently available to tailor to the talent pool required by companies. Skill requirements by new and existing investments have to be thoroughly understood by the investment promotion arm to support and facilitate the expansion or new investments planned by the companies. To some extent, the availability of workforce may be insufficient to meet the requirements of new investments. The rise of new jobs will moderately disrupt current employment landscape if the labour market consists of workforce with higher level of transferable skills, be it hard or soft skills. Indirect employee-poaching may be prevailing in industries

Table 4.5: Approved manufacturing investment by top five industry groups in Penang, 2011–2016

Industry	Total approved investment		Jobs created	
	RM million	% of total	No.	% of total
Electronics & Electrical Products	21,066.17	60.8	49,454	57.1
Machinery & Equipment	2,508.14	7.2	5,440	6.3
Basic Metal Products	2,003.59	5.8	2,479	2.9
Scientific & Measuring Equipment	2,282.14	6.6	8,420	9.7
Transport Equipment	1,910.01	5.5	3,422	4.0
Others	4,900.29	14.1	17,389	20.1
TOTAL	34,670.34	100.0	86,604	100.0

Source: Own calculation based on MIDA's Figures

with job positions that are in demand and easily replaceable. Additionally, this pool of workforce is more mobile compared with those with specific technical skill requirements.

Vacancies

Job vacancy is one of the core indicators for business performance. Job hiring activity increases to meet the increasing demand when business operation expands. Employers can utilise the platforms established by

the government to post job vacancies at zero cost. These are JobsMalaysia under the Ministry of Human Resources³⁶ and Penang Career Assistance and Talent (CAT) Centre set up by the Penang government. Large firms with talent acquisition department recruit candidates through webpage, referrals and word-of-mouth advertising. If employers seek niche skills, they can engage employment or recruitment agencies to assist in searching candidates with the right skill specifications.

Table 4.6: Jobs created by new and existing companies in Penang from 2015–2021

Year of release	Year of completion	Type of investment	Company	Type of industry	Jobs created
2017	2018	New	Aemulus Holdings	Automation	-
2016	NA	New	Atotech	Chemical for semiconductor	35
2016	2017	New	Boston Scientific Corporation	Medical Devices	400
2016	2018	New	Celestica Inc	Global Business Services	200
2014	2016	New	HP Inc	Computer peripherals	1,000
2015	2016	New	JA Solar Holdings Co Ltd	Renewable energy	1,300
2016	NA	New	Jinko Solar Technology	Renewable energy	2,552
NA	2016	New	Kerry Logistics Network	Logistics Services	-
2017	2021	New	Luxoft	Information Technology	500
2017	2017	New	Scandinavian IBS	Automation	180
<i>Total jobs created by new companies</i>					6,167
2014	NA	Expansion	B Braun	Medical Devices	-
2016	2018	Expansion	Bosch Car Multimedia Penang	Automotive (multimedia)	70
2016	2017	Expansion	Broadcom Limited (formerly Avago Technologies)	Electronic Manufacturing Services	235
2015	2019	Expansion	Jabil Circuit Inc	Electronic Manufacturing Services	2,500
2016	NA	Expansion	Keysight Technologies Malaysia	Industrial Electronics	400
2016	2020	Expansion	KLS Martin	Medical Devices	500
2016	NA	Expansion	Linear Technology	Semiconductor	-
NA	NA	Expansion	OSRAM Opto Semiconductor	LED	300
2015	2016	Expansion	Paramit	Medical Devices	800
2016	2018	Expansion	SAM Engineering	Aerospace components	-
2015	NA	Expansion	Toshiba Medical Systems Manufacturing	Medical Devices	200
NA	2019	Expansion	ViTrox	Automation	1,000
<i>Total jobs created by existing companies</i>					6,005
Grand total jobs created.					12,172

Note: Only investment projects that appeared in newspaper reports are captured.
Source: Penang Institute's news collection as of March 2017

³⁶ JobsMalaysia is an automated online job matching system provided by the Ministry of Human Resources. It provides facilities for job seekers to search jobs and employers to recruit the right candidates. All facilities are accessible to all users at no charge.

they can engage employment or recruitment agencies to assist in searching candidates with the right skill specifications.

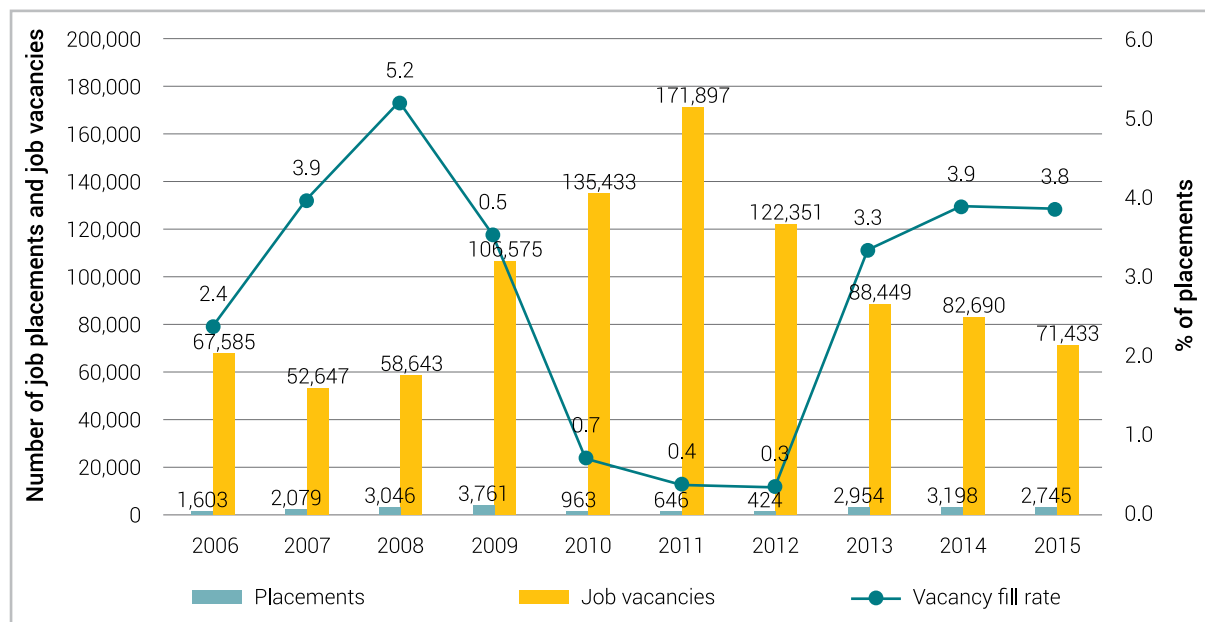
The level of labour demand can measure through the examination of job vacancy posted by employers on the job searching platform. From the public employment agency, JobsMalaysia data show that despite the fact that job hiring activity has softened in the past few years, the number of jobs being filled remained languished. New job vacancies recorded an upward trend and peaked in 2011 (Figure 4.6). Since then, the number has been decreasing. It had gradually decreased from 2012 to 2015. The number of job vacancies, however, remained high. About 71,000 new job vacancies were reported in 2015. It was 6.6% of total job vacancies advertised across all states in Malaysia, equivalent to the share of Penang's total population in Malaysia.

In terms of job placements, it was surprisingly found that only 3.8% of the job vacancies were successfully filled

in 2015 (Figure 4.6). Prior to this, the placement rate has been consistently weak. The numbers, however, may not necessarily reflect the real case. Some employers may not report back to JobsMalaysia when vacancies are filled. The likelihood of job placement opportunities could be high if each job vacancy is monitored regularly. Nevertheless, the World Bank (2009) asserted that Malaysian firms took about four weeks to fill a vacancy for mid- and high-skill positions. This duration is longer than those in India (within two weeks) and Indonesia (within one week).³⁷

Out of more than 71,000 jobs, manufacturing sector made up the largest share of total jobs hiring, which was nearly 70% of total job vacancies in Penang, and it represented 15.7% of the national vacancies in the same sector. This was then followed by accommodation, food and beverage service activities (8.6%), and construction (7.2%) (Figure 4.7).

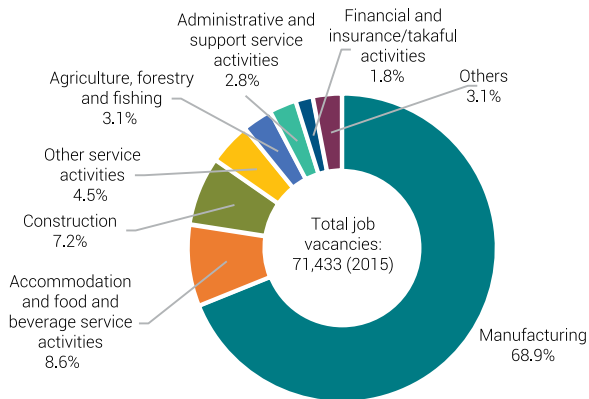
Figure 4.6: Job vacancies, job placements and vacancy fill rates in Penang, 2006–2015



Source: Ministry of Human Resources Malaysia via the DOSM's Social Statistical Bulletin

³⁷ Ushiyama (2013)

Figure 4.7: New job vacancies by major industries in Penang, 2015



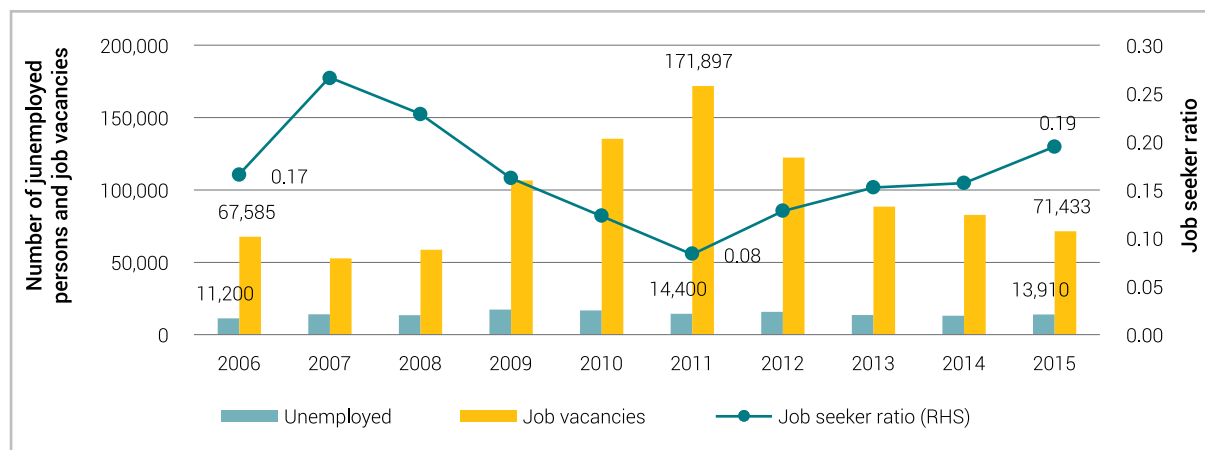
Source: Own calculations based on DOSM's Social Statistical Bulletin

It is very important to note that job openings in Penang reported by employers through JobsMalaysia portal in large majority are (still) in the manufacturing sector and require lower to mid-skilled workers (agricultural, forestry and fishery workers, craft and related trades workers, plant and machine-operators and assemblers, clerical – support – workers, and service and sales workers). This channel is not representative of the structure (and shifts therein) of overall labour demand. The low number of vacancies pertaining to high-skilled jobs requiring high-qualified workers is probably due to employers recruiting such workers through other channels, such as other online job portals, employment agencies, recruitment companies and informal methods. Meanwhile, some job portals cater to lower-skilled recruitment.

The number of job openings reported by employers through JobsMalaysia portal has substantially declined since 2011, as shown in Figure 4.8. This may be combined with the trend of an overall increase in demand for labour as is evident from the ratio of unemployed persons to job vacancies in Penang. Since 2007, this ratio fell from 0.7 to between 0.1 and 0.3, indicating that job openings have always been larger in number than jobseekers. It has been noted that vacancies, while indicating labour need, may not be a perfect yardstick for actual or net demand because of chain effects of job shifts and labour mobility (behaviour of secondary supply). A better indicator would be the number of vacancies resulting from new job creation. However, no data on this are available. The data suggest a clear shift of labour demand towards higher qualification and skill levels

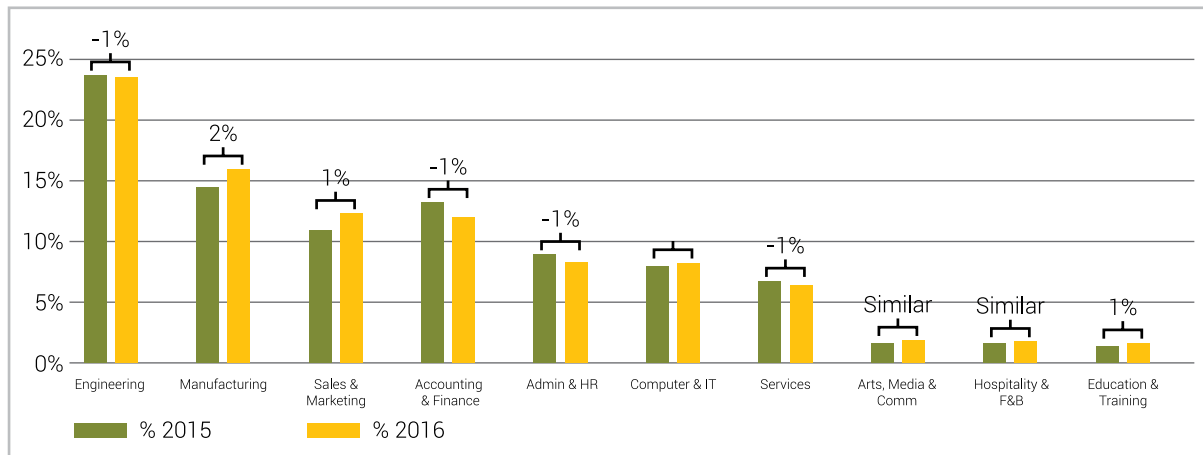
Online job portal is widely used by employers and job seekers to search for candidates with the right skills and curriculum vitae (CV) placements. While manufacturing or production still accounts for about one-quarter of the total job vacancies currently advertised, Figure 4.9 reveals an advanced profile of job specialisations, with engineering making up about a quarter of the total job vacancies advertised in the northern region. In addition, about 30% of the vacancies posted were collectively found in accounting & finance, administration & HR, and computer & IT specialisations. Interestingly, this could reflect the core functions of recently established Global Business Services (GBS) operations. This leads to some observations on shifts in regard to the qualitative side of demand.

Figure 4.8: The ratio of unemployment to job vacancy (job seeker) in Penang, 2006–2015



Source: Own calculation based on DOSM's Social Statistical Bulletin

Figure 4.9: Job vacancies posted in the top 10 job specialisations within the Northern Region in Malaysia, 2015 vs 2016



Source: Ministry of Human Resources Malaysia via the DOSM's Social Statistical Bulletin

4.2.2 Qualitative demand

As the economy is restructured and upgraded with a larger focus on knowledge-intensive activities, labour demand in terms of qualifications and skills is evidently changing. MNCs and SMEs alike now need high(er)-skilled employees with competencies in areas such as engineering, design, finance, accounting, supply chain management and marketing. This is reflected in the demand structure in terms of not only educational qualifications and occupations, but also experience and a larger focus on soft skills next to hard skills. These demand changes are reflected in (skill) requirements as encountered in job vacancies. We have established this on the basis of an inventory and analysis of advertised vacancies in industries within the scope of this study and targeting higher-qualified workers. From our inventory, vacancies within these criteria are sizeable in number. Below we offer the findings.

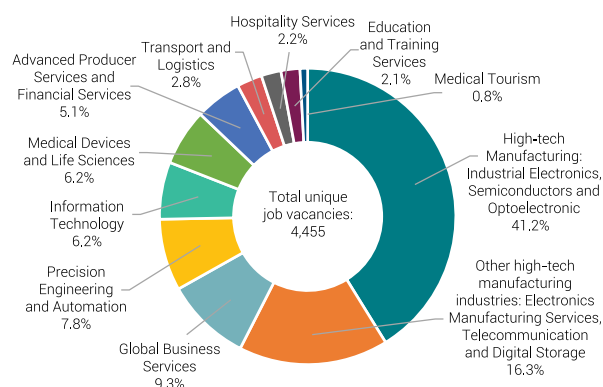
a) Top recruiting industries and their firms

To assess the structure of labour and skill demand within the scope of the study, we gathered real-time job vacancies posted on JobStreet.com from 31 December 2015 to 30 June 2016 using a web-scraping tool. We

confine mining to include jobs advertised by companies based in Penang; with educational requirements of at least a certificate/diploma; and companies within the studied industry groups.

Over the first half of 2016, a total of 21,107 job advertisements were collected on a fortnightly basis. Of these, 41.3% or 8,714 job advertisements met the above selection criteria. After taking repeat advertisement of the same vacancy into account, 4,455 unique vacancies are used in this study (Figure 4.10). Over half of these are in high-tech manufacturing industries, which consist of industrial electronics, semiconductors, optoelectronics, electronics manufacturing services (EMS), telecommunication and digital storage. This is followed by Global Business Services (GBS) (9.3%), precision engineering and automation (7.8%), information technology (IT) (6.2%) and medical devices and life sciences (6.2%). This result corroborates with the development focus of the Penang state government whereby high-tech manufacturing and GBS – business process outsourcing (BPO), information technology outsourcing (ITO) and knowledge process outsourcing (KPO) – are targeted in the next economy.

Figure 4.10: Unique job vacancies by industry type in Penang, 31 December 2015–30 June 2016



Source: Vacancy database

Table 4.7 shows the top 10 companies posting vacancies in Penang. Within the six months, the top 10 recruiting companies constitute a share of about 30% of the total vacancies. All of them come from high-tech manufacturing industries, and are large MNC establishments. Flextronics – a Singapore electronics

manufacturing services (EMS) company – advertised the highest number of job openings via the web portal, constituting 5.6% of all vacancies. A number of these establishments have a long presence, either replacing outgoing staff or expanding and upgrading operations. Compare this with the results in Table 4.6, five out of 10 companies announced expansion activities. These companies are B. Braun, Robert Bosch, Jabil Circuit, Keysight Technologies and OSRAM Opto Semiconductors.

Many of the vacancies are posted by large companies in high-tech manufacturing industries with employment headcounts of more than 5,000 employees. They need manpower to improve the business operations, including human resource management, information technology, maintenance, supply and distribution, health and safety, product development and logistics. This involves positions of senior executives, managers and senior managers. Also, more than half of such vacancies require candidates with five or more years of work experience across these job positions. This certainly implies the high demand of skilled and experienced labour in high-tech manufacturing industry.

Table 4.7: Top recruiting companies in Penang, 31 December 2015–30 June 2016

No	Company name	No. of job vacancies	% of total job vacancies
1	Flextronics	248	5.6%
2	OSRAM Opto Semiconductors (Malaysia) Sdn Bhd	217	4.9%
3	Keysight Technologies Malaysia Sdn Bhd	152	3.4%
4	Plexus Manufacturing Sdn Bhd	137	3.1%
5	Robert Bosch (M) Sdn Bhd	115	2.6%
6	Lumileds Malaysia Sdn Bhd	109	2.4%
7	Dell Global Business Center Sdn Bhd	100	2.2%
8	Motorola Solutions Malaysia Sdn Bhd	91	2.0%
9	Jabil Circuit Sdn Bhd	90	2.0%
10	B. Braun Medical Industries	88	2.0%
Total		1,347	30.2%

Source: Vacancy database

b) Positions and skills most prevalent/targeted in recruitment

For each vacancy posted, we can obtain the characteristics such as tasks, educational background, skill requirements, terms of employment and basic company background. Apart from examining the overall unique vacancies, Table 4.8 compares the characteristics of unique vacancies across high demand positions³⁸. The number of vacancies in high demand category forms 13.2% or 590 positions.

From the overall perspective, three-quarter of the total vacancies are filled by senior and junior executive positions in Penang. As mentioned, most companies use web-based engine to search for lower level jobs while higher level jobs are commonly matched by engaging employment firms or recruitment consultants. For example, some companies engage recruitment consultants to search for suitable candidates to fill managerial positions such as directors, senior managers and chief officers. Furthermore, the majority of the job openings are found to be persistent and high in demand especially senior executive positions. This suggests that senior executive positions may be more mobile than other position levels owing to the fact that they are high in demand, and staff turnover is predicted to be high as most senior executive positions are hypothetically persistent. This also implies the lack of high-qualified labour in the senior executive segment of Penang's labour market.

The above findings also coincide with the length of work experience required. In regard to higher level positions requiring a high-qualified person, companies seek workers with sufficient experience (more than two

years). While about 74% of firms state both options, 15% of them recruit sufficient experienced workers (Table 4.9). The former is likely to be seen in new establishments that hire workers with diverse skill sets and experience, while experience carries more weight for longer established firms. Furthermore, firms in high-tech manufacturing industries more often seek experienced workers. Overall, more than one-third of the total vacancies require candidates with over five years of relevant work experience. Among senior executive positions, approximately half requires candidates with more than five years of work experience. Similar results can be observed in high-demand positions; about 56% of job vacancies seek employees with over five years of work experience. Within the high-demand positions, the majority of vacancies for junior executives require less than two years of work experience. Those with relevant work experience between two and five years can, however, apply for junior and senior executive positions. Meanwhile, almost all the high-demand job vacancies require five or more years of work experience.

In terms of skill classes, soft skills are most widely required among companies in Penang. The proportions are particularly higher in persistent and high-demand vacancies than those in overall vacancies. Compared with generic hard skills, most vacancies emphasise the importance of specific hard skills. Nonetheless, most vacancies also require competencies in English and foreign languages, namely Mandarin, Japanese and Thai, which are important hard generic skills compared with other hard generic skills such as ICT skills, legislative and regulatory awareness.

³⁸ A vacancy can be posted multiple times across the 14 mining periods. A unique job position is defined as high demand if the total occurrence frequency of vacancies falls within the top 10% of the total mining periods – the number of "hits" a vacancy obtains throughout the mining periods.

Table 4.8: Summary statistics of the characteristics of job positions

Characteristics	All		High demand*	
	Sum	%	Sum	%
Unique job positions	4,455	-	485	10.9
Job position level				
Entry-level	471	10.6	50	10.3
Junior executives	1,639	36.8	188	38.8
Senior executives	1,718	38.6	199	41.0
Managers	459	10.3	38	7.8
Senior managers	84	1.9	10	2.1
No. job positions available	84	1.9	0	0.0
Company size				
1–50 employees	461	10.3	29	6.0
51–200 employees	633	14.2	50	10.3
201–500 employees	563	12.6	43	8.9
501–1,000 employees	473	10.6	41	8.5
1,001–2,000 employees	551	12.4	89	18.4
2,001–5,000 employees	626	14.1	64	13.2
More than 5,000 employees	1,096	24.6	167	34.4
Year of work experience				
Below 2 years	1,419	31.9	160	33.0
2–5 years	1,002	22.5	121	24.9
5 years and above	1,561	35.0	175	36.1
Broad skill classes				
Hard generic skills	2,363	53.0	237	48.9
Specific hard skills	3,314	74.4	369	76.1
Soft skills	3,396	76.2	403	83.1
Hard generic skills				
Environmental awareness	249	5.6	21	4.3
Legislative and regulatory awareness	720	16.2	64	13.2
ICT skills/E-skills	658	14.8	64	13.2
English language	1,132	25.4	109	22.5
Foreign languages	1,172	26.3	105	21.6
Soft skills				
Personal effectiveness	807	18.1	94	19.4
Relationship and services	2,144	48.1	276	56.9
Impact and influence	908	20.4	93	19.2
Achievement skills	2,272	51.0	283	58.4
Cognitive skills	910	20.4	110	22.7
Measure of high demand				
Number of periods for which each unique job position appears	11,499	19.5	3,185	6.6

* Top 10% by frequency of occurrence of a unique job position.

Note: Summation for each characteristic is not necessarily equivalent to the total job vacancies.

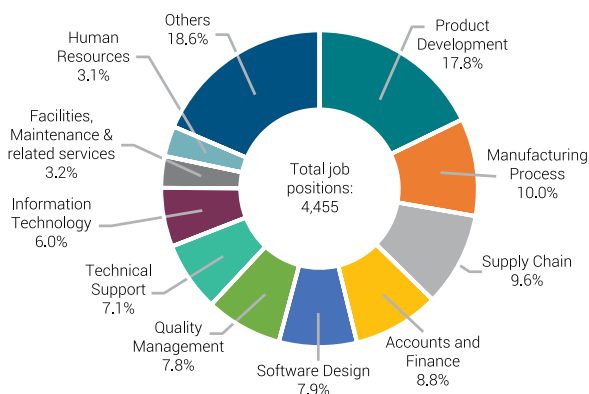
Source: Vacancy database

The requirements of soft skills, on the other hand, indicate that over half the jobs require achievement skills³⁹, and relationship and service skills⁴⁰. The importance of devising these soft skills is more evident in vacancies that are in high demand and persistent. Meanwhile, personal effectiveness skills⁴¹ appear to be the least requested skills. The findings coincide with the assertion made by the employment agencies whereby current graduates lack communication skills and the ability to articulate technical knowledge.

The specification of job positions can also indicate the quality of jobs – in terms of manpower requirements – advertised by companies in Penang. Figure 4.11 shows that out of 4,455 unique vacancies, nearly half of them are related to product development (17.8%), manufacturing process (10%), supply chain (9.6%), quality management (7.8%), and facility, maintenance & related services (3.2%). Engineering positions dominate vacancies that consistently characterise the economic structure of Penang, requiring higher level of knowledge and solutions in manufacturing activities.

These positions include application engineers, product development engineers, automation engineers, R&D engineers, mechanical design engineers and many other positions.

Figure 4.11: Job positions by major job titles advertised in Penang



Source: Vacancy database

Table 4.9: Type of candidates targeted for hiring by firms

Type of industry	Applicants							Total
	Fresh graduates/ school-leavers		Sufficient experience (> two years)		Both		No response	
	No.	%	No.	%	No.	%		
High-tech manufacturing	1	9.1	4	36.4	6	54.5	0	11
Other high-tech manufacturing	0	0.0	3	30.0	7	70.0	0	10
Precision Engineering & Automation	0	0.0	0	0.0	4	80.0	1	5
Medical Devices & Life Sciences	0	0.0	0	0.0	3	100.0	0	3
Advanced Producer Services & Financial Services	3	15.8	3	15.8	13	68.4	0	19
Global Business Services	0	0.0	2	18.2	8	72.7	1	11
Hospitality Services	0	0.0	1	11.1	8	88.9	0	9
Information Technology	0	0.0	0	0.0	11	91.7	1	12
Transport & Logistics	1	25.0	0	0.0	2	50.0	1	4
Education & Training Services	0	0.0	1	25.0	2	50.0	1	4
Medical Tourism	0	0.0	0	0.0	4	100.0	0	4
Total	5	5.4	14	15.2	68	73.9	5	92

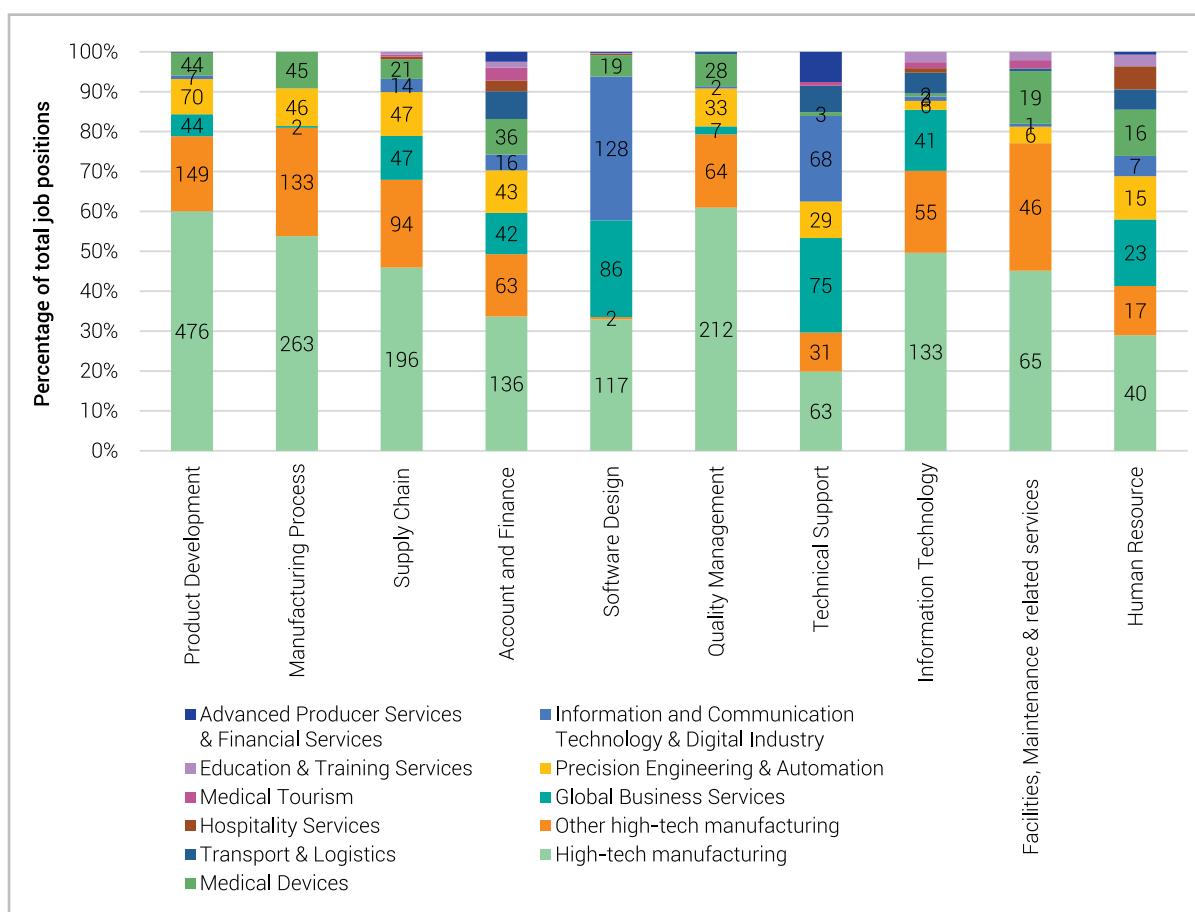
Source: Employer survey

³⁹ Achievement skills include problem-solving skills, being proactive, result-oriented, and self-motivated.

⁴⁰ Relationship and service skills comprise communication skills, interpersonal skills, team building spirit, team player and customer-oriented.

⁴¹ Personal effectiveness skills are attributes such as ability to work independently, ability to handle stress, and self-control management.

Figure 4.12: Job positions and industry type by major job titles in Penang (in number and %)



Note: The data labelled in the bar chart refer to the number of unique job positions advertised by specific industry.

Source: Vacancy database














































In terms of industry distribution, both high-tech manufacturing and other high-tech manufacturing companies (excluding medical devices companies) advertised the most across all job positions except human resources, software design and technical support. Figure 4.12 illustrates that high-tech manufacturing companies essentially lead in positions such as manufacturing process, quality management, product development and facilities, maintenance & related services, accounting for nearly 80% of the total vacancies in each major job title respectively.

All vacancies are grouped based on common titles of positions advertised by companies. Out of 4,455 job openings, 82.7% or 3,683 job positions can be categorised into 10 major job positions as discussed earlier. Table 4.10 shows the characteristics of

advertised vacancies by 10 major job positions, while Table 4.11 summarises the profiles of advertised vacancies for each corresponding major job position.

Interestingly, about 60% of software design positions such as software developers/engineers, system engineers, SAP functional consultants and other IT-related job titles are largely needed in Information Technology (IT) and Global Business Services (GBS) firms. Similar observation is found in technical support positions such as IT technicians and technical customer support. The vacancies in the IT fields seem to reveal a new growth engine within the region. Some manufacturing companies unify the functions of IT technical support, human resources, and accounts and finance in their shared services hubs in Penang.

Table 4.10: Vacancy characteristics of major job positions in Penang

Job title	Job position (%)	Related experience required (%)	Characteristic of an average job vacancy	
			Education level	Field of Study
1. Product development 793 unique positions Average # periods: 2.7 Persistent: 14.1 Hard Generic Skills: 40.5% Specific Skills: 79.7% Soft Skills: 77.3%	Entry-level  11.6 Junior executive  29.6 Senior executive  49.1 Manager  7.8 Senior manager  0.8 No job position  1.3	Fresh graduate  22.8 2-5 years  23.8 5 years  41.5	Diploma; Bachelor Degree; Master's Degree	Electrical/ Electronic; Mechanical; Mechatronic; Electromechanical; Computer Science
2. Manufacturing Process 489 unique positions Average # periods: 2.8 Persistent: 14.9 Hard Generic Skills: 47.4% Specific Skills: 73.0% Soft Skills: 77.9%	Entry-level  9.0 Junior executive  34.6 Senior executive  42.9 Manager  9.6 Senior manager  1.4 No job position  2.5	Fresh graduate  29.0 2-5 years  24.9 5 years  38.2	Diploma; Bachelor Degree; Master's Degree	Industrial Engineering; Electrical/ Electronic; Mechanical; Mechatronics; Engineering
3. Supply Chain 427 unique positions Average # periods: 2.6 Persistent: 9.4 Hard Generic Skills: 59.5% Specific Skills: 79.4% Soft Skills: 78.5%	Entry-level  6.3 Junior executive  42.2 Senior executive  34.7 Manager  12.9 Senior manager  3.3 No job position  0.7	Fresh graduate  32.6 2-5 years  19.7 5 years  36.1	Diploma; Bachelor Degree; Master's Degree	Business Studies; Economics; Management; Administration; Logistic; Commerce
4. Account and Finance 404 unique positions Average # periods: 2.3 Persistent: 8.9 Hard Generic Skills: 63.6% Specific Skills: 82.7% Soft Skills: 76.7%	Entry-level  10.4 Junior executive  42.6 Senior executive  33.4 Manager  10.9 Senior manager  0.5 No job position  2.2	Fresh graduate  34.7 2-5 years  23.3 5 years  33.4	Professional Certificate; Diploma; Bachelor Degree; Master's Degree	Accounting; Finance; Accountancy; Banking; ACCA; CPA
5. Software Design 355 unique positions Average # periods: 2.8 Persistent: 23.1 Hard Generic Skills: 40.6% Specific Skills: 95.5% Soft Skills: 76.3%	Entry-level  11.5 Junior executive  31.8 Senior executive  52.4 Manager  2.5 Senior manager  0.6 No job position  1.1	Fresh graduate  34.4 2-5 years  22.0 5 years  34.4	Diploma; Bachelor Degree	Computer Science; Information Technology; Computer/Telecommunication Engineering

Vacancy characteristics of major job titles in Penang (continued)

Job title	Job position (%)	Related experience required (%)	Characteristic of an average job vacancy	
			Education level	Field of Study
6. Quality Management 348 unique positions Average # periods: 2.8 Persistent: 17.0 Hard Generic Skills: 46.6% Specific Skills: 77.0% Soft Skills: 77.9%	Entry-level 11.5 Junior executive 37.1 Senior executive 38.5 Manager 10.6 Senior manager 0.9 No job position 1.4	Fresh graduate 27.9 2-5 years 26.4 5 years 38.2	Diploma; Bachelor Degree	Electronics & Electrical; Mechanical; Materials; Applied Sciences; Physics; Chemistry
7. Technical/Customer Support/Services 317 unique positions Average # periods: 2.4 Persistent: 11.4 Hard Generic Skills: 70.0% Specific Skills: 60.6% Soft Skills: 71.3%	Entry-level 19.2 Junior executive 52.1 Senior executive 18.3 Manager 6.9 Senior manager 0.0 No job position 3.5	Fresh graduate 51.7 2-5 years 22.4 5 years 13.9	Diploma; Bachelor Degree	Computer Science; Computer Engineering; Telecommu- nication; Information Technology
8. Information Technology 268 unique positions Average # periods: 2.5 Persistent: 11.6 Hard Generic Skills: 41.8% Specific Skills: 78.4% Soft Skills: 83.2%	Entry-level 6.7 Junior executive 33.2 Senior executive 42.5 Manager 11.6 Senior manager 5.2 No job position 0.4	Fresh graduate 26.9 2-5 years 16.4 5 years 44.8	Diploma; Bachelor Degree	MCSE and CCNA Certification; Computer Science; Information Systems; Information Technology
9. Facilities, Maintenance & Related Services 144 unique positions Average # periods: 2.3 Persistent: 9.0 Hard Generic Skills: 64.6% Specific Skills: 70.1% Soft Skills: 63.9%	Entry-level 6.9 Junior executive 43.1 Senior executive 40.3 Manager 6.9 Senior manager 1.4 No job position 1.4	Fresh graduate 29.2 2-5 years 29.9 5 years 33.3	Professional Certificate; Diploma; Bachelor Degree	Electrical & Electronic; Mechanical; Mechatronic; Electromec- hanical; Chargeman certificate by Suruhanjaya Tenaga
10. Human Resource 138 unique positions Average # periods: 2.2 Persistent: 5.8 Hard Generic Skills: 70.3% Specific Skills: 55.1% Soft Skills: 79.0%	Entry-level 5.8 Junior executive 37.7 Senior executive 34.1 Manager 17.4 Senior manager 2.9 No job position 2.2	Fresh graduate 22.5 2-5 years 23.2 5 years 43.5	Diploma; Bachelor Degree	Human Resource Management; Business Studies/ Management; Management

Table 4.11: Skill profiles of major job titles in Penang

Job title	Hard Generic Skills		Soft Skills		Specific skills
1. Product development 793 unique positions Average # periods: 2.7 Persistent: 14.1 Hard Generic Skills: 40.5% Specific Skills: 79.7% Soft Skills: 77.3%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	 7.3 11.3 6.1 17.8 16.8	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	 17.5 47.2 24.0 53.0 23.7	Experience in automated vision with Solidwork, system design, FPGA code, firmware programming, avalon switch fabric, electrical design, troubleshooting, electronics board designs and full product life cycle development; Familiar with Agile BOM structure and Agile updating activities; understand mechanical drawing; skills in ASIC Design or PCB Design, Package Electrical Design, Hspice, APD or simulation tools; strong command in Solidworks; knowledge in SAP and AutoCad; experience in Engineering Change Notice (ECN)
2. Manufacturing Process 489 unique positions Average # periods: 2.8 Persistent: 14.9 Hard Generic Skills: 47.4% Specific Skills: 73.0% Soft Skills: 77.9%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	 8.4 15.5 11.0 21.7 18.4	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	 12.5 43.8 22.9 58.1 20.0	Skills in MS Office and AutoCad; ability to define problems, collect data, establish facts and draw valid conclusions; knowledge in Trim and Form/Singulation, computer skills, vision system, X-ray system, FMEA and Microsoft Office Suite; expertise with embedded systems programming, signal processing, cost efficient electronic design; proficient in PCB design software (e.g. CadSoft EAGLE, Altium Designer, Mentor Graphics, CADSTAR and OrCAD PCB Designer, PSpice); experience in mechanical design using Solidwork and AutoCAD; familiar in applying SPC, MSA, DOE, CP in production environment; experience implementing CI/Lean methodologies such as Kanban, VSM & A3
3. Supply Chain 427 unique positions Average # periods: 2.6 Persistent: 9.4 Hard Generic Skills: 59.5% Specific Skills: 79.4% Soft Skills: 78.5%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	 4.2 21.1 19.9 24.1 26.7	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	 16.6 47.3 19.0 49.6 23.4	Knowledge in cost analysis, MS Excel/Access and ERP; experience in supply chain, purchasing, inventory, material and warehouse management; experience in cost accounting or cost estimation; knowledge of forecasting methodologies such as Oracle or SAP

Skill profiles of major job titles in Penang (continued)

Job title	Hard Generic Skills		Soft Skills		Specific skills
4. Account and Finance 404 unique positions Average # periods: 2.3 Persistent: 8.9 Hard Generic Skills: 63.6% Specific Skills: 82.7% Soft Skills: 76.7%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	2.7 20.8 25.2 28.5 35.4	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	25.0 50.0 0.0 12.5 0.0	Experience as General Ledger (GL) accountant; payroll accounting, Account Receivable and Collections experience; cost accounting; SOP 81-1 accounting; audit; knowledge in public listed requirements; SAP FI/CO modules, cash flow, taxation, costing and budgeting; financial analysis
5. Software Design 355 unique positions Average # periods: 2.8 Persistent: 23.1 Hard Generic Skills: 40.6% Specific Skills: 95.5% Soft Skills: 76.3%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	5.4 3.9 31.3 18.6 23.4	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	24.5 54.9 16.6 51.0 27.9	Experience in Java Web Application development Solid server-side JAVA/JEE, JSP, Servlets, JDBC, SQL, EJB, Spring, Struts, JavaScript, HTML, DOM, AJAX, JavaScript, CSS, Android Studio, eclipse and XML; knowledge of Oracle Identity Manager (OIM) 11g R2, Oracle BI Publisher, complex SQL query, Java programming, Visual Basic, C#, C#.Net, Single-Sign-On (SSO), LDAP and Active Directory (AD), WebLogic Application Server and Oracle Database; possess programming skills, database skills and Operating Systems; strong interest in software R&D; passport scanner and authentication knowledge; Microsoft Certification MCSE, CCNA; skills in Server installation, MS Server and MS SQL setup, Backup software (Symantec, Acronis or others) setup PC setup; knowledge of PHP web framework such as CodeIgnitor, Yii, Laravel
6. Quality Management 348 unique positions Average # periods: 2.8 Persistent: 17.0 Hard Generic Skills: 46.6% Specific Skills: 77.0% Soft Skills: 77.9%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	6.0 18.1 11.2 20.1 19.3	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	18.1 51.7 22.4 54.3 18.1	Knowledge in ISO 13485 FDA 21, ISO 9001/13485, TS 16949/AS9100, AutoCAD, Microsoft Office Application and Reliability Statistics; experience in reliability test, design experience, statistical analysis, failure analysis and reliability analysis; knowledge in JEDEC, AEC-100 and relevant reliability standards

Skill profiles of major job titles in Penang (continued)

Job title	Hard Generic Skills		Soft Skills		Specific skills
7. Technical/Customer Support/Services 317 unique positions Average # periods: 2.4 Persistent: 11.4 Hard Generic Skills: 70.0% Specific Skills: 60.6% Soft Skills: 71.3%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	1.3 12.6 10.7 46.1 38.5	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	13.6 50.2 15.5 48.3 17.0	Skills in Microsoft Operating Systems, Test Engineering, Documentation, technical and helpdesk support; experience in managing office IT, network infrastructure and security administration for LAN, router and server; experience in customer service and support for machine vision inspection; knowledge of techniques in system set-up, buy-off, principles, tools and instruments involved in the production and use of precision technical plans, drawings and models
8. Information Technology 268 unique positions Average # periods: 2.5 Persistent: 11.6 Hard Generic Skills: 41.8% Specific Skills: 78.4% Soft Skills: 83.2%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	1.5 10.1 6.3 26.5 15.3	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	21.6 57.8 20.1 57.1 16.8	Experience in Citrix XenApp, Citrix XenDesktop, Citrix Receiver, VMWare, ESX, Windows 2008 & 2012; Experience in Manufacturing Execution Systems (MES) & Manufacturing Automation; Proficient in Web & Database Technology (Oracle); strong programming knowledge (Java, PL/SQL/C#); scripting knowledge (Perl, VB/VBS, Powershell); experience in designing and developing Tableau Dashboards; knowledge in LAN, & WAN, IP address, network cabling, IBM Lotus notes, Entity Framework Bootstrap CSS3, HTML 5 etc.
9. Facilities, Maintenance & Related Services 144 unique positions Average # periods: 2.3 Persistent: 9.0 Hard Generic Skills: 64.6% Specific Skills: 70.1% Soft Skills: 63.9%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	29.2 29.9 10.4 22.9 21.5	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	9.7 38.9 16.0 49.3 7.6	Experience in performing maintenance on test machine; knowledge of service, checking and repairing of building facilities and equipments such as chillers, air compressors, vacuum pumps, PCW system, water pumps, fire protection system; knowledge in electrical system; able to troubleshoot minor electrical breakdown; good understanding about mechanical drawing.
10. Human Resource 138 unique positions Average # periods: 2.2 Persistent: 5.8 Hard Generic Skills: 70.3% Specific Skills: 55.1% Soft Skills: 79.0%	Environmental awareness Legislative and regulatory awareness ICT skills/E-skills English language Foreign language	5.1 39.9 21.7 27.5 37.0	Personal effectiveness Relationship and service Impact and influence Achievement skills Cognitive skills	15.9 55.8 31.9 44.9 9.4	Knowledge in HR related systems, databases, processes and procedures; in-depth knowledge of local, federal and state laws, and HR best practices; strong understanding of employment law, industrial relations acts and practices; knowledge and experience in managing employee relation and industrial relation issues;

With reference to skill profile, the analysis of vacancy found that specific hard skills are more important than generic hard skills with the exception of positions in technical/customer support/services and human resources. Openings in software design indicate nearly 96% (355 positions) requiring specific hard skills, representing the highest proportion of specific skills among all major job positions. Specific hard skills required include Java Web Application, Oracle database system and server installation. Likewise, specific hard skills are greatly in demand in product development and manufacturing process compared with hard generic skills. Nevertheless, English language is identified as the most sought-after competency among other hard generic skills in product development, manufacturing process, quality management, technical/customer support/services and information technology. Albeit lesser in demand, foreign languages comprising Bahasa Malaysia and Mandarin come next. Meanwhile, foreign languages rank at the top for supply chain and accounts and finance positions.

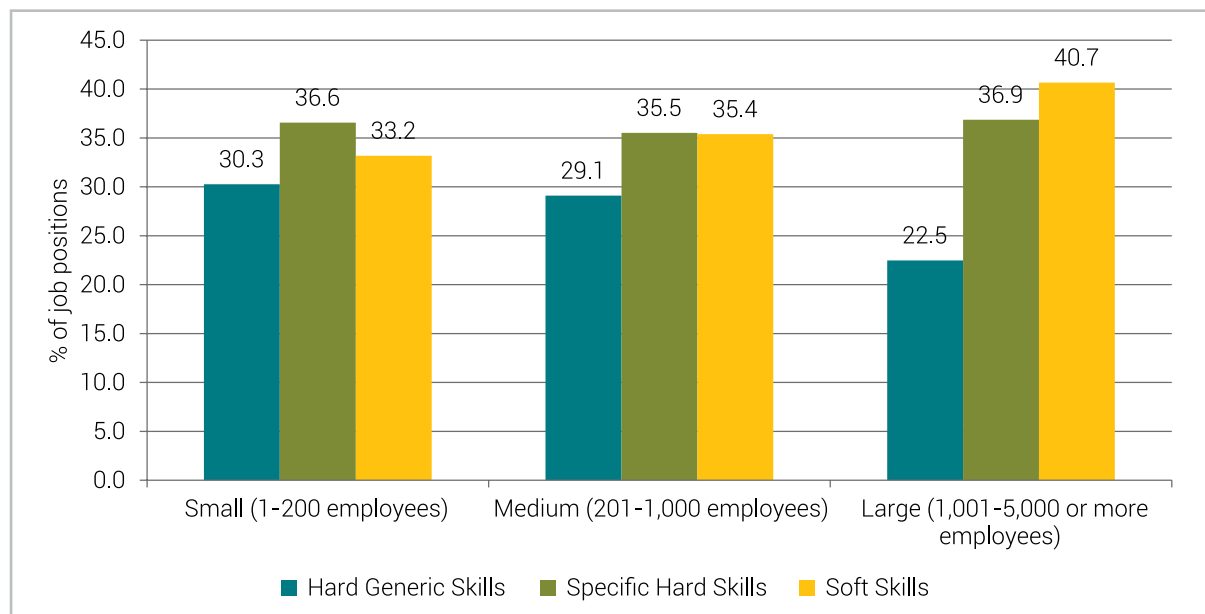
Apart from language skills, knowledge in business law, regulations and guidelines are equally crucial to perform tasks that are associated with legislations and regulations. Legislative and regulatory awareness proficiency is found to be more prevalent in supply chain, quality management, facilities, maintenance & related services, and human resources. Some examples include: understanding of quality management system of ISO 13485 for Quality Assurance (QA) Engineers who work in the design and manufacture of medical devices to ensure compliance with standards, rules and regulations; HR Generalists must be knowledgeable in employment law, industrial relations acts and practices.

While vacancies in facilities, maintenance and related services look for specific hard skills more than soft skills, all other job openings show that hard skills are generally not as important as soft skills. At least 70% of the job positions place soft skills as the required skills for all advertised vacancies except facilities, maintenance and related services. As discussed in Table 4.8, most of these vacancies require skills in relationship and service and achievement skills, which include good communication skills, problem-solving skills, ability to work in a team, self-motivated and result-oriented. These qualities are widely sought by employers.

In general, the larger the establishment is, the higher the demand for soft skills is compared with that of generic and specific hard skills. Figure 4.13 shows that nearly 41% of jobs advertised by large establishments, which have more than 1,000 headcounts, require soft skills. In contrast, the requirement for generic hard skills diminish in large establishments. However, the requirement for specific hard skills are indifferent for small, medium, or large establishments.

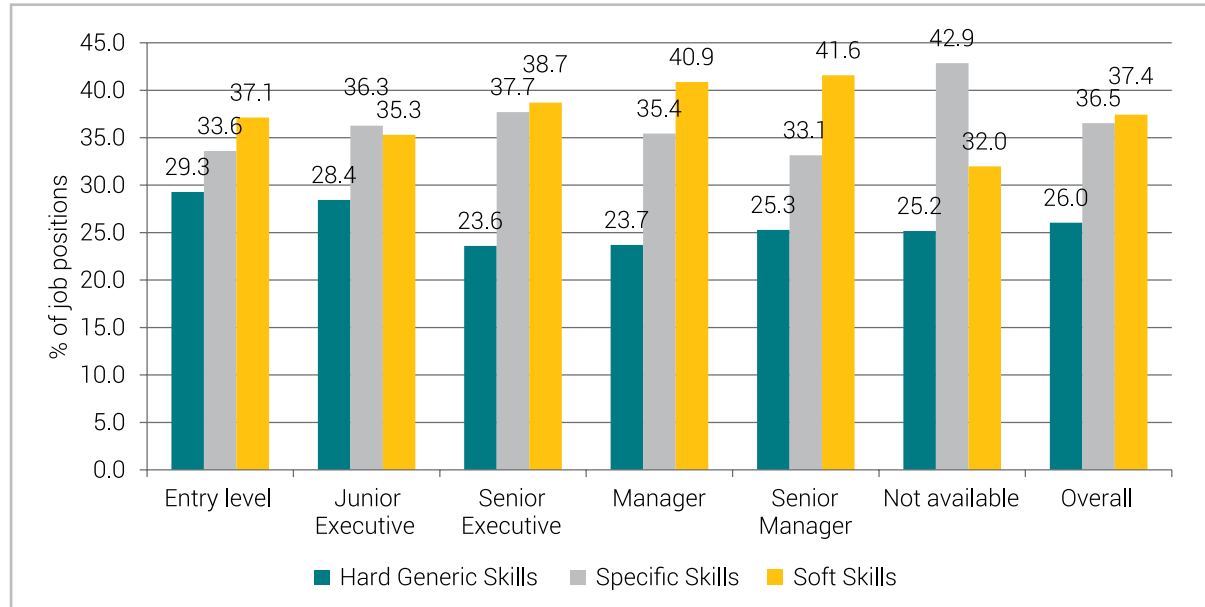
Similarly, as the job level goes up, more vacancies require soft skills more than other hard skills. A senior manager is expected to have soft skills to qualify for the role. Specifically, about 42% of this position require soft skills (Figure 4.14), and among the soft skills, achievement skills are highly sought-after, followed by relationship and services skills; but these positions require less cognitive skills such as analytical mind, conceptual thinking and information processing (Figure 4.15). As opposed to senior managers, cognitive skills are found to be essential for senior executive positions.

Figure 4.13: Generic hard, specific hard and soft skill requirements by firm size



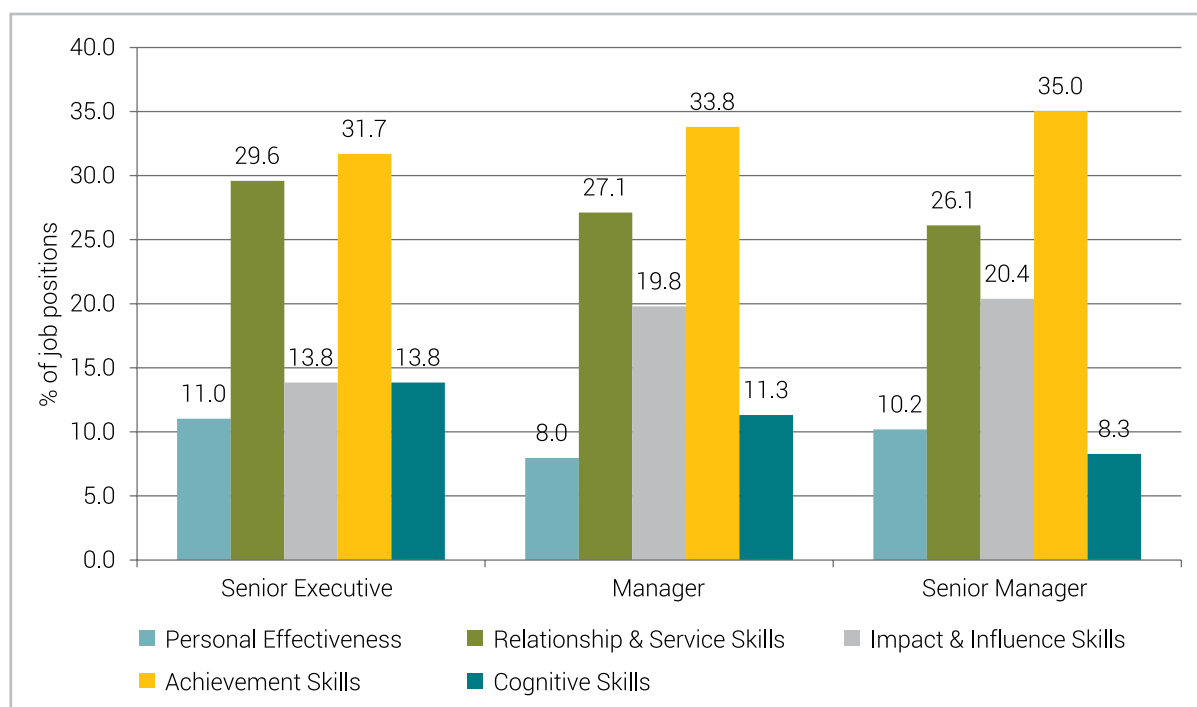
Source: Vacancy database

Figure 4.14: Generic hard, specific hard and soft skill requirements by position level



Source: Vacancy database

Figure 4.15: Soft skill sets required in top positions



Source: Vacancy database

4.3 Profiles that are considered as critical by the market

The Critical Occupation List (COL) was initiated by TalentCorp and the Institute of Labour Market Information and Analysis (ILMIA) to identify the critical occupation in Malaysia's key economic sectors. In this study, we reproduced the List of Critical Occupation 2016/17, and adapted it into the Penang context.

Critical occupations that are relevant and hard-to-fill in Penang's labour market were collected from the focus group meetings. These occupations seek to examine the representativeness of the national COL in Penang's employment market. The members of various focus groups are requested to specifically assert sub-occupations or job titles that are hard-to-fill in each sector for in-depth understanding of the specific critical occupations. The Penang-adapted COL 2016/2017 is appended in Annex 15 of Technical Report. The critical occupation is formed based on the Malaysia Standard Classification of Occupation (MASCO) 2013.

In relation to Penang's key economic drivers, oil & gas (including petrochemical) and aerospace sectors are

omitted from the study. This means that Electrical & Electronics, Information and Technology and Global Business Services (IT & GBS), Telecommunications & Media, Financial Services, Accounting, Education and Medical Devices fit well into the Penang's economic structure, and therefore participants of focus groups are asked whether critical occupations are relevant and also hard to fill in Penang. We will discuss hard-to-fill vacancies in the next chapter.

The Penang COL is largely reflective on the national COL. Out of 29 respondents, over half of the respondents found that critical occupations identified in E&E sector are highly applicable to the Penang context, followed by the IT, GBS and Creative Industry (Box 4.1). This highly corroborates with the economic structure of Penang where E&E sector is noticeably the main economic source of growth in the state. Within E&E sector, *Electrical Engineers*, *Electronic Engineers*, and *Industrial and Production Engineers* are the top three critical occupations with the highest relevance to Penang's labour requirements, whereas *IT Services Managers*; *Mathematicians*, *Actuaries and Statisticians*; and *Business Services Managers* have the least relevance (Table 4.12).

Box 4.1: The Critical Occupations List (COL) report by TalentCorp

As part of the efforts under the 11th Malaysia Plan to address skill mismatches in the labour market, the Critical Skills Monitoring Committee (CSC) was formed, jointly led by TalentCorp and the Institute of Labour Market Information and Analysis (ILMIA), and Ministry of Human Resources (MOHR). The principal function of CSC is to adopt new approaches to skill imbalances monitoring, in collaboration with the World Bank and in line with international best practices. One of the key initiatives is to construct a Critical Occupations List (COL) that will facilitate the availability of talent based on industry specific needs.

The COL is an evidence-based list of occupations in Malaysia that reflects the most sought-after occupations besides identifying which industries are at risk of facing shortages or difficulties in hiring. The pilot COL 2015/2016 had reflected occupations that are skilled, sought-after, and strategic in six key sectors in Malaysia. It covered Electrical & Electronics, Oil & Gas, Information Technology & Global Business Services (IT & GBS), Telecommunications & Media, Financial Services and Accounting. Following its release, the report has been well received by policy makers and employers.

Since then, the CSC has been reviewing, strengthening, and updating the COL. This has led to the COL 2016/2017 undergoing an expansion to reflect 10 key sectors in Malaysia. The latest COL report expanded its scope by covering Electrical & Electronics (including Machinery/Equipment and Advanced Engineering), Education, Aerospace, Medical Devices, and Petrochemicals.

Top-down analysis and bottom-up evidence

The COL is an evidence-based and participatory approach to address skill imbalances in the country. Based on lessons learnt from international experiences such as the UK Migration Advisory Committee and Australia Department of Education and Training, Malaysia's COL is developed through a combined approach of top-down analysis and bottom-up evidence.

1. Top-down analysis: CSC identifies occupations that are skilled based on the categorisation of Malaysia Standard Classification of Occupations (MASCO) 2013; National statistics are analysed to detect occupations that are sought-after based on the Department of Statistics' Labour Force Survey 2011–2014, which shows high employment and wage growth as an indicator of high demand. If the occupations are skilled-based and sought-after, these occupations must be strategic, which are in line with Malaysia's investment and economic goals.
2. Bottom-up consultation: Results from the top-down analysis are then corroborated by the industry via a combination of surveys and consultations, along with engagements with sector regulators, industry lead bodies, and companies. The analysis covered selected firms located in the northern region (Penang and Kedah) and the southern region of Peninsular Malaysia (Johor) for the E&E industry; and firms located in East Malaysia focused on oil & gas sector.

The COL was finalised upon adjusting the preliminary COL in response to the feedback and validation from the regulators and industry lead bodies. It consists of 48 occupations that are critical across 10 key sectors in Malaysia (an increase from the previous 42 occupations listed). Occupations identified by CSC are based on the categorisation within MASCO (2013). Even though the final COL has been published, it is still open for feedback, providing the opportunity for government agencies, employers, and individuals to provide further input or evidence on sought-after occupations. This further contributes to the organic nature of the list.

How Can We Benefit?

An understanding of the specific skills demanded by the labour market helps the government to prioritise publicly financed initiatives such as TalentCorp's Returning Expert Programme (REP) and Residence Pass-Talent (RP-T), the Immigration Department's Employment Pass, government scholarships, upskilling and reskilling programmes, and courses offered by institutes of higher education, including TVET. The industry can also go beyond conventional business methods and explore alternative measures such as targeting Malaysians abroad and investing to develop sought-after skills, either through in-house training or industry academia collaboration. The public, in return, will be able to make better informed decision when it comes to selecting course of study and career paths based on the demands of the industry.

The following reflects the current and potential use of the COL in selected human capital policy interventions.

- Upskilling: An updated information on the type of specialisations and competencies that the industry requires.
- Technical Vocational Education and Training (TVET): The CSC aims to expand the list to semi-skilled occupations in the future, and will therefore provide information on the types of TVET occupations that are sought-after and the type of qualifications required.

- Graduate Employability: The COL can guide graduate employability programmes to provide relevant training and knowledge for graduates to elevate the employability rate.
- Scholarship Management & Higher Education: The COL incorporates industry evidence to provide guidelines for shaping higher education curriculum and scholarship allocations.
- Attracting Foreign Talent: The COL can be a useful tool to target expatriates based on their specific expertise and to fit a specific skill demand that the country is lacking.

Outcome

Besides identifying critical occupations, compilation of the COL is a useful guide for the following public initiatives:

1. University course review – New courses proposed by public universities are cross-checked against the COL for relevance to industry needs.
2. Graduate employability – With reference to the COL, training programmes for graduates and profiling tests for jobseekers are tailored to focus on skills that are required by the industry.
3. Returning Expert Programme (REP) – In facilitating the return of Malaysian professionals from overseas, additional points are now granted to REP applicants who are working in critical occupations.

The application of the COL for the following initiatives are currently in progress:

1. Scholarship management – The COL will be used by the Public Service Department (JPA) in determining and prioritising courses to offer through their scholarship programmes.
2. Residence Pass-Talent (RP-T) – In facilitating the employment of expatriates in Malaysia, additional points will be granted to expatriates working in critical occupations.

Overall, few differences emerged in regard to a Penang-specific COL relative to the national COL. Given the prominence of the E&E industry in Penang, *Software Developers, Manufacturing Professionals, Electronic Engineers* and *Mechanical Engineers* show a higher relevance in Penang than they do at national level.

Programmers and Mathematicians, Actuaries and Statisticians from IT, Global Business Services & Creative industry may not appear as relevant as occupations in the E&E sector, demand for these occupations is still relatively high, perhaps implying scarcity of these skills.

Although *IT Service Managers* from Telco & Multimedia sector; and *Software Developers, Applications*

Table 4.12: The relevance of national COL to Penang*

Industry	Broad critical occupation	Relevance to Penang (%)
1. Electrical & Electronics Sector	Software Developers	62.1
	Manufacturing Professionals	65.5
	Electronic Engineers	72.4
	Mechanical Engineers	65.5
	Information and Technology (IT) Services Managers	27.6
	Electrical Engineers	79.3
	Mathematicians, Actuaries, and Statisticians	13.8
	Industrial and Production Engineers	65.5
	Applications Programmers	55.2
	Engineering Professionals Not Elsewhere Classified	24.1
	Policy and Planning Managers	62.1
	Mechanical Engineering Technicians	51.7
	Business Services Managers	44.8
	Electronics Engineering Technicians	62.1
	System Analysts	62.1

2. Telco & Multimedia Sector	Information and Technology (IT) Services Managers	17.2
	System Administrators	48.3
	Database Designers and Administrators	20.7
	Applications Programmers	41.4
	Telecommunications Engineers	34.5
	Database and Network Professionals Not Elsewhere Classified	13.8
	Mathematicians, Actuaries, and Statisticians	17.2
	Financial Analysts	37.9
	Systems Analysts	41.4
	Computer Network Professionals	27.6
	Management and Organisation Analysts	41.4
	Business Services Managers	41.4
3. ICT, Global Business Services, Creative Industry	Software Developers	37.9
	Applications Programmers	37.9
	Electronic Engineers	44.8
	System Analysts	37.9
	Mathematicians, Actuaries, and Statisticians	10.3
	Accountants	58.6
	Financial Analysts	44.8
	Graphic and Multimedia Designers	37.9
	Computer Network Professionals	41.4
	Information and Technology (IT) Services Managers	37.9
	Manufacturing Professionals	58.6
	Software and Application Developers and Analysts Not Elsewhere Classified	37.9
	Accounting Associate Professionals	48.3
	Information and Technology (IT) User Support Technicians	41.4
	Personnel and Career Professionals	58.6
	System Administrators	48.3
	Administrative Managers	31.0
4. Financial Services Sector	Financial Analysts	48.3
	Finance Managers	48.3
	Lawyers	44.8
	Accountants	62.1
	Financial and Investment Advisers	51.7
	Applications Programmers	48.3
	Securities and Finance Dealer and Brokers	27.6
	System Analysts	48.3
	Mathematicians, Actuaries, and Statisticians	13.8
	Information and Technology (IT) Services Managers	27.6
	Business Services Managers	34.5
	Personnel and Career Professionals	62.1
	Credit and Loans Officers	44.8
	Advertising and Marketing Professionals	48.3
	Research and Development Managers	34.5
	Insurance Underwriters	24.1
5. Accounting Sector	Financial Analysts	48.3
	Finance Managers	69.0
	Accountants	69.0

* The critical occupations in each sector are sorted in descending order based on the highest percentage of hard-to-fill occupations responded by the focus group members

4.4 Projected labour demand suggested by the employer survey

When respondents were asked whether emerging tasks in the next 12 months will necessitate their current high-qualified employees to acquire new skills, approximately 85% of the total responses to the employer survey expect their employees to acquire new skills or knowledge, while only about 11% of them do not require their employees to acquire new skills. This also indicates that only a handful of employers will not expect any newly emerging tasks that demand new skills. This can be due to the fact that some industries such as hospitality services, and transport and logistics are expected to have little changes in the next 12 months.

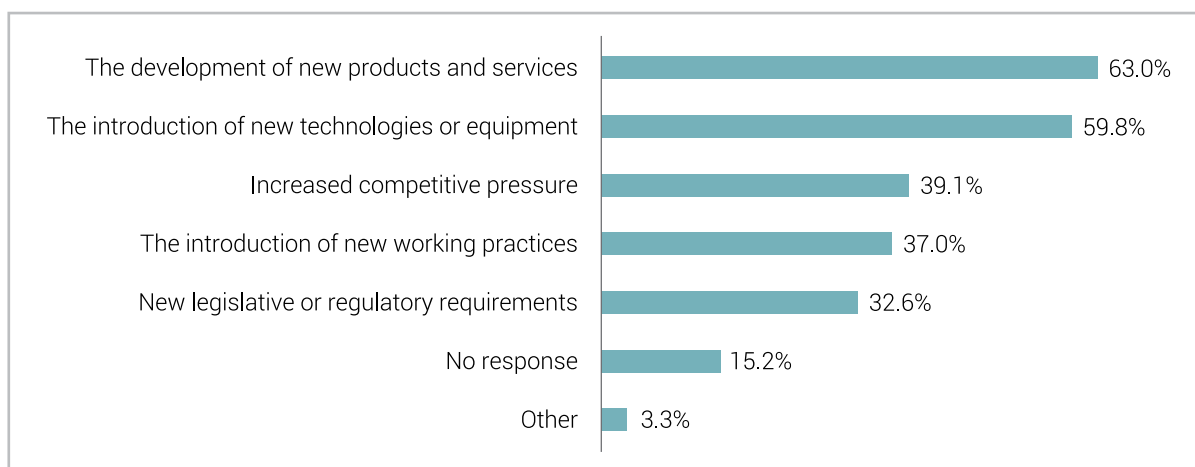
As for the reasons for acquiring new skills, the survey reported that it was mainly attributed to "the development of new products and services" (63%) followed by "the introduction of new technologies or equipment" (59.8%), as shown in Figure 4.16. In the manufacturing sector, functions that will be impacted include Research & Development (R&D), New Product Introduction (NPI), IT software, and programming. While in the services sector, these will affect the functions of an

establishment in business development, GST software and corporate secretariat. "Increased competitive pressure" is the next reason for acquiring new skills, and it very much impacts corporate planning, sales and marketing, and production engineering.

The projected skill requirements in the future include 146 skills reported across 71 firms. Of these, most of the prospective skills require specific hard skills to perform newly emerging tasks. This is evident that specific hard skills are skills requiring certain proficiencies, which could be a niche area for a specific industry. About 65.8% of the skills are specific hard skills; 26.7% are soft skills; and only 5.5% are hard generic skills.

The survey also indicated that companies from high-tech manufacturing, other high-tech manufacturing, advanced producer and financial services, and IT/digital industry would require more specific hard skills than other industries. For example, hardware design, Autocad, cardene allegro and mentor graphic, RF debug, data automation and robotic engineering are needed by high-tech manufacturing in future whereas cloud technology, data science, SAP-cloud ERP system, Angular2, Java and SQL server are wanted by IT/Digital Industry.

Figure 4.16: Reasons for acquiring new skills as a result of newly emerging tasks (% of respondents)



Source: Employer survey

Soft skills are mostly required in GBS, and Advanced Producer and Financial Services. In particular, skills such as management, creative and critical thinking, adaptability, problem-solving, customer service, analytical, presentation, communication, public relations and team work are still required in the future.

With reference to the ability to meet future needs, a majority of the respondents believe that they are able to meet these needs in future except specific hard skills. Out of 71 respondents, 84.6% of them reported that they could meet the requirements of soft skills needed in the future, followed by 75% for generic hard skills and 68.8% for specific hard skills.

4.5 Evolving nature of work

Work is clearly evolving, which means that we are seeing new technologies and behaviours enter our workplace as economies restructure. This is not only limited to Penang's economy, but also a global issue. In the past three decades, economies and industries around the world – Europe, the United States and Asia – have been reshaped by technological advancement. As products, processes and practices change, so is work nature. This is a continuous process. Technological change continues to engender new ways of doing things, and once embodied in capital, whether physical or human, it creates more value with fewer inputs. It can be economically disruptive, rendering existing skills and organisational approaches obsolete and irrelevant, and requiring entirely new skill sets. Technological change continues to be an important driver of changing work features and skill needs. Significant shifts in labour markets will be envisaged as future work is expected to have vast characteristics compared with the large majority of current jobs.

At the company level, skill demand depends on types of products and services produced, and so are influenced by the organisation's product market strategy, future growth plans and adoption of new technologies. The development of new technologies facilitates the creation of complex, international supply chains and perhaps, the greatest driver of change. The precise skill demand for the future is still uncertain as it depends on the exact manifestation(s) of new technologies at company level. Besides technical skills (IT, Engineering, high level Mathematics, risk analysis, technical pre-sales, energy management expertise, data collection and analytics), these might focus even more on soft skills: generic ones (communication, teamwork, problem-solving and entrepreneurship), creative capabilities, and influence skills (ability to communicate, analyse and persuade)⁴².

An illustrative case is the Factory of the Future⁴³ or Industry 4.0⁴⁴. 'Industry 4.0 digitalisation for productivity and growth', taken from European Parliament Briefing 2015, "Industry 4.0 is a term applied to a group of rapid transformation in the design manufacture, operation and service of manufacturing systems and products." The 4.0 designation signifies the world's Fourth Industrial Revolution, the successor to three earlier industrial revolutions that caused quantum leaps in productivity and changed the lives of people throughout the world. It is the transformation of whole spheres in industrial production through the merging of digital technology and the internet with conventional industry. In short, manufacturing operation (suppliers, the plant, distributors, even the product itself) will be digitally connected providing a highly integrated value chain. The term 'Industry 4.0' originated in Germany, but the concept largely overlaps developments that, in other European countries, may variously be labelled: 'smart factories', 'industrial Internet of Things (IoT)', 'smart industry', or 'advanced manufacturing'.

⁴² See Yawson (2010)

⁴³ See Skevi et al. (2014)

⁴⁴ See Capgemini (2014), Deloitte (2015), European Parliament (2015), German Trade and Invest (2014), McKinsey Global Institute (2013), PwC (2016).

The employment and skill development implications of Industry 4.0 are expected to be substantial. The nature of manufacturing activity has been shifting from manual labour to programming, automation and smart machines. Employees with low skill levels risk becoming replaceable unless they are retrained. On the other hand, workers who are able to make the transition to Industry 4.0 may find greater autonomy and more interesting or less arduous work. Employers need personnel with creativity and decision-making skills as well as technical and ICT expertise. By 2020, labour markets in the European Union (EU) could be lacking as many as 825,000 IT professionals; this shortage may even be more pronounced in advanced manufacturing settings where big data analysts and cyber-security experts are required. While various initiatives have been undertaken to encourage the acquisition of e-skills, young people may not necessarily be interested in the digitalisation of the workplace: in one survey only 13% of young adults in Germany would consider a career in IT despite the majority of them viewed the sector as

offering the best job prospects⁴⁵.

In Malaysia, while an increasing number of degree holders augur well for the supply side of the labour market, it remains to be seen whether it can keep pace with the demand side as the impact of new technologies – some potentially economically disruptive and impinging on work practices and organisation – is gradually felt.

Table 4.13 presents some vision of manifestations of technological transitions in Penang's economy. Those in the past and current may give rise to workplace changes; ongoing changes can be expected to make their mark in the future. Figure 4.21 presents an overview of Penang's potential technological pathway in the future as the new technological paradigm starts to enter. Table 4.14 presents a forecast of job transformation implications of the paradigmatic changes. It is imperative that Penang prepares and equips itself for a smooth transition.

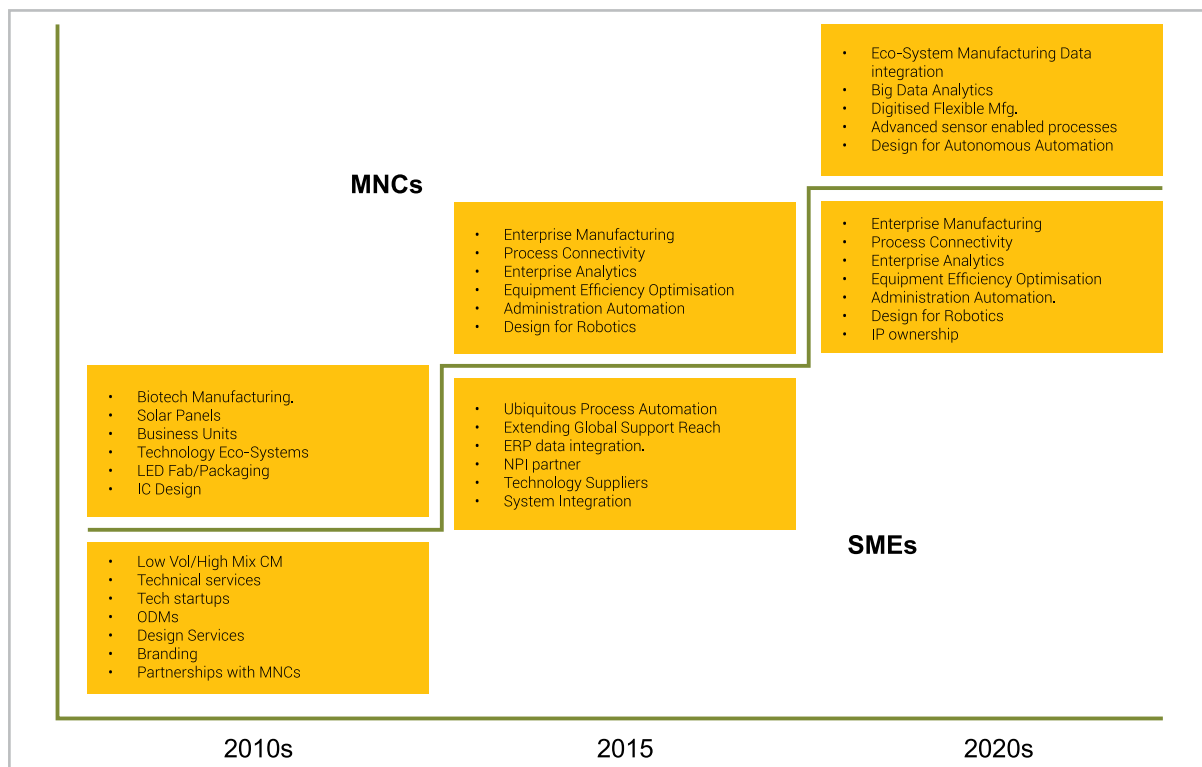
Table 4.13: Key technology trends currently occurring, impinging on work trends

Past	Present	Future
Trend Paths		
<ul style="list-style-type: none"> - Metals and traditional ceramics - Separate Engineering and Biology - Selective Breeding - Small-scale Integration - Micron plus lithography - Main Frame - Standalone computers 	<ul style="list-style-type: none"> - Composites and polymers - Bio-materials - Genetic Insertion - Very large scale integration - Sub-micron lithography - Personal computer - Internet connected to machine 	<ul style="list-style-type: none"> - Smart materials - Bio/Genetic engineering - Genetic engineering - Ultra/giga-scale integration - Nano-assembly - Micro-appliances - Appliances and assistant networks
Meta Trends		
<ul style="list-style-type: none"> - Single discipline - Macro-systems - Local - Physical 	<ul style="list-style-type: none"> - Dual/hierarchically discipline - Micro-systems - Regional - Information 	<ul style="list-style-type: none"> - Multi-discipline - Nano-systems - Global - Knowledge
Tickets to Technology Revolution		
<ul style="list-style-type: none"> - Trade schools - General University - Locally resourced products - Capital 	<ul style="list-style-type: none"> - Highly specialised training - Specialised degree - Locally resourced components - Increased capital 	<ul style="list-style-type: none"> - Multi-disciplinary training - Multi-disciplinary degrees - Products tailored to local resource - Mixed

Source: Yoon (2016)

⁴⁵ European Parliament (2015) pp. 2-4, 6-7.

Figure 4.17 Projected technological pathway in Penang



Source: Yoon (2016)

Table 4.14: Job transformation implications of prospective technological pathway

Phase	Outputs	Job Transformations
Design/NPI	<ul style="list-style-type: none"> • Intelligent and internet enabled machines and processes: <ul style="list-style-type: none"> - Easy integration between design and manufacturability - Fast design lead time - Hard tool postponement - Manufacturing system prototyping within virtual factories 	<ul style="list-style-type: none"> • Increasing dominance of software simulations in design: <ul style="list-style-type: none"> - System awareness design - Network interoperability - Artificial intelligence - Robotics and Cybernetics - Machine networks - Advanced material systems - Specialisation with multi-discipline foundation - Collaboration within the entire design chain - Data Science
Manufacturing	<ul style="list-style-type: none"> • Interlinking factory capacities across supply chain • Real time data curation and analytics • ERP management across supply chain • Machine utilisation and process efficiency. • Predictive problem-solving • Manufacturing = Order management, planning, manufacturing, warehousing, and delivery. 	<ul style="list-style-type: none"> • Data analytics-driven management: <ul style="list-style-type: none"> - Manufacturing system configuration and management - Software-enabled machine and process maintenance - Software upgrade development and process/hardware continuing improvements
Procurement	<ul style="list-style-type: none"> • Setting supply chain relationships and transaction rules: <ul style="list-style-type: none"> - Supplier chain virtualisation down to machine level - Capacity contracts - Setting and digitisation of rules of engagement 	<ul style="list-style-type: none"> • Increasing non-transactional-based work: <ul style="list-style-type: none"> - Negotiations - Communications - Data Analytics

Source: Yoon (2016)