Executive Summary

This report investigates three inter-related questions. First, what are the key drivers of Total Factor Productivity (TFP) amongst SMEs in the manufacturing sector? Second, How can we use these drivers to understand the state of competitiveness of SMEs in manufacturing? Third, how can we develop a mechanism for observing the evolution of SME’s productivity and innovation?

To address these questions, we relied on a triangulated research methodology that is driven by a comprehensive review of the academic and extant literature on the drivers of TFP; a Delphi study where we sought views of global and local experts and thought leaders (including academics, government officials, and policymakers) on the drivers of productivity and innovation in SMEs; and a series of in-depth interviews with SME Leaders to appreciate the challenges SMEs face in operating in the current business environment. This triangulated approach bought to the fore six drivers of TFP: Technology & Capital Utilisation; Pay & Performance Management; Training, Development & Organisational Learning; Innovation Culture; Government Policy, Markets & Regulation; Leadership & Management Quality.

A survey instrument containing 41 multiple-choice questions across these 6 drivers was developed and administered to 215 SMEs in the following sub-sectors: Chemicals & Chemical Products; Pharmaceuticals & Biological Products; Computer, Electronic & Optical Products; Fabricated metal products; Food & Beverage; Machinery and Equipment; Other Transport Manufacturing/Engineering. These sub-sectors account for 80 percent of the manufacturing output in Singapore.

Based on the responses of SMEs, we estimate the performance of SMEs through a composite score that aggregates performance across the 6 drivers. This is captured through a webportal developed exclusively for this project. Going forward SMEs can complete the survey online through the webportal and measure their competitiveness across 6 drivers of TFP in real time. SMEs are also provided specific recommendations, based on their composite score, to improve their productivity and innovation practices.

This report is organised in 8 sections. The first section discusses Singapore’s productivity imperative and outlines the central research questions this project endeavours to answer. Section 2 introduces the concept of Total Factor Productivity (TFP) and speaks to the challenges in measuring it. This is followed by a detailed review of the academic and extant literature on the drivers of TFP in Section 3. Section 4 elaborates the Research Methodology and Approach. Section 5 discusses the key research findings of the survey instrument. Section 6 unpacks the methodology in estimating the composite score of firms and the performance across sub-sectors. This is followed by specific recommendations in Section 7 for SMEs to improve productivity and innovation practices. Section 8 contains concluding observations.
We wish to thank the Singapore Innovation and Productivity Institute (SIPI) and SPRING Singapore for their support of this research. In particular, we wish to make special mention of Mr Surajit Dhar, Ms Gillian Lim and Mr Chang Phuan Heng of the Singapore Innovation and Productivity Institute.

Our thanks also go to Mr Lam Joon Khoi (Secretary-General of the Singapore Manufacturing Federation) and Dr Michael Teng (Assistant Secretary-General of the Singapore Manufacturing Federation). We would like to thank our Chief Expert, Professor Foo Check Teck for his constructive comments and mentorship throughout the project.

We also wish to acknowledge the wonderful service of our student Research Assistants including Ms Amrita Kaur, Mr Alvin Tan, Ms Andrina Lee, Ms Dewi Lasmini Bte Abdul Rashid, Ms Dawn Tan, Ms Felicia Xu, Mr Ellis Tan and Ms Nur Atiqa Binte Arbain; and Research Fellow Azad Singh Bali. Finally we wish to pay tribute to the many SME leaders and managers who gave up their time to participate in this study. We trust that its results will be of continuing utility and relevance.
Preamble

In February 2014, Murdoch Singapore (a subsidiary of Murdoch University, Australia) was engaged by the Singapore Innovation and Productivity Institute to undertake a research study formally referred to as the ‘Benchmarking Study on Innovation and Productivity of the local manufacturing sector and development of online benchmarking analytics portal’. Given the importance of Small to Medium Enterprises in Singapore, the study’s empirical focus centred on these firms, defined as having 200 employees or less and less than $100 million dollars in annual turnover with minimum 30 percent local shareholding.

The key objective of the study was described in the following terms:

‘To characterise industry performance in areas of innovation and productivity through the establishment of top 5 to 8 indicators in operational performance and building a good benchmarking database of 200 local SME manufacturing & engineering companies. The online benchmarking analytics portal serves as a platform for individual companies to input their company data based on the productivity indicators and observe their competitiveness in terms of innovation and productivity’.

Therefore the study’s aim was not to measure the productivity of SMEs in the manufacturing sector, but rather to examine the state of key drivers of total factor productivity in manufacturing. The study was conducted in the space of twelve months, with the preliminary findings presented during National Productivity month in October, 2014, and the entire study completed by February 2015. The key deliverables of this study include this final report and the development of a repository of benchmark data collected from 215 SMEs, accessible through a bespoke web portal. The web portal will serve as a tool of continuing utility for the sector as SMEs are encouraged to benchmark themselves against their peers, industry and subsector leaders. Additionally, the web portal has been designed to provide firms with recommendations and ideas on how they may improve their productivity and innovation. In this way, firms will be able to track their performance over time, and the Singapore Innovation and Productivity Institute will be able to monitor sectoral developments and improvements as they occur.

Brief CVs of Chief and Partner Investigators

Professor Peter McKiernan - Dean of the School of Management and Governance, Murdoch University

Peter joined Murdoch as its Interim Dean of the School of Management & Governance in July 2012 from Scotland’s leading business school at the University of Strathclyde, where he was a Professor of Management and Interim Head of Department. Previously, he was the Head of the School of Management at the University of St Andrews.

Peter is a prize winning and active researcher engaged in cutting edge analysis of changing political, economic and social trends, their impact on strategic formulation and implementation for businesses. He has authored or edited many books, including the international best seller ‘Sharpbenders’, plus ‘Strategies of Growth’, ‘Inside Fortress Europe’, ‘Management Styles’, ‘Strategic Leadership’ and two volumes on the ‘Historical Evolution of Strategic Management’. Peter has published widely in top rated peer reviewed journals in Europe and the USA and served on many editorial boards. As well as being a co-founder of the European Management Review. Peter has served as President of the British Academy of Management and President of the European Academy of Management and is the only UK-based professor to hold Fellowships of both academies (FBAM and FEURAM). He is an inaugural Companion of the Association of Business Schools (CASB), an Academician of the Academy of Social Sciences (AASS) and a Fellow of
the Royal Society for the Arts (FRSA). In 2012, the Central and Eastern European Management Development Association (CEEMAN) voted him their ‘Institutional Champion of the year’. He holds a Visiting Professorship at the University of Malta and two Visiting Senior Research positions at HHL (Leipzig) in Germany.

Peter has gained extensive international business experience while acting as a strategy coach and trainer for a number of major multinational companies including Aegon UK, AT&T, BT, Bertelsmann-Random House, Shell, BP, Corus, Ford of Europe, GEC, Nynas, Marks and Spencer, Jardine-Matheson, IBM, Philips, Cadbury's, Reed International, the Co-operative Society as well as a host of small and medium sized businesses.

Associate Professor Peter Waring – Singapore Dean, Murdoch University

Associate Professor Peter Waring is Murdoch University’s Singapore Dean, based in Singapore where the University has significant transnational education activities. As the Singapore Dean, Peter is responsible for advancing the University’s academic and strategic interests in Singapore. Peter has previously held academic positions at the University of Newcastle and the University of NSW (Asia) including the leadership positions of Acting Pro Vice Chancellor (International) at the University of Newcastle and Academic Director and Deputy CEO of Newcastle’s Singapore operations. A qualified lawyer, Peter also holds degrees in Commerce and Management. He is the co-author of four books on employment relations and has published more than sixty book chapters and articles in leading international and national journals. His research and teaching interests span the business and law fields of employment relations, human resource management, corporate governance and labour law. In 2011, Peter was a recipient of the Australian Government’s ‘Outstanding Young Alumni Award’ in Singapore. He has lived in Malaysia and Singapore for the past 11 years.

Dr Christopher Vas, Academic Director Executive Education Murdoch University, Australia

Christopher Vas holds a PhD from the Australian National University. He was previously Program Director at the HC Coombs Policy Forum – a joint think tank between the Australian Government and the ANU – he directed the Productivity & Competitiveness and Policy Futures Policy Research Programs. Chris has worked on issues related to workforce innovation and productivity within the Industry Workforce Development Branch of the Australian Government’s Department of Industry and Innovation. His role involved the identification of leading practices in workforce development, innovation and productivity and the provision of evidence-based policy advice through liaison with national and international stakeholders. He also managed for the Government a $1m project on Leadership, Culture and Management practices in High Performing Workplaces in Australia.

Partner Investigators

Dr Johanna Macneil, Senior Lecturer, University of Newcastle, Australia

Dr Macneil holds a PhD from the University of Melbourne and was formerly a senior management consultant for Corrs Schneider (later Schneider (Australia) Consulting) (1999-2006); a Senior Lecturer in Management and Executive Director of the Centre for Change Management at Deakin University (1996-1998); and a Senior Research Fellow at Monash University’s National Key Centre in Industrial Relations (1992-95). Dr Macneil holds a special research interest in benchmarking, productivity and international best practice, having played a key role in the Australian Best Practice Demonstration Program of the early 1990s.
Key Definitions

a. Labour Productivity measures the effectiveness and efficiency of employed labour. It is usually measured as a ratio of the value added (output) by the number of employees.

b. Sales per Employee measures the efficiency and effectiveness of marketing strategy, and is measured as a ratio of total sales by the number of employees.

c. Value added-to-sales ratio measures the proportion of sales created by the organization over the cost of purchased material – i.e. the monetary value associated with the firms’ production process. It is measured as a ratio of value-added over total sales.

d. Profit margin measures the proportion of sales left to the organization after deducting all costs. It is measured as a ratio of operating profit over sales.

e. Profit-to-value added ratio is a ratio of the operating profit to the value added.

f. Labour cost competitiveness measures the efficiency and effectiveness of the organization in terms of its labour costs. Usually, it is measured as a ratio of value added over total labour cost.

g. Labour cost per employee measures the average remuneration per employee and is usually measured by total labour costs divided by number of employees.

h. Sales per dollar of capital measures the efficiency and effectiveness in fixed assets in the generation of sales. It is measured by total sales divided by the value of fixed assets.

i. Capital intensity measures the extent to which the organization or business is capital intensive. It is measured as a ratio of the value of fixed assets to the number of employees.

j. Capital productivity measures the efficiency and effectiveness of fixed assets in the generation of value added – i.e. the ratio of value added over value of fixed assets.

k. Total Factor Productivity (TFP) or Multi-factor Productivity relates a change in output to several types of inputs. TFP is often measured residually, as that change in output that cannot be accounted for by the change in combined inputs.

l. Innovation – we rely on the Oslo Manual (OECD) definition of innovation as “the implementation of a new or significantly improved product or process…marketing method, organizational method in business practices, workplace organization”

m. Small to Medium Enterprise (SME) – SMEs are defined as organization with less than 200 employees or $100m in annual turnover and minimum 30 percent local shareholding.
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1. Singapore’s Productivity Imperative

Over the last decade, Singapore has experienced very low productivity growth and lags by a considerable margin, productivity and innovation levels among the advanced economies such as the US, Japan, Germany, Korea and Sweden. Under the leadership of the Government, Singapore’s economy is undergoing a transformation that will see it take a high skill/high productivity pathway. In so doing, the economy will rely less on foreign labour and invest more in local human capital to drive innovation and productivity improvements.

Access to a supply of relatively inexpensive foreign labour has sometimes been cited as a contributing cause of Singapore’s economic success. With predictions that low to no productivity growth would persist, the Singapore Government has taken difficult decisions to purposefully slow the growth in its foreign workforce. This decision has been taken in acknowledgment of the fact that the ‘sectors which are most dependent on foreign workers are also the ones furthest behind international standards of productivity’ (Shanmugaratnam, 2013:c18). The government’s resolve to improve productivity and innovation can perhaps be best captured by the following data point. The word ‘productivity’ appeared over 200 times in the Budget Statements during the period since 2010, compared to 20 times during the decade ending 2010 (Hawyee Auyon, 2014).

However there is strong evidence to suggest that productivity growth is weakest in those sectors where the growth in the foreign labour force has been strongest. In aggregate, the size of the foreign workforce in Singapore is considerable. The Ministry of Manpower’s statistics indicate that the total foreign labour force as at December 2013 amounted to 1.321 million workers or approximately 25 percent of the total resident population or just 39 percent of the total labour force of Singapore. Since 2009, the total foreign labour force has grown from 1.053 million workers to 1.321 million workers or just over 25 percent (Ministry of Manpower, 2014). The Government has taken significant and difficult steps to restrict the further growth of the foreign labour force by raising foreign worker levies and restricting the pool of work permits available. These policy initiatives are sending important signals throughout the economy and the business sector that firms must improve their productivity if they are to stay competitive.

In his 2013 Budget speech, Deputy Prime Minister and Minister for Finance Mr Tharman Shanmugaratnam underscored the importance of productivity growth for sustaining economic growth and living standards in Singapore. In his speech he declared:

‘Raising productivity is not just our most important economic priority, but enables us to build a better society. Higher productivity is the only sustainable way to raise incomes for ordinary Singaporeans, and provide jobs that give people a sense of responsibility and empowerment’ (Shanmugaratnam, B13)

Central to the lifting of productivity, according to Minister Shanmugaratnam, is the role to be played by Small & Medium Enterprises (SMEs), especially in the manufacturing sector. In Singapore SMEs employ 70 percent of all workers so raising productivity and innovation levels in these firms is especially important. The Minister has commented that:

‘We must help our SME sector revitalise itself. There are however wide divergences in efficiency amongst SMEs even in the same industries’ (Shanmugaratnam, 2013:c18).
1. Singapore’s Productivity Imperative

Over the last decade, Singapore has experienced very low productivity growth. It lags labour productivity and innovation levels in the US, Japan, China and India by a considerable margin, as Table 1 indicates:

Table 1: Global Productivity Growth Rates 2012-2013

<table>
<thead>
<tr>
<th>Regional indicators</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North America</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour productivity growth</td>
<td>0.9%</td>
<td>0.9%</td>
</tr>
<tr>
<td>GDP growth</td>
<td>2.8%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Total Factor Productivity</td>
<td>0.7%</td>
<td>0.4%</td>
</tr>
<tr>
<td><strong>Euro region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour productivity growth</td>
<td>-0.1%</td>
<td>0.4%</td>
</tr>
<tr>
<td>GDP growth</td>
<td>-0.07%</td>
<td>-0.3%</td>
</tr>
<tr>
<td>Total Factor Productivity</td>
<td>0.8%</td>
<td>-0.6%</td>
</tr>
<tr>
<td><strong>Labour productivity growth in...</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>-0.4%</td>
<td>0.8%</td>
</tr>
<tr>
<td>China</td>
<td>7.3%</td>
<td>7.1%</td>
</tr>
<tr>
<td>India</td>
<td>3.1%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Japan</td>
<td>1.2%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Poland</td>
<td>5.6%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Russia</td>
<td>3.1%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Singapore</td>
<td>-2.5%</td>
<td>1.6%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-1.8%</td>
<td>0.5%</td>
</tr>
<tr>
<td>United States</td>
<td>0.7%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

Source: Adapted from the Conference Board’s Report on Global Productivity 2013

Experts and government authorities regard Singapore as a highly competitive economy. Recently, Senior Minister of State for Trade & Industry, Mr Lee Yi Shyan noted, the World Economic Forum Global Competitiveness Report 2013-14 ranked Singapore second behind Switzerland for competitiveness. However Singapore’s reputation as a competitive economy is not matched by its poor record on most measures of productivity and innovation.

Figure 1A illustrates the trends in total labour productivity, including the manufacturing sector, in Singapore for the period 2001 – 2013. Singapore’s total labour productivity grew annually by 1.6 percent between 2008-2013, marginally higher than 1.1 percent annually during the previous five years. While there have been advances in labour productivity in particular sectors of the economy, a structural shift in employment away from these productive sectors has resulted in declining total labour productivity (Goh, 2013). Such sectoral changes are not unique to Singapore, as they are prevalent in economies including Finland, Japan, Netherlands and Germany that are also undergoing structural changes to their economy.
1. Singapore’s Productivity Imperative

Figure 1A: Productivity in Singapore

As the figures represent year-on-year changes in productivity, the sharp increase in labour productivity in 2009-10 must be viewed in the context of a gradual decline since 2005, resulting in a low base. For most of the time period illustrated in Figure 1A, labour productivity in the manufacturing sector has followed total labour productivity in the economy. This is striking, given the declining share of the manufacturing sector in the economy over the past decade: this sector declined from 33 percent in 2000 to 25 percent in 2006, and currently accounts for less than a fifth of GDP.

1.1 Business Model Innovation (BMI)

In this context, one of the main challenges is the identification of the reasons for weakening productivity and to understand how to revitalize TFP. An important pathway to improving productivity and revitalizing competitiveness is through a focus on innovation at all levels, but especially business model innovation.

The imperative to innovate organisational business models in Singapore is triggered by the slowing of incremental productivity improvements over the last decade. Singapore is highly connected. It aims to do more by linking business activities within and across organisations. This extends to processes that make up an organisation’s core business model but, more importantly, to linking stakeholders, suppliers, partners and customers through vertical and horizontal business integration.

The level of operational and process excellence achieved across Singapore’s businesses has been remarkable. This is evidenced in Singapore’s ranking as number 2 among 148 countries on the Global Competitiveness Index\(^1\) over the past two years. Despite such an impressive global standing, Singapore is keen to improve and transform its economy as one that is built upon excellence in innovation. In this context, a focus on BMI, as a means to increase productivity further, has become of particular interest.

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1. Singapore’s Productivity Imperative

1.2 People and Ideas

At the 2013 Singapore Innovation and Productivity Institute conference, the Acting Minister for Manpower Tan Chuan-Jin stated:

“...innovation can come from all levels within the company, from both leadership and worker levels. Many people have ideas but companies also need to look at how to engage these people and ideas” (Tan Chuan-Jin, 25 October, 2013)

Alongside these findings, research has revealed the importance of improved leadership, management and organisational culture in facilitating innovation. The people element of productivity is important, especially in the manufacturing sector, as research shows that every 1 percent improvement in management can result in 6 percent higher productivity (Management Matters 2013). For instance, in Australia, a study on High Performing Workplaces (HPWs) (Boedker et al 2011) showed how productivity was 12 percent higher, with an associated average financial performance of 15.63 percent higher, than low performing workplaces. This is consistent with remarks made recently by Acting Minister for Manpower Tan Chuan-Jin at SiPi’s conference:

“To do business model innovation, we need top quality management and leadership who are not just focused on optimising the old business model, but have the foresight to invest in new models and the courage to experiment.”

(Tan Chuan-Jin, 25 October, 2013)

1.3 Information and Communication Technology

In a recent paper, Vu (2013) observes that the intensity of information and communication technology (ICT) has influenced average labour productivity growth in Singapore. Decomposing the sources of Singapore’s growth, he found that ICT capital played a substantial role, contributing 1 percent to GDP growth and 0.8 percentage points to labour productivity growth during the 1990–2008 time period. As Seetoh and Ong (2008) note, Singapore embraced ICT-led manufacturing in the 1980s. Also, Vu (2013) measured the sector’s contribution to GDP and labour productivity growth between 1990 and 2008. He observed that ICT manufacturing contributed 0.3 and 0.4 percentage points to GDP and labour productivity growth.

1.4 International Trade

Further, Mahadevan and Kalirajan (2000) found that TFP in the manufacturing sector began to decline in the late 1980’s and even became negative in the following decade. They attributed this falling “technical efficiency” to declining productivity in manufacturing sector. While the productivity of the manufacturing sector has declined, as a result of its uncompromising growth strategy, Singapore continues to remain integrated deeply with global and financial markets. Its trade to GDP2 ratio for 2000-12, was in excess of 400 (WTO, 2013).

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2 The sum of exports and imports, divided by GDP.
1. Singapore’s Productivity Imperative

Machinery and electrical products dominate Singapore’s trade composition. These account for more than 50 percent of total exports, followed by chemicals, minerals, and metals (~33 percent). This suggests that there are many opportunities for manufacturing firms in Singapore to participate and compete in global and regional supply chains and that many are doing so successfully.

Singapore has endeavoured to establish a regulatory and licensing structure that is conducive to business. The World Bank’s annual Ease of Doing Business Survey, ranked 189 economies on 10 topics including starting a business, access to credit, registering real estate, paying taxes, enforcing contracts, and protecting investor. Singapore ranked number 1 on a weighted index of these 10 dimensions.

1.5 Research and Development

Research and Development (R&D) activities are central to enhancing productivity and innovation. Figure 1C displays Gross Expenditure on R&D (GERD) in Singapore as a share of GDP, Business Enterprise Research and Development (BERD) and Government financed R&D from 1995 and 2010. Total spending by Singapore has increased from about 1 percent to above 2 percent (peaking 2.5 percent before the 2008 financial crisis). While relative share of the BERD spending has increased significantly from the mid-1990s, government’s share in gross R&D spending is still significant (about 40 percent). The private sector accounts for 75 percent of all R&D spend in the USA. There may be a greater emphasis for businesses and industry to focus on their R&D spend in Singapore to avoid falling behind.

Figure 1C: R&D Spending in Singapore (as share of GDP)

Source: Source: OECD 2013 (http://dx.doi.org/10.1787/888932774528)
## Central Research Questions

In the above context of declining productivity in Singapore, and the government’s policy impetus to energise the manufacturing space and increase its economic contribution to Singapore, this research endeavours to study productivity and innovation practices in SMEs in the manufacturing sector in Singapore. “SMEs account for 99 percent of all incorporated businesses, 70 percent of employment and about 50 percent of economic output in Singapore” (Teo Ser Luck, 2013). These SMEs therefore are instrumental in improving productivity and energising the manufacturing sector in the Singapore economy. This study focuses on three interconnected questions:

<table>
<thead>
<tr>
<th>Question</th>
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<tr>
<td>What are the key drivers of TFP and Innovation among SMEs in the manufacturing sector?</td>
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<tr>
<td>How can we use these drivers to understand the state of competitiveness of SMEs in manufacturing?</td>
</tr>
<tr>
<td>How can we develop a mechanism for observing the evolution of SMEs productivity and innovation?</td>
</tr>
</tbody>
</table>
2. Total Factor Productivity: An Introduction

2.1 A Brief Conceptual Review

Productivity is often conceptualized as a measure of efficiency in production, a ratio of how much output is obtained from a given set of inputs. As briefly discussed above, the literature has focused on using two broad factor inputs namely capital and labour. While it is useful to study how productive each of the individual factor inputs are, often their productivity also depends on the intensity of other factor inputs utilized. In view of this, analysts often focus on the productivity of input factors collectively, or Total Factor Productivity.

A production function draws the boundaries of all possible output from a given set of inputs, and therefore changes in TFP would be represented as shifts in the isoquants of a production function. One of the main advantages of relying on TFP as an analytical tool in assessing efficiency, is that it is not influenced by changes in the relative prices of factor inputs, as such changes result in movement along the isoquants and not in shifts of the isoquant. Therefore, it helps isolate the role of efficiency vis-à-vis changes in the inputs utilized in increasing production.

The standard approach in measuring productivity is to engage in a decomposition exercise, disaggregating output as a function of factor inputs: \( Y_t = A_t F(K_t, L_t, M_t) \), where \( Y \) is output, \( F \) is a function of factor inputs including capital (K), labour (L), and other materials (M). TFP, \( A_t \), in this equation, therefore, explains the residual output that cannot be attributed to the input factors. This formulation of productivity was first advanced by the seminal contribution of Robert Solow and Trevor Swan, separately, in the 1950s. However, has been since considerably developed by Jorgenson and Griliches, (1967); Christensen and Jorgenson, (1969); Jorgenson et al, (1987); Mankiw et al, (1990). In the earlier Solow-Swan conceptualization, the residual output was attributed to technical progress, which analysts have sought to unpack as various dimensions of productivity. The literature on measuring this technical progress or productivity has straddled many disciplines including, but not limited to economics, management sciences, human resource management, organizational psychology, engineering, etc. Further, these disciplines have relied on heterodox methodological approaches in measuring productivity. This review of the literature will reflect on these disciplinary and methodological approaches.

2.2 Challenges in Measuring Productivity

As discussed, productivity is essentially a ratio of outputs to inputs, measuring which gives rise to many challenges. For instance, how do we measure output in businesses that produce multiple products? To overcome this analysts often rely on total revenue (deflated to accommodate inflationary trends) of the output, but as Syverson (2011) notes this can give rise to a range of issues when variations in prices result largely from the market power of firms rather than from the nature or quality of the product itself. Further, arriving at appropriate price deflators, which reflect the real value of output across and within sectors in an economy is challenging. Similar challenges also exist in measuring the marginal product of input factors. Often disaggregating labour and capital factor inputs, let alone accounting for variations in the quality of labour, is not easy in complex production processes.

Most studies overlook these challenges, and have come to rely on the total wage bill and the net value of capital assets reported annually (p. 311). There are also analytical issues that relate to the appropriate weights of various factor inputs in businesses that produce multiple products. This requires careful micro data on the output elasticity of the production function (Cooper et al 2006). However, the last two decades have witnessed a proliferation of nuanced firm-level data including relevant information outputs and disaggregated data on labour and capital variables. This has enabled the computation of elasticity estimates and the construction of TFP indices.
2. Total Factor Productivity: An Introduction

The purpose of this literature review is to carefully interrogate the relevant extant literature to inform the construction of the main survey instrument used in this study. More generally, in order to understand the key drivers of TFP among SMEs it is critical that we have a deep appreciation of the key contributions to this literature over time, and be able to contextualise the issues in the Singapore context. By ‘relevant’ literature we mean literature that is central to our understanding of the factors driving total factor productivity.

To discover the relevant literature, we focused on the following themes and established literatures:

1. The Singapore literature – productivity and innovation literature with a focus on Singapore.
2. The established global literature on productivity and innovation
3. Literature focused on SMEs in the manufacturing sector
4. The High Performance Work System Literature
5. Literature of relevance but which did not fit within the above themes

Our systematic search focused on these areas and encompassed not only the academic literature (books, book chapters and academic journal articles and working papers) but also reports and articles produced by consultants, think tanks, firms, industry experts and government agencies. In total we uncovered some 275 references, which are detailed at the end of this report.

As the discussion in this literature unfolds, several interesting insights emerge. First, the importance of productivity to economies and living standards is often not matched by a clear understanding of the concept, its measurement or key drivers. Productivity can change for a variety of reasons. For instance it can vary as a result of changes in the prices that are charged for goods and services or as a result of the proximity between suppliers and customers. Moreover variations in the composition of the workforce, in terms of the share of full-time and part-time workers, will affect productivity, as will shifting the composition of what is produced. That is, if more workers are employed in relatively high productivity sectors, then average productivity will increase.

When studying productivity, the change or growth in productivity is of interest. When we study trends across the economy, labour productivity growth can reflect changes in the composition of output and employment; the state of the business cycle, for example in a high growth and low unemployment situation additional labour resources are found within organisations (for example, through extended working hours and more intensive production) rather than through the hiring of additional workers; the rate of inflation; and the composition of employment. However, this is only part of the story. A broader concept of productivity is known as multifactor productivity or Total Factor Productivity which is a foundation concept for this study. This is the ratio of real output to total labour and capital input. According to the OECD (2001), TFP is often measured residually, as that change in output that cannot be accounted for by the change in combined factors. It is often not immediately apparent what independent variables or drivers account for the change in output therefore requiring deeper investigation and analysis of these factors.

The use of TFP reflects the fact that an important productive input is capital such as buildings, machinery, communications and technology. Through time, workers and workplaces become more productive because of investment in new capital that is more productive than the capital it has replaced. Total Factor Productivity reflects the role that investment and the application of new capital makes to improving productivity. With new
2. Total Factor Productivity: An Introduction

capital comes a need for new skills, innovation and the application of new knowledge at
the workplace. So through additional capital (capital deepening) productivity is increased
through a number of channels - output can be increased, fewer workers may be required
and the skills of the workforce improved. In practice there are two key problems with TFP. One,
how is capital measured? Second, in what combinations or proportions are capital and
labour used in production?

The literature also suggests that it is not just new productive investment in capital that drives
TFP but also how people are led, trained, developed and incentivized. The people element
of productivity becomes important, more so in the manufacturing sector, as research shows
us that every one percentage point improvement in management can result in 6 percent
higher productivity (Management Matters 2013). For instance, in Australia a recent study
on High Performing Workplaces (HPWs) (Boedker et al, 2011) showed how productivity was
12 percent higher with an average financial performance of 15.63 percent greater than
low performing workplaces. This equates to a difference of A$ 40,051 per full time employee.
This study went further to identify three key management practices responsible for spurring
high performance workplaces which included - employee participation in decision making
processes, responsiveness to changes in customer networks, and developing behavioural
and skills flexibility in employees. Furthermore, this study also showed the statistically
significant association between an organisation’s innovation and leadership practices and
the organisation’s productivity and leadership practices. This landmark study clearly shows
how an organisation’s HR practices are linked to productivity and performance (measured
through output growth).

It has also been widely accepted that value creation through business model innovation
(BMI) can further enhance productivity levels. A finding by the Economic Intelligence Unit
(EIF) from a global survey it conducted revealed that 54 percent of 4000 senior managers
preferred BMI as a source of competitive advantage rather than new products or services.
This finding has been echoed with a similar study conducted by IBM wherein it interviewed
over 750 organisational leaders who confirmed that BMI was much higher on the priority list
of CEOs, as a consequence of competitive pressures, than what was previously thought.

The point is that the concept of productivity is multidimensional and challenging, and its
measurement and interpretation is beset by complex problems. This is why caution must
be exercised when considering the findings of productivity studies such as those discussed
in this literature review. In the next section we examine the key determinants of Total Factor
Productivity according to the extant literature. These include:

(a) Management Practices
(b) Information and Communication (ICT), Research & Development
(c) Market Access and Integration of Firms
(d) Knowledge Transfer and Diffusion
(e) Competition
(f) Innovation
(g) High Performance Work Systems

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3. Determinants of Total Factor Productivity (TFP)

3.1 Management Practices

The dominant orthodoxy held by scholars working on firm-level data on productivity is that management practices is one the main drivers of TFP. This line of scholarship hypothesizes that the extent to which a firm manages effectively utilize input factors, impacts not only output but also TFP. While management consultants have advanced similar propositions, only recently have they been subject to empirical academic scrutiny. One of the earlier papers to map management best practices with measures of productivity in a cross-country comparison of medium-sized firms is Bloom and Van Reenen (2007).

Bloom and Van Reenen (2007) conduct a survey of over 700 managers from medium-sized enterprises in four key areas (operations, monitoring, targets, and incentives) and find that high-quality management and business practices are strongly and positively correlated with both labour and capital productivity and TFP. They hypothesize two predictors of the quality of management of medium-sized firms (and consequently productivity as a correlate): the first is that competition in a contestable market is positively correlated, and the second that the practice of primogeniture in family-owned firms was negatively correlated. In two follow-up studies published in 2010, these findings are broadly echoed in a wider sample of 6000 firms across seventeen economies.

Bhusnell and Wolfram (2009) and Bertrand and Schoar (2003) also find that individual managers and high-ranking executives impact the efficiency of firms and also impact output. Other studies suggest that sustained and active use of various facets of human resource management affects productivity of firms. These include using incentives including pay-for-performance, team-building exercises, regular communication between management and the production floor (Ichniowski et al 1997; Hamilton et al 2003; Bandiera et al 2009). A common theme in these studies as Syverson (2011) notes is that while each of these practices impacts productivity, their impact is magnified several-fold when implemented jointly. One of the limitations of such findings is that while they offer strong correlations, causal inference must be drawn cautiously.

3.2 Information and Communication Technology (ICT), Research & Development

The growth accounting literature has long documented the role of information technology in economic growth and productivity. Capital, as a factor input, discussed earlier consists of both information and communication technology (ICT), and non-ICT capital, which includes all of the other types of capital. A dominant theme, which emerges in the determinants of productivity literature, is the role of ICT capital in improving productivity. Earlier studies by Jorgenson and associates, as well as the recent book by Vu (2013) documents the various channels through which ICT impacts productivity. Many of the earlier studies focused singularly on the macroeconomic impacts of ICT contributing to higher productivity, and ultimately resulting in higher economic growth. However, more recent studies have started to unpack channels through which ICT impacts productivity particularly in manufacturing firms.

For instance, Bartel et al (2007) finds how computer numerically controlled (CNC) machines have resulted in faster turn around of orders, production speeds, and instilled greater quality control in the manufacturing sector. In a similar vein, Brynjolfsson et al (2008) find how ICT has enabled faster repetition of work practices that have been successful and productive. Bartelsman et al (2010) argue that ICT results in changing both the mean distribution of innovation, as well as the variance around the mean, ultimately impacting productivity. Faggio et al (2010) illustrate how advances in productivity in industries in the United Kingdom were highly correlated with the use of ICT.
3. Determinants of Total Factor Productivity (TFP)

While the proliferation of ICT has impacted productivity, greater institutionalization of work practices and operations can also improve productivity. The industrial organization literature documents such advances as learning by doing – essentially the phenomenon through which a firm experiences decreasing cost per unit as cumulative production increases (Benkard 2000; 2004; Besanko et al. 2010). Several studies have explored how this practice has contributed to productivity. Baldwin and Gu (2004) hypothesize that export participation is correlated with improved productivity, and identify a possible learning effect. The effect is larger for younger businesses, suggesting a strong base effect. The learning effect is associated with cumulative experience in exporting, however its impact on productivity differs across firms. Benkard (2000) estimates both a learning rate and forgetting rate in production processes. The latter is estimated to be as high as 40 percent in the example from the aviation sector in his study. High attrition rates and lack of systemic practices to codify and transfer institutional knowledge contributes to declining productivity.

In this context, past experiences within and across organizations implementing contracts helps build institutional knowledge and impacts productivity (Thornton and Thompson, 2001). In a similar vein, Kellogg (2011) studied the oil and gas industry and found that productivity increases with their joint experience, alluding to the importance of a stable contracting relationship (i.e. a long relationship) in building a conducive environment to boost productivity.

The direction of causality in exploring the link between R&D spending and productivity is not entirely clear. Often firms that invest in R&D already enjoy high levels of productivity, and therefore gains from R&D spending are marginal as these firms start from a higher base. On the other hand, the literature also documents advances in productivity in firms that engage R&D mostly through innovation. A similar issue of bi-directional causality is also present in the linkages between productivity gains and decisions of firms to export (Aw et al, 2000); where some firms see significant increase in productivity after entering the export market (Van Biesebroeck 2005; De Loecker 2007). Wang and Tsai (2005) estimate a ‘U-type’ relationship between R&D productivity and firm size. Their finding is robust when their sample is divided into technology-intensive and traditional sectors. In an earlier working paper they cite estimates of the output elasticity of –and the rate of return on -R&D spending. The former ranges between 0.06 and 0.14 while the latter is between 20 and 50 percent. The large variance in these results in part stem from differing methods of estimating output elasticities, as well as in the large variation in type of firms studied.

It is also useful to emphasize R&D spending is also associated with increased uncertainty. Studies that find R&D as an important determinant of productivity, also find that its efficacy as an explanatory variable is reduced once the element of uncertainty is modelled (see for e.g. Doraszelski and Jaumandreu, 2009).

Balasubramanian and Sivadasan (2011) using data on firms patenting activities find that patents (a proxy for R&D spending in the above context) is associated with increases in the firm size and higher TFP. While this is an intuitive result, establishing the direction of causality again is difficult. Similarly Bernard et al (2010) find that increasing the number of products produced by the firm is associated with an increased size of the firm (measured through both output and employment), as well as higher TFP.

3.3 Market Access and Integration of Firms

A strand of the productivity literature that is particularly relevant to SMEs are issues that relate to organization (vertical and horizontal integration) of the firm, in response to market access and supply chain constraints. The hypothesis is that firms, which are integrated to global and regional supply chains have higher productivity, as they can take advantage of economies of scale.

Melitz and Ottaviano (2008) in their study find that market size and trade, impact competition and productivity. Further, being deeply integrated within a supply chain forces firms to actively pursue advances in productivity as they face competitive pressures. Restrictions in market access – whether explicit or implicit – impose transaction costs on the firm and can lower productivity. Knittel (2002) and Fabrizio et al (2007) find that firms
3. Determinants of Total Factor Productivity (TFP)

experienced efficiency gains as result of certain changes in the regulatory environment. Bridgman et al (2009) show how regulations can remove incentives to increase productivity; while studies have also confirmed the negative impact of excessive regulation on productivity (Greenstone et al 2012). Removing these barriers lowers transaction costs and facilitates productivity. Lileeva and Trefler (2010) in a study of Canadian firms, find that firms that increased exports in response to dismantling trade barriers witnessed increased labour productivity, engaged in innovation, and adopted newer manufacturing technology. Krishna and Mitra (1998) observed increased competition and productivity in a panel of Indian firms after removal of structural economic barriers in 1991.

The literature in institutional economics has long identified vertical integration of firms in response to limitations or costs imposed in accessing markets (Williamson 1979). In a recent study, Mesquita and Lazzarini (2010) find advantages in both horizontal and vertical linkages enhancing the competitiveness of SMEs. The former yields advantages in productivity in the supply chain, while the latter is conducive to sharing resources and joint product innovation. This is also observed by Forbes and Landerman (2011). Their hypothesis is that with increasing “asset-specificity”, actions necessary to mitigate contingencies are difficult to exhaustively be included in contractual arrangements. They observed that vertical integration in the aviation sector allowed airlines to respond more swiftly to challenges, particularly in scheduling issues, affecting performance and productivity. In a similar vein Hortacsu and Syverson (2009), in studying non-agricultural businesses in the United States, note that vertically integrated plants have higher productivity levels than non-integrated plants.

While these are studies in heterodox business environments and country contexts, they are still relevant in identifying drivers of productivity in SMEs. Decentralized decision-making allows firms to more swiftly respond to challenges in production processes, which impacts productivity. Moreover, integration in supply chains and smooth market access also impact productivity.

3.4 Knowledge Transfer and Diffusion

Another major theme that emerges from the literature is that knowledge transfer and diffusion across and within firms is a driver of firm-level productivity. In a linear and temporal conceptualization of the impact of knowledge on productivity, the hypothesis and causal inference usually drawn in the literature is that once firms engage in R&D, it will result in innovative practices and the creation of new knowledge. This knowledge will be codified and transferred across firms in the industry, and yield advances in productivity as a positive externality. However, while such a conceptualization of the diffusion of knowledge is useful as a heuristic tool, causal inference again proves to be challenging to establish. Moreover, policies that emphasize transfer and diffusion could also reduce the incentives for firms to innovate (Syverson, 2011). Nonetheless, the size of knowledge transfers and the mechanisms through which they are operationalized are important research questions that have received empirical scrutiny in recent years.

Moretti (2004), for example, studies the spill over or externalities through the marginal product of human capital (proxied through the share of workers in other industries) in manufacturing firms and finds that it is positive. Griffith et al (2006) identify that the geographical location of the R&D is an important determinant in the transfer and diffusion of knowledge. Bloom et al (2007) find that technological spillovers impact productivity and create positive externalities. Bartelsman et al (2008) study global and industry-specific productivity convergence patterns. They find that firms’ productivity converges faster towards domestic standard than the global industrial leader. Keller and Yeaple (2009) identify that foreign direct investment (FDI) investments and their related spillovers account for a significant share of productivity growth.

Collectively, these papers identify various channels through which spillovers, technology transfer, diffusion of knowledge impact productivity. While knowledge transfer practices are ubiquitous in most sectors of the economy, it is important to underscore that there are still large variations in the productivity across firms within an industry, and across sectors in an economy as well. This suggests potential for greater transfer and diffusion of best practices, and alludes to the role of other determinants of productivity.
3. Determinants of Total Factor Productivity (TFP)

3.5 Competition

Competition impacts productivity through two broad channels. First, competition results in the most-efficient firms getting larger market shares. This is largely due to the pressures fostered in contestable markets, which exert continuous downward pressures on prices and consequently on unit costs. Firms respond to these challenges by truncating costly production processes, opening up room for more efficient firms to dominate the market share. It also serves as an implicit benchmark – firms that are unable to meet average productivity of the industry are forced out by competition, and new entrants to the industry have to cross this benchmark to sustain themselves Syverson (2011). A contestable market pushes out less efficient firms, and imposes pressures for re-organization. Foster et al (2006) find evidence of this in the retail sector in the United States.

The second channel involves firms consciously endeavouring to improve productivity to gain a competitive (cost) advantage in the market. In a review of the literature Foster et al (2001) found a positive correlation between productivity and firm survival and growth. Syverson (2004) offers an intriguing case study analysing the spatial impacts of productivity. His findings also resonate with the economic geography and industrial organization streams of literature. In studying productivity in concrete manufacturers, he finds that firms operating in concentrated or dense markets have higher average productivity and lower dispersion of productivity along the mean. This largely stems from spatial substitutability, which allows consumers to switch easily between suppliers if they are expensive (or inefficient).

In addition to the earlier discussion on the impact of removing trade and market barriers on productivity, competition through liberalizing trade policy also impacts productivity (Pavcnik, 2002). Competition in both export and import markets can impact productivity. Studies have concluded how some firms have increased productivity through innovation by relying on newer technology, ICT, and increased R&D spending in response to competition from cheaper imports (Bloom et al, 2011).

3.6 Innovation

Innovation has long been recognized as the cornerstone of efficiency in markets, and a source of competitive advantage. The Oslo Manual (OECD, 2005) defines innovation as "the implementation of a new or significantly improved product, or process, ...marketing method, organizational method in business practices, workplace organization...." The literature focuses on various aspects of innovation including in process and products. Raymond and Pierre (2010) studied the impact of R&D activities by SMEs on innovation by separating product R&D from process R&D, process R&D from process innovation, and process innovation from product innovation. The literature has also focussed on horizontal linkages within and across sub-sectors including manufacturing, services, etc. An example of this linkage is evident in a recent study by Arnold et al (2014). They find that reforms and innovations in products in the service sector in India positively impacted productivity in domestic and foreign-owned manufacturing firms. The magnitudes are significant and non-trivial; a one standard deviation in the index of ‘service liberalization’ is associated with 12 percent increase in productivity in manufacturing firms.

Innovations are also required to enhance productivity in firms that have enjoyed traditional comparative advantages across global markets. Tilton and Landsberg (1997) present a case study of copper mining in the United States, where despite having historically large mineral endowments (and thereby a comparative advantage), American firms lost their advantage to compete globally due to declining productivity. The case study documents a series of cost-reducing innovations in some firms that boosted labour productivity of mining firms and allowed them to compete on the global front.
3. Determinants of Total Factor Productivity (TFP)

De Jong and Marsili (2006) develop an empirical taxonomy of small firms in Netherlands according to their innovative activities. The taxonomy identifies four categories of firms clustered along 6 dimensions (inputs, outputs, sources of innovation, managerial attitudes, innovation planning, external orientation). The four clusters of firms are science-based, specialized suppliers, supplier-dominated, and resource-intensive. The science-based firms cluster is characterized by high innovativeness in both product and process, and often participate in collaborations. The specialized suppliers cluster firms are also characterized by reasonably high innovativeness, scoring high on product innovation and lowest in process innovation. Supplier-dominated firms cluster scores the lowest across the four clusters, and innovativeness is low across assessed dimensions of inputs, planning, and managerial attitudes. The last cluster of resource incentive firms has a balance of process and product innovation. These firms explicitly budget resources (time and money) for innovative activities. Such empirical taxonomies are useful to assess different dimensions of innovations across firms, and their productivity attributes. A summary of the classification is presented below.

Table 3A: Summary of De Jong and Marsili (2006)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Supplier-dominated</td>
<td>Low</td>
<td>Process</td>
<td>Capacity (time)</td>
<td>Suppliers</td>
<td>Low</td>
</tr>
<tr>
<td>Specialized-suppliers</td>
<td>Medium-high</td>
<td>Product</td>
<td>Specialized Personnel</td>
<td>Customers</td>
<td>Medium</td>
</tr>
<tr>
<td>Science-based</td>
<td>High</td>
<td>Product</td>
<td>R&amp;D budget, capacity, specialized personnel</td>
<td>Scientific development</td>
<td>High</td>
</tr>
<tr>
<td>Resource-intensive</td>
<td>Medium</td>
<td>Process and Product</td>
<td>R&amp;D budget, capacity</td>
<td>Suppliers</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Amara et al (2008) studied innovative practices in Canadian manufacturing SMEs and their relative uniqueness. A striking finding is that nearly four-fifths of the firms in their sample have developed product or process innovation. Novel or unique innovations are facilitated by enhanced learning capabilities, particularly their propensity to create internally new knowledge, as being able to “identify, assimilate and exploit knowledge from their external environment”. The study finds that variables related to learning by doing, learning by training and learning by interacting have the highest impact on the degree of novelty of innovation of SMEs.

One of the challenges in Amara et al (2008) is isolating the impact of innovation on productivity and growth in the firm. Essentially, innovation results in higher productivity and gives a firm a competitive advantage. However, in a rapidly integrating global marketplace, firms can gain their competitive (cost) advantage from other factors, even if they do not engage in R&D and innovative practices. Basile (2001) finds that exchange rate devaluation reduced the impetus on firms to innovate and improve productivity, as it allowed non-innovating firms to enter foreign markets.
3. Determinants of Total Factor Productivity (TFP)

Cassiman et al (2010) relies on Kolmogorov-Smirnov tests of equality of distributions in comparing TFP of exporting and non-exporting firms. They test the stochastic dominance of productivity distributions, and find exporting firms enjoy higher productivity. Further, they find that product innovation rather than process innovation induces small non-exporting firms to enter the export market. Their results also speak to policy issues related to promoting export participation versus policies that create a conducive environment for product innovation.

Cassiman et al (2010) findings also resonate with the study on UK firms completed by Criscuolo et al (2010). Criscuolo et al explore the link between global engagement and productivity, by studying knowledge differences between firms rather than differences in TFP. They rely on a ‘knowledge production function’, which measures investments in discovering new knowledge as well as how effectively existing knowledge is utilized. They find that ‘globally engaged’ (i.e. multinational or exporting) firms report higher patents filed, as well as a larger share of their sales stemming from innovation; these firms also rely on both external and internal knowledge flows to a greater extent relative to non-engaged firms; and lastly that ‘globally engaged’ firms have higher productivity stemming mostly from innovation; and learning from a global pool of information, and from suppliers, customers and academia.

Other dimensions of innovations including capabilities in learning, R&D, manufacturing, marketing, organizational, resource allocating, and strategy planning are studied in Guan and Ma (2003) in determining the export performance of around 200 industrial firms that operate in China. The study also uses three firm characteristics (domestic market share, size and productivity growth rate) as control variables. Their study finds that with the exception of manufacturing capability, other six innovation capability dimensions are correlated with export growth. These findings must be viewed in the context of other themes that have emerged in the literature (i.e. of export growth as well as innovation capabilities are positively correlated with productivity).

The literature also identifies two nested determinants of innovation. The first level of analysis is endogenous (i.e. firm specific) determinants; this is followed by exogenous (i.e. the operating environment) determinants of innovation. Sternberg and Arndt (2001) explore the role played by firm specific versus regional determinants of productivity in their study of European firms (most of which are SMEs). They rely on the European Regional Innovation Survey with data on more than 1800 manufacturing firms. They find that firm specific determinants play a larger role than regional determinants, even in geographical locations with high density of firms. Further, while exogenous factors facilitate inter-firm innovation cooperation, the magnitudes are much smaller relative to firm-specific variables. The various dimensions are summarized in Table 3B.

### Table 3B: Nested Determinants of Innovation

<table>
<thead>
<tr>
<th>Firm-Specific Determinants Impacting Firm’s Innovation Behaviour</th>
<th>Exogenous Determinants Impacting Firm’s Innovation Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Industry, Market Position</td>
<td>• Financial Resources</td>
</tr>
<tr>
<td>• Organizational Status</td>
<td>• Managerial Attitudes</td>
</tr>
<tr>
<td>• R&amp;D Capabilities</td>
<td>• Innovation Networks</td>
</tr>
<tr>
<td>• Competencies of Staff</td>
<td></td>
</tr>
</tbody>
</table>
3. Determinants of Total Factor Productivity (TFP)

Table 3B: Nested Determinants of Innovation

<table>
<thead>
<tr>
<th>Intra-regional Determinants (location and regional factors)</th>
<th>Outside the Firm (technology and innovation policy)</th>
<th>Extraregional Determinants (overall firm environment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Qualified Local Labour</td>
<td>• Incentives for Greater R&amp;D efforts</td>
<td>• Industry performance and development</td>
</tr>
<tr>
<td>• R&amp;D Facilities</td>
<td>• Incentives for R&amp;D in new fields</td>
<td>• Market and demand development</td>
</tr>
<tr>
<td>• Technology Transfer Facilities</td>
<td>• Incentives for R&amp;D cooperation</td>
<td>• Competitiveness</td>
</tr>
<tr>
<td>• Infrastructure</td>
<td></td>
<td>• Globalization and regionalization</td>
</tr>
<tr>
<td>• Regional Economic Structures</td>
<td></td>
<td>• Technological Progress</td>
</tr>
</tbody>
</table>

Source: Based on Sternberg and Arndt (2001)

Frenz and Ietto-Gillies (2010) study the impact of different sources of knowledge on innovation activities of firms in the UK. They differentiate between knowledge generated through R&D activities carried out by the firm and transfer and diffusion of external knowledge to their firm (via bought-in R&D, collaborative agreements, and intra-company knowledge transfer). They find that in-house R&D, bought in R&D, and intra-company transfers positively influence innovation performance. And, that cooperation and collaborative agreements for sharing R&D are less likely to influence innovation.

3.7 High Performance Work Systems

High Performance Work System (or HPWS) is a term used to describe a management strategy whereby a set of complementary human resource management (HRM) and work practices are implemented with the expectation that they will deliver improved organisational performance. This performance improvement is enabled through specific practices which help organizations “to tap into the ideas, skill and effort of all of their people” (Pfeffer, 1998).

Specifically, and drawing on the work of various notable scholars in this field (especially Appelbaum, Bailey, Berg, & Kalleberg, 2000; Becker & Huselid, 1998; Huselid, 1995) a HPWS can be defined as set of complementary HRM and work practices that enable employees to meet the following objectives:

• to develop work related skills;
• to use those skills at work;
• to have a say in decisions which affect their work;
• to understand the organisational context in which they work;
• to achieve recognition for their work effort; and
• to be treated equitably at work (Macneil, 2005).

The term High Performance Work System (HPWS) is associated with and/or used synonymously with High-Involvement Work Systems (HIWS) and High-Commitment Management (HCM) (Boxall & Macky, 2007, 2009). All represent sets of practices that can be differentiated from a more traditional bureaucratic and hierarchical approach to
3. Determinants of Total Factor Productivity (TFP)

work organisation and management (Tomer, 2001; Tsai, 2006). However, work systems that emphasise mutual gains (that is, changes to work and improvements in performance which benefit employees as well as the organisation), and which in this paper we call High Performance Work Systems (HPWS), provide the more convincing evidence (see, for example, Appelbaum et al., 2000; Bailey, Berg, & Sandy, 2001; Combs, Liu, Hall, & Ketchen, 2006; Harley, Allen, & Sargent, 2007; Horgan & Muir, 2006; Macky & Boxall, 2007; Tsai, 2006).

While there are differences to be found across versions of HPWSs, it is generally agreed that individual practices in a HPWS are designed to complement one another, that is, to support and reinforce the other. Indeed, this synergistic effect is said to be a significant reason for the success of a HPWS (Becker & Huselid, 1998; Huselid, 1995; MacDuffie, 1995; Posthuma, Campion, Masimova, & Campion, 2013).

Some researchers have proposed that HPWS are universally effective. Most notably, Pfeffer argued that the seven practices were necessary to guarantee improved organisational performance:

- Employment security
- Selective hiring
- Use of self-managed teams and decentralization of decision making
- Compensation contingent on organizational performance
- Extensive Training
- Reduced status distinction

While others have questioned his ‘one-best way’ approach, nevertheless these practices are commonly included in HPWS as defined by other researchers. Ahmad later tested the effect of Pfeffer’s proposed HPWS in the manufacturing industry and found overall support for that these practices are effective, regardless of the country in which the plants operated.

Others have argued that a HPWS should be more closely adapted to the context – for example, to manufacturing or production strategy (Lowe, Delbridge, & Oliver, 1997; MacDuffie, 1995; Patterson, West, & Wall, 2004), to competitive strategy (James Guthrie, Spell, & Nyamori, 2002), or to cultural context (Aycan, 2005; Edwards & Wright, 2001; Pettigrew, 1986; Tregaskis, 1997). Certainly, there is evidence of differences in the practices that are used in different countries (Ahmad & Schroeder, 2003; Flood, Guthrie, & Liu, 2008; Lorenz & Valeyre, 2005; Yalabik, Chen, Lawler, & Kim, 2008)

3.7.1 HPWS, labour productivity and innovation:

A HPWS is comprised of HRM and work practices designed to improve labour productivity, to improve various HR measures which impact on labour productivity (eg. turnover, absenteeism), or to improve broader organisational performance which is affected by labour productivity (eg. revenue, profit).

Many studies have shown an influence of HPWP on labour productivity (Flood et al., 2008) (J Guthrie, 2001; Huselid, 1995). One of the earliest but most rigorous (and consequently influential) was a study by Huselid that found that several high performance work practices have a positive impact on “both intermediate employee outcomes (turnover and productivity) and short- and long-term measures of corporate
3. Determinants of Total Factor Productivity (TFP)

financial performance” (1995:365). HPWP analysis included here by HRM practices in the areas of personnel selection, performance appraisal, incentive compensation, job design, grievance procedures, information sharing, attitude assessment, labour-management participation, intensity of recruitment efforts, hours of training per employee per year and promotion criteria (seniority versus merit).

Another study of the effect of HPWS on productivity was commissioned by the National Centre for Partnership and Performance, and the Equality Authority, in Ireland. Researchers investigated the effect of HPWSs on productivity, innovation and employee turnover in 132 Irish companies in the manufacturing and service industries. Building on Huselid’s 1995 work, the study found that the greater use of HPWSs was associated with a 12.4 percent variance in labour productivity. Researchers were also able to draw on earlier (2004) data, to show that increased use of a HPWS in this time period resulted in increased labour productivity over time (Flood et al., 2008).

The work by Flood and colleagues also found that the implementation of a HPWS was associated with improved innovation (2008). Innovation enhances productivity by increasing efficiency, but also by increasing the actual value of products and services delivered. It describes a company’s ability to effectively create revenue through introducing new products and services. Innovation can come through incremental, or process, improvements; and it can also come through more radical change (Subramaniam & Youndt, 2005; Wang & Chen, 2013). Human resource management and work practices have been identified to be a key factor for successful innovation (Combs et al., 2006).

A study in the People’s Republic of China investigated the effect of HPWSs on the innovative capabilities of a firm. The study concludes that HPWSs have an effect on both the incremental and radical innovative capabilities of organizations (Wang & Chen, 2013). The core practices in the HPWS in this study were sophisticated staffing practices, extensive training, knowledge- and skill-based reward systems, teamwork and employee participation.

Another study investigating innovation in Dutch firms found that task autonomy, training and performance-based pay are important for creating incremental innovations, whereas task autonomy and flexible working hours have been found to be most vital for radical innovation. The researcher also found that standby contracts – casual contracts with no set minimum hours or definite schedule – were associated with a significantly lower levels of innovation (Beugelsdijk, 2008); in other words, that practices that work against the commitment of employees may act to reduce innovation.

However, this range of good results associated with the implementation of a HPWS only serves to emphasise that, despite significant overlap across studies, no general consensus exists on what exact practices should comprise a HPWS (Boxall, Ang, & Bartram, 2011; Bryson, Forth, & Kirby, 2005; Lorenz & Valeyre, 2005; Posthuma et al., 2013). This has led to some criticism of the HPWS literature (Fleetwood & Hesketh, 2006). Moreover, if we accept the premise (as we do) that a HPWS is likely to be more effective if adapted to an organisation’s internal and external circumstances (Datta, Guthrie, & Wright, 2005; Paauwe & Boselie, 2007), it is important to identity factors in the nature of the manufacturing industry, small-medium sized enterprises (SMEs) and/or the Southeast Asian context might influence the nature or efficacy of the components of a HPWS.
3. Determinants of Total Factor Productivity (TFP)

3.7.2 HPWS and manufacturing industries

The efficacy of HPWS in the manufacturing sector overall (for example, Appelbaum et al 2000), as well as in specific manufacturing sectors (for example, Lowe, Delbridge and Oliver, 1997), has long been accepted. Indeed, most of the empirical research on HPWS has been conducted in manufacturing. In a landmark study in the automotive manufacturing industry, Macduffie measured five HPWS practices - work teams, problem-solving groups, employee suggestion schemes, job rotation and decentralisation of quality-related tasks - and found that when these practices were combined into an internally consistent HR system and integrated in a flexible production system, companies outperformed those using more traditional mass production systems in both productivity and quality (1995). Other studies have examined similar practices. What tends to differentiate the studies in manufacturing when compared to general and/or service sector studies is an increased focus on quality/continuous improvement/TQM practices, and an assumption that team- or cell-based work is a central component of the HPWS.

It has been argued that HPWS are effective in the manufacturing industry for several reasons. First, manufacturing processes benefit from the type of incremental innovation that can be generated by improvements in the skills and motivation of employees. Second, there is a long history (with associated evidence) of changes in HRM and work practices in manufacturing sectors designed to improve performance – the sector is accustomed to such innovations. Third, manufacturing sectors are frequently characterised by a skilled workforce and active unions, more likely to insist on the mutual gains that make a HPWS acceptable to workers and more likely to be sustainable.

3.7.3 HPWS and SMEs:

While there few empirical studies, evidence does exist that HPWS have had a positive impact on performance of SMEs. For example, one study of 275 French SMEs showed simultaneous and longitudinal correlations between HPWS and a firm’s performance (profitability, degree of innovation and social climate) (Razouk, 2011). Another study of 446 US firms with fewer than 100 employees found, that HPWS were related to lower workforce turnover, lower voluntary turnover and a higher perceived productivity (Way, 2002).

Nevertheless, although there is evidence that HPWSs improve SMEs performance, HPWSs are still less used in SMEs compared to larger organisations (Flood et al, 2008 #29). This might be due to challenges SMEs sometimes face, like lack of capabilities as well as resource (Fazzari & Mosca, 2009; Razouk, 2011).

3.7.4 HPWS in the Southeast Asian Context

An important influence on the effectiveness of any component of a HPWS is their social embeddedness, that is, the degree to which the HRM or work practice fits in its social and cultural context to be effective (Pauwe and Boselie, 2007). One study examining 14 highly performing companies found that some HR practices in a HPWS were used universally (i.e. talent management for senior managers, open job posting (OJP), expatriate management systems and succession planning tools) while others manifested considerable differences across countries (i.e. reward systems, diversity policies, performance management systems for non-senior staff, employee relations and training) (Farndale & Pauwe, 2007). The researchers explained these national differences in terms of differences in institutions (e.g. annual recruitment in Asian societies) as well as legislative requirements.
3. Determinants of Total Factor Productivity (TFP)

Cultural differences can affect which practices are considered high performance. As, for example, a high-performance practice in one country (e.g. grievance procedure in the US) can simply be a legal requirement in another (Boxall and Macky 2009, Boxall, Ang and Bartram 2011, Huselid, 1995). Moreover, differences in culture can also lead to a different level of acceptance and understanding of high performance work practices (Boxall and Macky, 2009).

An analysis of 193 peer-reviewed articles published over the past 20 years (1992-2011) found that training for job or firm specific skills, comprehensive benefits and specific and explicit hiring criteria are the most frequently researched practices in studies of HPWS in Southeast Asia. However, practices fostering equity and employee participation in decision-making (e.g. giving employees strategic information, soliciting employee opinions and suggestions, reduced status distinctions, etc.), commonly researched in other contexts, are less frequently analysed in the Southeast Asian context. The question remains if this discrepancy is due to a biased research focus or if those practices are actually less effective in enhancing organizational performance in the Southeast Asian sector (Posthuma et al 2013).

However, care must be taken not to overemphasise contextual effects. A study evaluating the effect of HPWS in organisations in Korea, Taiwan, Singapore and Thailand found that HPWS in these countries had a similar positive effect on turnover on locally owned companies as previously found in Western countries (Yalabik et al, 2008). Moreover, another study examining the effect of HPWSs effect in Taiwanese semiconductor design firms found a positive impact of an effective use of employee empowerment practices on organizational performance (Tsai, 2006).
4. Research Methodology & Approach

This research study aims to collect primary data on productivity and innovation practices from businesses in identified manufacturing subsectors in Singapore. It adopts a three-pronged approach in designing the survey instrument, as summarised in Figure 4A. First, we reviewed the extant literature critically on the determinants of TFP (including firm-level determinants) and the determinants of productivity in the Singapore context. This was accomplished by analysing academic databases (Web of Science and SCOPUS) and Google Scholar to cover. Second, we designed and conducted a Delphi study where we sought the views of global and local experts and thought leaders (including academics, government officials, and policymakers) on the drivers of productivity and innovation in SMEs. Finally, we identified and interviewed 20 SME Leaders to examine the policy context and to understand the challenges that they face. This triangulated approach produced 6 thematic determinants or drivers of TFP in SMEs:

- **Technology & Capital Utilisation**
- **Pay & Performance Management**
- **Training, Development & Organisational Learning**
- **Innovation Culture**
- **Government Policy, Markets & Regulation**
- **Leadership & Management Quality**

In identifying the key drivers of total factor productivity, we relied upon the pattern of data that emerged from three critical sources: our in-depth semi-structured interviews with SME leaders; the extensive literature review and the results of the Delphi study. Data from these sources was collected, coded, compared and analyzed. Common data from all three sources were categorized by theme following a systematic process described by Miles and Huberman (1984) in the following terms:

> “From the beginning of data collection the qualitative analyst is beginning to decide what things mean, noting regularities, patterns, explanations, possible configurations, causal flows and propositions. The competent researcher holds these conclusions lightly maintaining openness and scepticism, but the conclusions are still there, inchoate and vague at first then increasingly explicit and grounded”

As common data was added to each analytical category, the evidence for each of the key drivers became stronger and reinforced the criticality of the driver as a ‘prime mover’ of total factor productivity. The research methodology and survey instrument received ethics clearance from Murdoch University.

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4 A Delphi study is a structured communication technique in which a panel (or panels) of experts is consulted in order to access informed opinion on a subject. The objective is to move towards group convergence and an agreed answer based upon ‘collective intelligence’. Interaction in Delphi is anonymous and questions are presented to individuals in the group in such a way as to suppress any identification and thus remove any inhibitions or other constraints often felt by participants in face-to-face interaction.
While this study does not explore the causal mechanisms of how each of these drivers impacts TFP, a central proposition in our research is that their impacts are individual and interactive, in that their aggregate impact is much larger than the sum of their individual contributions. The purpose of the study was not to find evidence of causal relationships between the key drivers and productivity levels, but rather to examine the state of competitiveness of each of the key drivers which are known to influence total factor productivity.

A stratified random sample (based on the share of economic output to the manufacturing sector) was drawn from the ACRA\(^5\) database, which maintains information on businesses, by SSIC\(^6\) classification codes. The subsectors identified in this study are listed in Table 4A:

### Table 4A Industrial Subsector and SSIC Classification Codes

<table>
<thead>
<tr>
<th>Industrial Subsector</th>
<th>SSIC Classification – Two Digit Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals &amp; Chemical Products</td>
<td>C20</td>
</tr>
<tr>
<td>Pharmaceuticals &amp; Biological Products</td>
<td>C21</td>
</tr>
<tr>
<td>Computer, Electronic &amp; Optical Products</td>
<td>C26</td>
</tr>
<tr>
<td>Fabricated metal products</td>
<td>C25</td>
</tr>
<tr>
<td>Food &amp; Beverage</td>
<td>C10; C11</td>
</tr>
<tr>
<td>Machinery and Equipment</td>
<td>C28</td>
</tr>
<tr>
<td>Other Transport Manufacturing/Engineering</td>
<td>C30</td>
</tr>
</tbody>
</table>

\(^5\) Accounting and Corporate Regulatory Authority  
\(^6\) Singapore Standard Industrial Classification
4. Research Methodology & Approach

These subsectors account for more than 80 percent of manufacturing output in Singapore. To improve the response rate, we complemented this approach with a ‘snow-balling’ by asking that SME respondents to introduce us to other SME executives within their network. The number of firms surveyed across subsectors is illustrated in Figure 4B.

**Figure 4B: Distribution of 215 firms surveyed across industrial subsectors**

A team of eight part-time Research Assistants (final year students of SMF Institute of Higher Learning) worked in pairs to administer the survey to the sample of SMEs. Identified firms were sent brochures about the project and an information statement inviting participants to complete the survey. Interview appointments followed for the Research Assistants and the SME executives. The former used Ipads to record the participant’s answers and uploaded these responses to a cloud-based survey administrator, in real time. The findings they generated, will be discussed in more detail in the sections that follow.

4.1 Delphi Study

Usually, Delphi studies proceed to consensus among participants over several rounds. However, we received 28 usable responses in the first round with such a high degree of convergence of responses that a second round was not required. The expert respondents were asked five open-ended critical questions. These are summarised in Table 4B:

**Table 4B: Determinants of Productivity: Summary of Expert Responses.**

<table>
<thead>
<tr>
<th>In order of importance, what are the 5 most important drivers of TFP in SMEs?</th>
<th>Drivers</th>
<th>Expert respondents identified management quality and capabilities; learning mind-set focused on skill development and utilisation within the labour force; pursuit of technical efficiency driven by product and process innovation; economic stability fostered by competitive exchange rates, market access and growth-oriented public policies; a conducive workplace culture, with high degree of employee participation and acceptance of change are known to drive productivity and innovation within an SME.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Expert respondents identified management quality and capabilities; learning mind-set focused on skill development and utilisation within the labour force; pursuit of technical efficiency driven by product and process innovation; economic stability fostered by competitive exchange rates, market access and growth-oriented public policies; a conducive workplace culture, with high degree of employee participation and acceptance of change are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Human Capital</td>
<td>Expert respondents identified management quality and capabilities; learning mind-set focused on skill development and utilisation within the labour force; pursuit of technical efficiency driven by product and process innovation; economic stability fostered by competitive exchange rates, market access and growth-oriented public policies; a conducive workplace culture, with high degree of employee participation and acceptance of change are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Technology Strategy</td>
<td>Expert respondents identified management quality and capabilities; learning mind-set focused on skill development and utilisation within the labour force; pursuit of technical efficiency driven by product and process innovation; economic stability fostered by competitive exchange rates, market access and growth-oriented public policies; a conducive workplace culture, with high degree of employee participation and acceptance of change are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>Expert respondents identified management quality and capabilities; learning mind-set focused on skill development and utilisation within the labour force; pursuit of technical efficiency driven by product and process innovation; economic stability fostered by competitive exchange rates, market access and growth-oriented public policies; a conducive workplace culture, with high degree of employee participation and acceptance of change are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Culture of Collaboration</td>
<td>Expert respondents identified management quality and capabilities; learning mind-set focused on skill development and utilisation within the labour force; pursuit of technical efficiency driven by product and process innovation; economic stability fostered by competitive exchange rates, market access and growth-oriented public policies; a conducive workplace culture, with high degree of employee participation and acceptance of change are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In order of importance, what are the 5 most important drivers of innovation in SMEs?</th>
<th>Drivers</th>
<th>Expert respondents identified competitive pressures to lower costs and survive in the industry; a culture of open communication, spirit of innovation; solution-oriented work practices, increased organisational learning; protection of intellectual property, political stability, availability and access to global financial markets; and linkages with external bodies and centres of knowledge are known to drive productivity and innovation within an SME.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive Forces</td>
<td>Expert respondents identified competitive pressures to lower costs and survive in the industry; a culture of open communication, spirit of innovation; solution-oriented work practices, increased organisational learning; protection of intellectual property, political stability, availability and access to global financial markets; and linkages with external bodies and centres of knowledge are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Leadership &amp; Culture</td>
<td>Expert respondents identified competitive pressures to lower costs and survive in the industry; a culture of open communication, spirit of innovation; solution-oriented work practices, increased organisational learning; protection of intellectual property, political stability, availability and access to global financial markets; and linkages with external bodies and centres of knowledge are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Skills &amp; Knowledge</td>
<td>Expert respondents identified competitive pressures to lower costs and survive in the industry; a culture of open communication, spirit of innovation; solution-oriented work practices, increased organisational learning; protection of intellectual property, political stability, availability and access to global financial markets; and linkages with external bodies and centres of knowledge are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>Expert respondents identified competitive pressures to lower costs and survive in the industry; a culture of open communication, spirit of innovation; solution-oriented work practices, increased organisational learning; protection of intellectual property, political stability, availability and access to global financial markets; and linkages with external bodies and centres of knowledge are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td>Expert respondents identified competitive pressures to lower costs and survive in the industry; a culture of open communication, spirit of innovation; solution-oriented work practices, increased organisational learning; protection of intellectual property, political stability, availability and access to global financial markets; and linkages with external bodies and centres of knowledge are known to drive productivity and innovation within an SME.</td>
<td></td>
</tr>
</tbody>
</table>
Table 4B: Determinants of Productivity: Summary of Expert Responses.

<table>
<thead>
<tr>
<th>In order of importance, what are the 5 most important factors restricting innovation in SMEs?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td>Lack of Innovation</td>
</tr>
<tr>
<td>Champions</td>
</tr>
<tr>
<td>Lack of Innovation Culture</td>
</tr>
<tr>
<td>Lack of Enablers</td>
</tr>
<tr>
<td>Poor Human Capital</td>
</tr>
<tr>
<td>Lack of Financial Capital</td>
</tr>
<tr>
<td>Expert respondents identified apathetic leadership, poor management styles, lack of strategic awareness; complacency, culture of fear, inability to manage failure and consistently reduced tolerance of risk-taking; insulation from competition, limited market access, and lack of policy support from the government to improve innovation; limited human and financial capital manifested in low skilled labour, limited education infrastructure, and limited resources to take financial risks were factors that restrict innovation within an SME.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In order of importance, what are the five (5) most important factors restricting productivity in SMEs?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td>Poor Leadership</td>
</tr>
<tr>
<td>Lack of Incentives</td>
</tr>
<tr>
<td>Technical Inefficiency</td>
</tr>
<tr>
<td>Lack of Competition</td>
</tr>
<tr>
<td>Lack of Quality Labour</td>
</tr>
<tr>
<td>Expert respondents identified the lack of adequate vision and requisite soft skills in senior management; an undiluted focus on profits rather than creating value, limited appetite for risk and failure; out-dated technology and primitive production lines; limited access to markets and inability to compete with dominant firms; systemic weaknesses in the labour force including low levels of literacy and numeracy, motivation, and reduced incentives were factors that restrict productivity advanced within an SME.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Would you kindly comment on other factors which you believe restrict productivity and innovation in SMEs?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td>Incentives &amp; Responses</td>
</tr>
<tr>
<td>Economies of Scale</td>
</tr>
<tr>
<td>Innovation</td>
</tr>
<tr>
<td>Finance</td>
</tr>
<tr>
<td>Human Capital</td>
</tr>
<tr>
<td>Expert respondents identified the lack of incentives; issues related to poor market access and the inability to unleash gains from economies of scale; limited innovation processes and practices; lack of access to risk capital, limited integration with global markets and supply chains; and lack of willingness to fight unproductive labour, limited communication with labour force were factors that inhibit productivity and innovation within an SME.</td>
</tr>
</tbody>
</table>
4. Research Methodology & Approach

4.2 Interviews with SME Leaders

As part of the triangulated research methodology, 20 SME Leaders were interviewed for between 1 to 2 hours. These conversations helped to better appreciate the business environment and challenges SMEs faced with regards to improving their productivity and innovation practices. There was a high degree of convergence in the responses of SME leaders, and their challenges in the current business environment. These are summarised below:

(i) Labour Market Reforms. SME leaders across the board underscored the challenges associated with rising labour costs in response to the government’s initiatives to reduce the dependence on foreign labour. Rising levies and income thresholds required to sponsor employment visas, has put pressure on wages, and increased the cost of doing business. These increases in wages have not always been associated with increased productivity. While the increments to levies are announced in advance and are a signal of the government’s policy intent to guide businesses, SME leaders highlighted the challenges in restructuring their business processes and labour utilisation patterns in a relatively small time frame. They noted that a more gradual approach to reducing reliance on foreign labour would help manage the transition costs of businesses. They recognised that the current labour market reforms were for the long-term economic sustainability of Singapore, and that they would have to improve firm-level productivity in order to compete in a tightening Singapore labour market.

(ii) Domestic Employment & Attrition. One of the main challenges in energising the manufacturing sector relates to the difficulty in recruiting young engineers to work in SMEs, in the manufacturing sector. As an SME respondent highlighted:

“It [is very] challenging to recruit young graduates …on the shop floor. They are easily persuaded to join the services sector”.

Relatively long and more demanding working hours, coupled with SMEs being clustered in industrial areas, has reduced the appeal of working in the manufacturing sector. Unable to attract these skilled graduates, whose first employment preference is large MNCs and the service sector, leaders have come to rely on foreign nationals that are employed on permits over the past two decades. In response to the tightening labour market, leaders recognize that they will have to pursue a mix of monetary and non-monetary incentives to attract fresh graduates to seek employment and to continue to work in SMEs.

(iii) Limited Opportunities for Training. While leaders were aware of government schemes and financial incentives to attend training programs and upgrade skills of the workforce, many highlighted the limited opportunities to release workers from the production floor to attend training workshops. As a leader in a metal fabricating SME noted, “We are an SME. We do not have the time to send our employees to training workshops”. The high attrition rates in the sector have reduced the efficacy of training workshops. Though, leaders recognized the importance of creating a learning mind-set and ensuring that their workforce was trained in the cutting-edge methods.
4. Research Methodology & Approach

(iv) Challenges to Automate Production Processes. A major impediment to improving productivity is the inability of an SME’s current business model to mechanise or automate the production process. While this may stem from the nature of the business model, it also resonates with the relatively small orders that do not allow for economies of scale associated with automated production processes. A pharmaceutical participant highlighted that:

“[the] production equipment has latent potential that can be unleashed if larger orders are forthcoming”.

(v) Government Schemes. Most of the SMEs had accessed one or more government schemes to upgrade the level of technology or send their employees to training workshops. The most frequently accessed scheme was the Productivity and Innovation Credit (PIC), which has allowed SMEs to buy capital equipment that was prohibitively expensive. Leaders appreciated the wide-range of schemes that were made available to them, but highlighted challenges in preparing the requisite paperwork and increased uncertainty on which would be most suitable to the SME at their current juncture.

(vi) Challenges in Reproducing Leadership. Another consistent concern related to practices associated with reproducing senior leadership. As one leader highlighted:

“My biggest concern is reproducing leadership. Who will take this forward?”

Another executive in the machinery and equipment sub-sector noted that:

“SMEs are family owned and have ageing leadership. Some see little incentive to change because they are comfortable and others don’t wish to change because they are busy trying to survive”.
5. Research Findings

5.1 Descriptive Statistics

Most of the firms reported that their labour force had remained constant over the past year, with about 31 percent reporting that it had ‘increased’, with operations seeing the highest growth. More than 51 percent of the firms reported an increase in capital investment (Figure 5A), though this did not seem to be in R&D, according to a large number of executives.

![Figure 5A: Change in Operating Indicators Over the Past Year](image)

Most firms reported modest increases in sales and revenue, but these were outpaced by growth in non-labour and labour costs (Figure 5B). Increasing labour costs are a direct result of the tightening labour market in Singapore, in response to the government’s initiatives on reducing the reliance on foreign manpower. Executives reported that growth in labour costs was higher than growth in labour productivity. Growth in labour costs must be matched by advances in productivity, *ceteris paribus*, if a business is to remain competitive. The data for the firms surveyed suggests that there is an urgent imperative for businesses to improve labour productivity, if they expect to remain profitable.

![Figure 5B: Change in Operating Indicators Over the Past Year](image)
A majority of firms were owned privately, with multiple owners. Most of these companies were incorporated as private limited corporations. This was followed by family-owned businesses, partnerships and sole proprietorships. Publicly-listed companies accounted for less than 7 percent of the sample. Many of the privately held companies with multiple owners can be assumed to have most of the equity held within a family, and engaging in the practice of primogeniture.

**Figure 5C: Ownership Structure**

Which of the following best describes the ownership structure of your firm?

<table>
<thead>
<tr>
<th>Ownership Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole Proprietor</td>
<td>10%</td>
</tr>
<tr>
<td>Partnership</td>
<td>15%</td>
</tr>
<tr>
<td>Family owned</td>
<td>20%</td>
</tr>
<tr>
<td>Private owned with multiple</td>
<td>55%</td>
</tr>
<tr>
<td>owners</td>
<td></td>
</tr>
<tr>
<td>Public company</td>
<td>0%</td>
</tr>
</tbody>
</table>


Most of these indicators are measured to some degree in the firms surveyed in our sample. The most frequently monitored is profit margin (91 percent), followed by labour cost per employee (76 percent) and labour costs competitiveness (70 percent). Leaders reported that they rarely measure value added-to-sales ratio (46 percent), capital intensity (45 percent) and capital productivity (42 percent). Given the tightening labour market, it is expected that firms monitor their labour competitiveness more frequently than their use of capital. However, each of the 10 recommended indicators reflect different facets of productivity and innovation.

**Figure 5D: Measurement of Operational Indicators**

- **Labour Productivity**
- **Sales per Employee**
- **Value added-to-sales ratio**
- **Profit Margin**
- **Profit-to-Value added**
- **Labour Cost Competitiveness**
- **Labour Cost per Employee**
- **Sales per Dollar of Capital**
- **Capital Intensity**
- **Capital Productivity**
- **Others**

---

7 The practice whereby the firm is inherited by the first-born of the family
5. Research Findings

5.2 Performance Across Drivers

Driver A: Technology and Capital Utilisation

Several studies have highlighted the role of capital and technology in driving economic growth and productivity (Jorgenson et al 1987; Mankiw et al 1990; Vu 2013). Capital is a driving force in improving efficiency and productivity in the manufacturing sector. The use of automated production technologies is associated with improved quality control, production speeds, and ultimately higher productivity. The proliferation of computer numerically controlled or CNC machines, robotic manufacturing and automated production methods and enterprise resource systems across production floors are commonly acquired assets in productivity and innovation practices.

The data suggests that firms do not use advanced production technologies and that only 13 percent them reported that the level of technology in their firm’s operations was ‘state of the art’. An overwhelming share (80 percent) reported that their technology was ‘industry standard’ (Figure 5E). The limited use of advanced production technologies is striking, given the relatively large contribution of ‘machinery and equipment’, ‘metal products’, and ‘manufacturing engineering’ to the manufacturing sector in Singapore.

Figure 5E: The Level of Technology in Firm’s Operations

![Pie chart showing the level of technology in firm’s operations]

The use of modern peripheral technologies, such as smart phones and tablet computers (82 percent), and cloud-based computing systems (51 percent) is a promising facet of SMEs. Data reveal that there is a limited use of advanced technologies, such as robotic manufacturing, as well as enterprise solutions, such as enterprise resource systems and customer relationship management software. Transition to these technologies might become imperative in a tightening labour market, where firms aim to reduce their reliance on manpower and move towards more capital-intensive solutions for survival.
5. Research Findings

Figure 5F Technology Practices within the Firm

While the penetration of new technologies remains relatively shallow in the manufacturing sector, a large share of firms (75 percent) reported that three broad factors drive investment in new technologies within the firm: government policy and regulation; knowledge of new technologies; and the ability of senior managers to seek out technical solutions (Figure 5G). This finding reiterates the strong role of the Singapore government in encouraging SMEs to adopt superior technical solutions. Increased awareness amongst SME Leaders and senior managers on the latest technical solutions for their subsector may increase investment in technology, improving efficiency and driving productivity. Other factors that influenced new investments in technology included the ‘cost structure of Singapore operations and the availability of skilled labour’.

Figure 5G: Determinants of Investments in New Technologies within a Firm.

While adoption of advanced technical solutions is not common amongst the SMEs surveyed, nearly 50 percent of them reported that they assessed new technological solutions that could improve productivity within the firm at least once every six months (Table 5A), with 33 percent doing so annually. This suggests that, while SMEs are aware of technical solutions, their adoption of these solutions may be constrained by other factors. SMEs surveyed did not utilise the expertise of external consultants to advise on technical solutions with more than 40 percent never having appointed such consultants.
5. Research Findings

Table 5A: How Frequently Does Your Firm Do The Following?

<table>
<thead>
<tr>
<th>Activity</th>
<th>At least Once in 6 months</th>
<th>Annually</th>
<th>More than Annually</th>
<th>Never</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess new technological solutions to improve productivity</td>
<td>46.0%</td>
<td>34.0%</td>
<td>8.8%</td>
<td>7.9%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Benchmark with firms using state of the art technology</td>
<td>30.2%</td>
<td>22.8%</td>
<td>9.3%</td>
<td>28.4%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Appoint consultants to advise on technology solutions to improve productivity and innovation</td>
<td>14.0%</td>
<td>23.3%</td>
<td>14.0%</td>
<td>44.2%</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

Driver B: Pay and Performance Management

It is useful to think about pay and performance management in the context of creating a HPWS. These are broad human resource management and work practices that are designed to improve labour productivity and organizational performance. They require employers to create an environment that fosters best productivity and innovation practices. Employees are rewarded and incentivized while being given opportunities and discretion in their work practices to engage in innovative practices. It is important to emphasize that effective HPWS are a function of incentives and discretion. They must be supported by systemic firm-level efforts to improve human capital, knowledge and utilization of advanced technologies, and a learning mind-set.

The majority of firms (62 percent) reported that their largest occupation group were production workers with 20 percent claiming that the largest of these were engineers. While production workers and engineers account for the largest shares of employment by SMEs globally, the relative dominance of firms whose workforce primarily constitutes production workers over engineers is striking. This speaks to the relative skill level of the workforce and the quality of production technology in operation at the firm.

**Figure 5H: Breakdown of Employment Groups Across SMEs.**

Most of the firms reported partial engagement with the key features of HPWS, where staff are adequately incentivized and given performance feedback. Managers and employees in the largest occupational group received between 0-20 percent of their total salary in performance-related bonuses in about 50 percent of firms. About 30 percent reported that their employees received between 21-40 percent of annual compensation through similar bonuses. This suggests that a significant proportion of employees are incentivized to meet performance targets. Figure 5I below highlights that in 60 percent of firms, managers
regularly provide formal feedback to their employees. However, 33 percent reported that they rarely, or have never used, formal performance appraisal systems. There was limited variation in the above trend across occupational groups. Greater reliance on structured feedback at regular intervals is known to improve performance and overcome work-related challenges (Meyer 1991; Easterly et al 1990; Ghorpade, 2000).

**Figure 5I: Use of Formal Performance Appraisal Systems**

In addition to the performance related bonuses, a large number of executives reported that they reward employees for practices that are strongly correlated with improving productivity and innovation within the firm. These include working flexibly across a range of tasks; collaborating with colleagues on projects; coming up with ideas to improve business processes, amongst others. Less than 20 percent reported that they ‘rarely’ or ‘do not reward’ their employees for engaging these practices.

**Figure 5J: Use of Incentives to Improve Productivity and Innovation**
5. Research Findings

Driver C: Training & Development

While incentives and performance systems are prized in improving labour productivity and fostering innovation, the importance of building human capital and a learning mindset in the workforce that charts advances in production techniques and methods, must be emphasized. Improving an employee’s skillset through training and development (T&D) and upskilling, by attending professional development courses, is central to improving labour productivity. T&D is particularly relevant in the manufacturing sector, given the nature of occupational hazards and the emphasis on safety and quality control. These activities improve technical competence amongst employees and contribute to organizational effectiveness by building a culture of institutional learning.

A skilled workforce is vital to ensuring that an SME remains competitive. While most leaders reported that their workforce was fairly adept at working in teams and learning new skills, they highlighted that the quality of graduates from vocational and polytechnics was stronger compared to university graduates (Figure 5K). However, 20 percent of leaders reported that their workforce’s ability to operate with information technology was between ‘weak’ and ‘fairly weak’.

This suggests a low propensity of some SMEs in adopting advanced technical solutions that rely on employees being well versed in IT. This finding corroborates with the earlier findings wherein firms reported that availability of skilled labour, knowledge of new technologies and senior managers abilities to seek out technical solutions, were important when investment in new technologies was concerned (see Figure 5G).

Figure 5K: How would you rate the following aspects of the workforce?

The second aspect of T&D activities, in the context of creating a learning organization, is the use of clear career pathways for employees in the organization. This includes horizontal (across functionalities) and vertical (taking on senior positions at appropriate junctures) transitions over time. Only 30 percent reported using clear career pathways for employees, moving from one grade to another over time. But, 31 percent noted that their employees did not transition from one grade to the next, but stayed for long periods within the same pay and functional grade. This suggests that there has been limited emphasis placed on developing and upgrading skills of the workforce in a large number of SMEs.
The third aspect of T&D relates to ensuring that the workforce undergoes regular training. The Ministry of Manpower (Singapore) reports that a typical employee in the manufacturing sector received about 3 days of training per year in 2013. In this sample, 50 percent of leaders reported that they provide less than 2 days of training, 20 percent provide between 2-5 days and another 20 percent provide above 5 days of training per year per employee. This suggests a significant deficit and opportunity to drive productivity. While SME leaders interviewed underscored the importance of training and upskilling of their workforce, they reported several challenges of removing personnel from the production floor in the current business environment.

In this sample, there was only limited use of programs to develop senior management talent, with 80 percent reporting that they do not use, or have rarely used, formal qualification programs, such as MBAs, for their senior management team. This finding resonates with the concern expressed by many of the difficulty of renewing their leadership over time. Senior management rarely, or did not, attend formal training programs, such as executive short courses in about half the firms. A similar number reported the limited use of performance measurement tools for their senior managers. This neglect of cultivating and developing senior managers amongst SMEs appears to be in sharp contrast to the reported use of formal performance appraisal systems and training programs for junior managers and production workers.
5. Research Findings

Driver D: Innovation Culture

Innovation has been long recognized as the cornerstone of dynamism and efficiency in businesses, and a source of competitive advantage (Best, 2001; Porter and Kramer 2006). This study adopts a broad definition of innovation as described in the Oslo Manual: “as the implementation of a new or significantly improved product, or process...marketing method, organizational method in business practices, workplace organization” (OECD, 2005: 46). Innovative business practices allow businesses to retain their cost competitiveness and give them flexibility to respond to challenges in the business environment. Innovations in products or processes are intricately linked to the R&D activities conducted by a firm. While gross expenditure on R&D in Singapore is comparable to advanced economies, a greater emphasis by businesses and industry to focus on R&D in Singapore may be required.

Our data suggests that between 25-45 percent of firms surveyed do not invest or engage in R&D activities; with only 25 percent of them making regular investments. More strikingly, nearly 25 percent reported that they do not invest in such activities. A vital component of R&D and innovation relates to how connected SMEs are with centers of research and how closely they collaborate with other businesses. Our data suggests that SMEs are more inclined to collaborate with other business than with universities. Collaborations with academic institutions may be used to overcome the lack of investment and employment by SMEs in R&D. However, most leaders reported a limited collaboration, particularly with universities, in developing innovative products.

Figure 5O: Frequency of Innovative Activities within a Firm
5. Research Findings

Our data suggests that SMEs are only partially engaged with developing HPWS. Innovation is largely top-down where employees are not actively encouraged to generate new ideas or practices and have limited discretion to participate in such practices. Experimentation and risk-taking are necessary but not sufficient conditions to foster innovative practices. Tolerating failure, and learning from it, is essential. In the firms surveyed, a large share (50 percent) reported tolerating failure ‘sometimes’. If an environment that thrives on innovation is to be created, greater acceptance of tolerance and experimentation would be required.

Figure 5P: Does the Firm Tolerate Failure?

Another element that links various themes including innovation culture are the mechanisms used to communicate effectively with personnel. The SMEs interviewed reported extensive use of ‘open-door policy’ and ‘meetings with senior management’ to communicate with employees. Limited use of other mechanisms such as ‘attitude surveys’, ‘news letters’, ‘company intranet’, and ‘employee handbook’ were reported. Best practices in communications suggest that the relative efficacy of these mechanisms depend on the subject matter being communicated. Effective communication therefore requires appropriate use of each of these instruments.

Figure 5Q: Use of Communication Mechanisms within the Firm.
While 60 percent of firms reported that their employees were ‘always’ encouraged to develop innovative products, more than a third of the firms reported that they only ‘sometimes’ encouraged their employees. Moreover about 20 percent of the firms reported that their employees were not given discretion to develop new firm policies to facilitate innovation, come up with business processes or search for new markets for existing products.

**Figure 5R: Employee Discretion to Develop Innovation and Productivity Practices.**

**Driver E: Government Regulation & Policy**

A key theme that emerged from the interviews with SME leaders and the Delphi study relate to the access SMEs have to markets, and the role of government in fostering an environment that is conducive to productivity and innovation. Singapore is well integrated with global capital and financial markets, and is part of the global supply chain. Its Free Trade Agreements (FTAs) and minimal business regulations have contributed to it being a hub for business and commerce. Nonetheless, over the past few years, the government has initiated economic and labour market reforms that aim to increase the relative share of manufacturing output, productivity, and domestic labour force participation rates in the manufacturing sector.

A wide range of financial incentives have been made available for businesses to engage with the government’s restructuring agenda. Our data suggests that most SMEs are familiar with the government’s agenda and an overwhelming share have accessed government schemes – over 90 percent had discussed the need to improve productivity & over 85 percent had accessed financial schemes – over the past year. Many firms (50 percent) however had not appointed consultants or solution providers to advise on productivity related issues.
Nearly 70 percent of all SMES interviewed reported a ‘high’ to ‘moderate’ reliance on foreign workers. While there was evidence that SMES are trying to reduce this dependence, many also reported that their current business model would not survive without foreign workers. Studies suggest that access to cheap labour is a disincentive to firms to be productive or innovative as firms can derive their cost advantage from cheaper labour. This finding is not corroborated by our data – SMEs do not view foreign workers as an impediment to productivity.

**Figure 5T: Reliance of Foreign Labour**
5. Research Findings

Figure 5U: Impact of Government’s Financial Schemes

SMEs reducing their dependence on foreign workers would necessarily require greater share of the domestic labour force to join the manufacturing sector and/or parts of the production process to be automated and mechanized. Neither of which are easy to do and efforts on both accounts would have trade-offs and a significant gestation period before their effects are visible. Leaders said that their relatively small size was an impediment to automating the production process. However, the Government’s initiatives on these fronts, Productivity and Innovation Credit (PIC) and Capability Development Grant (CDG), may have traction with SMEs that are trying to mechanize their production lines. This finding corroborates with the increased capital investment some firms are making in their business. This is highlighted in Figure 5A.

Figure 5V: Public Policy and Productivity Drivers in the Singapore Economy

Driver F: Leadership & Management Quality

Research evidence has shown that SMEs find it extremely challenging to attract Singaporeans to work in the manufacturing sector. This has resulted in employers being reluctant to invest in a transient workforce and upskilling and management development for senior managers because of short tenures. This has complicated the leadership and management challenges for the SME.
Leadership and management are vital in promoting productivity and cultivating innovation in firms. Sustained improvements in the quality of management are associated with improved organizational performance, and labour productivity. A strong vision and business strategy, clearly identified operational targets, regular performance conversations and employee engagement are examples of practices that improve organizational effectiveness and productivity.

A common theme across all subsectors relates to the difficulties in cultivating senior management talent and reproducing leadership. Many participants acknowledged that leadership was critical for the ‘vision and strategy’ of the firm and for influencing productivity and innovation efforts. For their managers, leaders expressed a need for analytical problem solving, careful monitoring of staff performance and the active promotion of productivity improvements.

Many leaders reported that top performing employees are ‘identified, developed and promoted.’ This finding corroborates the insight (see Fig 5I) wherein over a 33 percent expressed that no formal performance appraisal systems were used to guide employees work performance.

Figure 5W: Role of Leaders

Figure 5X: Role of Managers
6. Estimation of Composite Score

6.1 Methodology

How is the Composite TFP Score Estimated?

The aim of the Webportal is to create a platform by which firms can benchmark their productivity and innovation practices, with rival and non-rival firms within their sub-sector and across the industry. To do this a ‘Composite TFP Score’ is estimated, based on the performance of a firm across the six drivers that were identified as driving productivity and innovation in the manufacturing sector in Singapore. A firm’s performance on each of these drivers is scored out of 10 points and is described as the TFP driver score. An SMEs performance across the 6 drivers is then aggregated to arrive at the composite TFP score. As each of the drivers has an equal weight (i.e. 10 points) and therefore the highest composite score a firm can achieve is 60 points.

How is the TFP Driver Score Estimated?

Up to 7 questions from each TFP driver are selected to contribute to a TFP driver score. The questions are referred to as scoring questions (SQ). Each SQ within a driver is assigned the same weight in determining the TFP driver score. For example, if there are 5 SQs the score assigned to each of the SQs is 10/5, 2 points. Based on a firm’s responses to the SQs, the TFP driver score is estimated. In the Training and Development driver there are five SQs. The maximum score assigned to each question is therefore 2 points.

How are SQs Estimated?

As the SQs are based on a Likert scale, responses that are most correlated with ‘best practices’ in improving productivity and innovation are given 100 percent of the score. The weight proportionally reduces with responses that are not considered ‘best practices’. Under the Training and Development driver, SME leaders were asked to rate aspects of their workforce on a Likert scale from ‘weak’ to ‘strong’. As each SQ in this driver was worth 2 points and this particular SQ has 6 possible responses, each response was worth 2/6 or 0.33. As ‘strong’ is correlated with best practices in improving productivity and innovation, respondents that elected ‘strong’ for each of the 6 responses were assigned 100 percent of the score, i.e. 0.33. The weights reduce proportionally for those respondents that elected ‘fairly strong’, ‘fairly weak’, and ‘weak’ as highlighted in the box below. The scores for each of the responses are then aggregated to determine the score of the SQ. In this example, if a respondent elected ‘weak’ for all 6 of the responses, they would be assigned a total score of 0.50.

---

8 Lickert Scale is a one-dimensional scoring method. It is used to record individual opinions and preferences on an issue.
6. Estimation of Composite Score

<table>
<thead>
<tr>
<th>Weights</th>
<th>Weak</th>
<th>Fairly weak</th>
<th>Fairly Strong</th>
<th>Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Weights)</td>
<td>(0.25)</td>
<td>(0.50)</td>
<td>(0.75)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Quality of Uni Grads</td>
<td>0.08</td>
<td>0.17</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>Quality of ITE Grads</td>
<td>0.08</td>
<td>0.17</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>Ability to learn new skills</td>
<td>0.08</td>
<td>0.17</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>Ability to work with IT</td>
<td>0.08</td>
<td>0.17</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>Ability to Work in teams</td>
<td>0.08</td>
<td>0.17</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>Work Ethic</td>
<td>0.08</td>
<td>0.17</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>Maximum Score</td>
<td>0.50</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
</tr>
</tbody>
</table>

6.2 Composite TFP Scores Across Sub-sectors

The Composite TFP Scores for firms surveyed across the manufacturing sector in Singapore are reported in Figure 6A below. There is variation in the composite scores across the sub-sectors, ranging between 30.6 and 33.8. The variance in these scores must be interpreted with caution. Each of these sub-sectors relies on different production technologies, work practices, and operate under different regulatory structures. Pharmaceuticals is the highest performing industrial sub-sector, followed by Other Transport Equipment. Both these sub-sectors are known to rely extensively on technology and use capital-intensive production techniques. Fabricated Metal Products and Machinery and Equipment, both contributing in large shares to Singapore’s manufacturing output, have relatively lower composite scores.

Figure 6A: Composite Score Across Sub-Sectors

It is useful to reflect on the share of labour (measured by compensation paid to employees) and share of capital (measured by operating surplus) in national income in analysing productivity across industrial sub-sectors in Singapore. Singapore’s uncompromising growth strategy has relied on only lightly regulated labour markets and on reducing the cost of doing business for firms. This has placed downward pressures on wages, and over time reduced the share of labour income in GDP. Access to relatively cheap labour has reduced the incentive of SMEs to mechanize and automate production technologies in many industries including Fabricated Metal Products, and Machinery and Equipment. While this appears to be correlated with the data presented in Figure 6A, further research would be required to establish a causal argument.

* In most advanced economies the share of labour in national income is about two-thirds. In 2012, this share was 41 percent for Singapore (Government of Singapore, 2014a).
6. Estimation of Composite Score

6.3 TFP Driver Scores

Table 6A presents data on TFP driver scores of SMEs. Based on the data presented in Table 6A, the following observations are made. There is greater variation in the TFP driver scores (Table 6A) than in the TFP composite score (Figure 6A). The average score ranges from 4.1 (Technology & Capital Utilisation) to 7.0 (Innovation Culture). Across the six drivers surveyed, the data suggests that firms have performed much better on developing their staff’s skills, creating an environment that is conducive to innovation, accessing government schemes to improve productivity relative to using advanced technology and capital solutions, and managing their workforce through a system of incentives and performance management tools.

Table 6A: Average Performance Across Drivers & Sub-sectors

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers &amp; Electronics</td>
<td>4.2</td>
<td>4.6</td>
<td>5.7</td>
<td>7</td>
<td>5.6</td>
<td>5.4</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>4.2</td>
<td>4.8</td>
<td>6.2</td>
<td>7.4</td>
<td>5.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Chemicals &amp; Chemical Products</td>
<td>3.9</td>
<td>4.6</td>
<td>5.6</td>
<td>6.9</td>
<td>5.2</td>
<td>5.6</td>
</tr>
<tr>
<td>Machinery &amp; Equipment</td>
<td>3.9</td>
<td>4.6</td>
<td>5.3</td>
<td>6.8</td>
<td>5.2</td>
<td>5.4</td>
</tr>
<tr>
<td>F &amp; B</td>
<td>3.7</td>
<td>5.2</td>
<td>5.9</td>
<td>7.4</td>
<td>5.3</td>
<td>4.8</td>
</tr>
<tr>
<td>Fabricated Metal Products</td>
<td>4.1</td>
<td>4.4</td>
<td>5.4</td>
<td>6.6</td>
<td>4.8</td>
<td>5.3</td>
</tr>
<tr>
<td>Other Transport Equipment</td>
<td>4.6</td>
<td>4.7</td>
<td>5.9</td>
<td>6.8</td>
<td>5.2</td>
<td>5.4</td>
</tr>
<tr>
<td>Others</td>
<td>3.8</td>
<td>4.3</td>
<td>5.2</td>
<td>7.2</td>
<td>5</td>
<td>5.2</td>
</tr>
</tbody>
</table>

The Other Transport Equipment sub-sector, mostly consisting of firms that cater to the marine industry leads the adoption of best practices relating to the use of technology and capital. The F&B sub-sector has the highest score on Pay and Performance Management. Participants in the pharmaceutical sub-sector reported following best practices in fostering a culture of innovation, as well as adopting strong leadership practices. The Fabricated Metal Products sub-sector has the lowest score on Government Regulation & Policy. This suggests they are likely to have a higher reliance on foreign manpower and are less engaged with the government’s productivity agenda (measured as accessing schemes, sending employees to workshops, etc).
6. Estimation of Composite Score

Figure 6B: Annualised Real Productivity Growth by Sector, 2010-2013

Figure 6B presents a snapshot of Exhibit 4 of the Economic Survey of Singapore Second Quarter of 2014 (MTI, 2014). This graphic presents the trend rate of productivity growth and annual productivity growth at the macro aggregate level as well as sub-sector level. As productivity growth is highly correlated with growth in real GDP, cyclical fluctuations present in macroeconomic data are also pervasive annual productivity data. The authors of the survey use a Hodrick-Prorscott Filter, a statistical tool used to remove interim fluctuations from a time series data set, and measure productivity changes that 'reflect long-term structural, rather than cyclical, factors' (p11) in the Singapore economy’s productivity growth.

They make two broad observations. First, trend productivity growth was higher than the actual productivity growth for the overall economy, underscoring the importance of cyclical fluctuations in recent productivity data. Second, in some of the sub-sectors the trend productivity growth was much higher than annual productivity growth particularly for those that are in export-oriented sectors. This is also relevant for the electronics sub-sector, which experienced low annual productivity growth. However after adjusting for cyclical fluctuations, the sector recorded a trend rate of growth of 3.9 percent (ibid). This suggests that the decline in annual productivity growth in this sector is due to cyclical factors, and does not reflect underlying trends.

Two sub-sectors that have experienced the highest annual and trend rates of productivity growth in this time period are Transport Engineering and Biomedical Manufacturing. These two sectors have also achieved the highest composite score based on their productivity and innovation practices in our study.
6. Estimation of Composite Score

Table 6B presents the share in total establishments, the share in Value-Added by manufacturing establishments in Singapore, and the Composite Score of the relevant sub-sectors. The sub-sectors selected for this study account for nearly 90 percent of the value-added by manufacturing establishment and 60 percent of total establishments in Singapore. While the Electronics sector experienced low annual productivity growth over the past three years (Figure 6C), it has the highest share in value-added amongst manufacturing establishments.

Caveat

It is important to be cautious when comparing various metrics presented in Figure 6C and Table 6B. First, the composite scores do not measure productivity and should not be interpreted as a proxy for productivity. They measure the extent to which businesses adhere to best practices in improving productivity and innovation in the manufacturing sector. Second, the Economic Survey of the Singapore Second Quarter suggests that productivity data in Singapore is pro-cyclical and, therefore, removing these fluctuations is important in analysing productivity data. The composite scores estimated in this study are not based on time series data collected and, therefore, a similar estimation is not possible.

Table 6B: Select Manufacturing Statistics, Singapore

<table>
<thead>
<tr>
<th>Sub-sectors</th>
<th>Share in Total Establishments</th>
<th>Share in Value-Added and Rank</th>
<th>Key Driver Composite Scores &amp; Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food &amp; Beverages</td>
<td>9.0</td>
<td>4.0 (6)</td>
<td>32.3 (4)</td>
</tr>
<tr>
<td>Chemicals &amp; Chemical Products</td>
<td>3.3</td>
<td>7.0 (4)</td>
<td>31.8 (5)</td>
</tr>
<tr>
<td>Pharmaceuticals &amp; Biological Products</td>
<td>0.5</td>
<td>17.0 (2)</td>
<td>33.8 (1)</td>
</tr>
<tr>
<td>Fabricated Metal Products</td>
<td>14.2</td>
<td>5.0 (5)</td>
<td>30.6 (7)</td>
</tr>
<tr>
<td>Computer, Electronic &amp; Optical Products</td>
<td>3.4</td>
<td>34.0 (1)</td>
<td>32.5 (3)</td>
</tr>
<tr>
<td>Machinery &amp; Equipment</td>
<td>18.0</td>
<td>11.0 (3)</td>
<td>31.2 (6)</td>
</tr>
<tr>
<td>Other Transport Equipment</td>
<td>12.1</td>
<td>11.0 (3)</td>
<td>32.6 (2)</td>
</tr>
<tr>
<td>Total</td>
<td>60.5</td>
<td>89.0</td>
<td></td>
</tr>
</tbody>
</table>

Source: Government of Singapore (2014a), and author’s estimates
7. Recommendations

7.1 Improving Technology and Capital utilisation

Adopting technology solutions and upgrading capital in the production process is known to drive efficiency and improve productivity. This is particularly relevant for SMEs in the manufacturing sector in Singapore. As the Strategic Economic Plan published in 1991 highlights “The domestic sector has unfortunately not benefitted significantly from the influx of foreign investments, which bring it latest technology and management methods. Upgrading of this sector has been significantly below that of the internationally-oriented sector…” (Government of Singapore, 1991). Technologies such as cloud-based computing platforms and tablet computers can help monitor data and vital information in real-time, providing a manager with oversight of the entire production process and enabling improvements in efficiency.

These technologies can enable effective communication strategies and allow for flexible labour force planning and management. Solutions such as automated production processes, computer numerically controlled machines (CNC), and enterprise resource product or systems enable better enterprise and workforce planning, a finer precision control in complex production processes, and help reduce downtime and human error. Ultimately, these solutions can bring the firm closer to the customer, and allow it to substitute capital for labour, in a tightening labour market. Benchmarking an SME’s technology practices with firms within a particular sub-sector can provide further insights into how SMEs can incorporate practices to improve productivity. In this context, solution providers and consultants can play an important role by coaching and offering tailor-made and sub-sector specific solutions to their SME.

Threshold Score: 0-4.0

SMEs that score in the lower end of the distribution on this driver can:

- Identify best practices adopted by firms in their relevant sector
- Undertake internal discussions to explore how less-invasive technology solutions such as cloud computing, smartphones and tablet computing devices can improve business operations
- Work with a consultant to design a structured program of technology intervention in the business

Threshold Score: 4.1-6.9

SMEs that fall in the middle of the distribution on this driver can

- Consider moving towards more automated production processes, relying on robotic manufacturing technology, CNC machines, and implementing enterprise planning programs. A gradual shift to more mechanized and automated production solutions, to the extent that is feasible, will improve economies of scale, reduce down-time and human error and ultimately improve productivity.
- Firms may wish to automate non-production process tasks through the adoption of Customer Relationship Management software or through the implementation of a Human Resource Information System.
7. Recommendations

Threshold Score 7.0 - 10.0

- SMEs that fall in the upper end of this distribution mostly rely on automated production technologies, have access to and implement state of the art technology solutions, regularly benchmark their practices with competing firms and rely on consultants to advise them on technology solutions.

- Firms in this range may look to taking the ‘next step’ by working with Universities and Research Institutes to develop novel technological innovations to take positions of technological market leadership.

7.2 Improving Pay and Performance Management

An energized and engaged workforce is crucial to firm success, and is strongly correlated with enhanced productivity and innovation. As Deputy Prime Minister and Minister for Finance, Tharman Shanmugaratnam noted in his budget speech “Employers must recognise what the best companies have found: that people are their biggest opportunity. Every employer must look for the potential in their people, and put time and effort into developing this potential with them. It also means looking out for mid-career Singaporeans who are temporarily dislocated, and helping them to get back in, get re-trained where necessary, and contribute their worth. And it matters greatly too when employees are empowered.” (Government of Singapore, 2015)

In this context, it is useful to think about pay and performance management in the context of creating High Performance Work Systems (HPWS). HPWS are broad human resource management and work practices that are designed to improve labour productivity and organizational performance. Employees are rewarded and incentivized while being given opportunities and discretion in their work practices to engage in innovative practices. Pay and performance management therefore is a vital component to developing HPWS and improving productivity.

Formal performance appraisal systems across all occupational levels, including production workers and line managers, is essential for taking stock and identifying performance and development opportunities and challenges. It serves as a tool to help both employees and line managers work through a structured plan to address specific performance-related challenges. Incentivising staff through performance bonuses, and rewarding them for working flexibly across a range of tasks, working in teams, and for coming up with ideas to improve the business can help keep the workforce motivated and energized.

Threshold Score: 0-4.0

SMEs that fall in the lower end of the distribution in this driver can:

- Identify best practices adopted by firms in their sub-sector

- Allow line managers as well as employees to identify tangible objectives, specifically where customer service is involved. Recognise and reward employees that perform tasks more efficiently

- Consider implementing a system of formal performance appraisal across all occupational groups within the business. SME leaders must consider having performance conversations at a regular frequency (e.g. quarterly), and motivate their staff through incentives (e.g. performance bonuses). Under performance can be identified and addressed.
7. Recommendations

Threshold Score: 4.1-6.9

SMEs that fall in the middle of this distribution can:

- Consider how individuals might perform better in teams and how teamwork can be rewarded
- Delegate responsibility and empower teams to self-manage; help teams to link operational imperatives to business objectives strategy
- Consider the impact of different forms of monetary and non-monetary compensation on employee motivation.

Threshold Score: 7.0 - 10.0

- Firms in the upper-end typically rely on monetary and non-monetary incentives to motivate their staff; on regular performance conversations to provide their staff with feedback; rewarding their staff for working flexibly across a range of tasks; on working teams and on showing initiative in improving the business. SMEs in this end of the distribution may consider working with human resource specialists on how to sustain an energized workforce.
- Firms in this range may take the ‘next step’ by considering how their performance management system can be enhanced through complementary human resource management practices and policies.

7.3 Improving Training, Development (T&D) and Organizational Learning

An important factor in enhancing TFP is the development and upgrading of human capital. This is particularly relevant for Singapore. A white paper released by the Government of Singapore in 2013 highlighted that by 2030 about two-thirds of Singaporeans will hold PMET (Professional, Managerial, Executive and Technical) jobs (Government of Singapore, 2013). This will require investing in human capital and continually upgrading skills of the labour force. In this context employers can play a crucial role. Ensuring that employees have the requisite skills, and are up to date with the latest technology, solutions, and practices within their industrial sub-sector, is an essential pre-requisite to improve productivity and foster innovation. To enable this, the workforce must go through regular training and development courses to ensure that they keep abreast of cutting-edge developments and practices within their industrial sub-sector. T&D is particularly relevant in the manufacturing sector, given the nature of occupational hazards and the emphasis on safety and quality control. These activities improve technical competence amongst employees and contribute to organizational effectiveness and the building of a culture of institutional learning.

In addition, the workforce must have a structured career pathway that recognizes employee performance, skill acquisition and initiative, and enables their advancement. Clear and coherent training and development strategies, that emphasize both technical and soft skills, supports the creation of an environment that fosters innovation and innovative practices. A holistic approach is required to achieve improved skills and organizational learning. This would require working employers (SMEs in this case) working with education and training institutions, while employees themselves become active participants identifying areas on improving effectiveness.

As the Prime Minister recently remarked “Employers must seek constantly to improve their operations, recognise their workers’ skills and value and train workers…. Education and training institutions have to equip workers with the relevant skills. …Workers themselves must hone and upgrade their skills, as well as help to identify problems at work and improve work processes.” (Government of Singapore, 2014b)
7. Recommendations

Threshold Score: 0-4.0

Firms that fall in the lower end of the distribution can

- Identify best practices for T&D, which other firms in the subsector undertake
- Develop an organisation-wide T&D strategy linking it to the employee roles, operational imperatives and company strategy
- Consider sending employees to relevant training and skills development workshops. The average training received per employee in Singapore manufacturing firms is about 3 days a year. It is also important to give employees the discretion to implement what they have learnt in training workshops, to enable organizational learning. For more information, firms can consult with the Workforce Development Agency (WDA) – see www.wda.gov.sg

Threshold Score: 4.1-6.9

Firms that fall in the middle of this distribution are well poised to:

- Consider the development of a formal career path for their employees whereby each is encouraged to advance their career. This factor correlates with organizational learning as it creates rich institutional knowledge. An internal career ladder incentives skill acquisition when matched with a tiered salary system
- Consider the importance of hard technical skill development as well as soft skill (eg. Communication) development
- Consider management development mechanisms for senior managers including qualification programs such as MBAs, and executive short courses, which include a coaching element to guide the workforce through specific problem areas. Technical training must be complemented with individual coaching and mentoring.

Threshold Score: 7.0 - 10.0

- Firms that fall in the upper end of the distribution can reflect on the learning and development strategy of the organization, and how it can be sustained. Working with technical consultants and partnering with management institutions may help communicate training and development strategies more coherently and effectively
- Firms in this range may wish to take the ‘next step’ by working with consultants to identify skill deficits and examine pre- and post- productivity impacts of investments in training and development.

7.4 Improving Innovation Culture

Building a culture of innovation across businesses in different sectors is essential and embodied in Singapore’s growth and development strategy. Indeed, the report of the Committee of Singapore’s Competitiveness highlighted “Given our limited resources, Singapore has to compete on the basis of capabilities rather than costs...As competition intensifies, Singapore needs to continually move up the technological and capabilities ladder” (Government of Singapore, 1998).
7. Recommendations

The importance of innovation across businesses and domains was recently again underscored by the Prime Minister, "Innovation does not have to be rocket-science, but companies must be willing to relook at how things are done. We will continue to work with employers and unions in all industries to raise their productivity – not just through technology, but also by transforming business processes, management, and business models" (Government of Singapore, 2014).

The process of innovation and innovative practices are key to improving productivity and ensuring that businesses remain competitive. Innovative business practices allow businesses to retain their cost competitiveness and provide flexibility to respond to challenges in the business environment.

Innovations in products, processes or business models are also linked to the R&D activities conducted by firms. Academic studies have long recognized the importance of a bottom-up innovation process in the manufacturing sector, wherein employees generate ideas and innovative practices to improve the business. To enable this, a culture that allows employees to get together and discuss challenges related to quality, production processes, and service delivery should be encouraged.

Effective communication strategies to ensure that senior management listen to employees (through, for example, attitude surveys, open door policies, suggestion schemes, and newsletters) are vital to building an innovation culture. Providing employees a degree of discretion for them to experiment and come up with new ideas to improve the business is essential in building an innovative company. Tolerating risks, and even failure, in the context of experimentation can be a necessary component of such a stratagem.

Threshold Score: 0-4.0

Firms that fall in the lower end of the distribution in this driver may:

- Consider encouraging their employees actively to discuss various aspects of the production process together with a view to identifying bottlenecks and improving production and service delivery
- Allow employees to communicate these ideas through open-door policies or, more formally, through suggestion schemes or emails to line managers

Threshold Score: 4.1-6.9

Firms that fall in the middle of this distribution may:

- Consider investing in research and development, and working closely with research centres to develop innovative products or practices
- Empower employees with discretion to develop new products and services, or business processes, or firm-level policies to facilitate innovation
- Provide employees with time and incentives to develop innovations to products, processes or the business model
7. Recommendations

Threshold Score: 7.0 - 10.0

- Firms here must recognize and allow for continuous experimentation, risk-taking, and even tolerate failure. Many firms will nominate an innovation champion(s) to spur activity across the firm.

- Firms here may collaborate with other businesses and research centres to develop new products or processes. The conscious development of an appetite for experimentation, discretion, and risk-taking will facilitate and sustain innovation.

7.5 Improving Government Policy and Regulation

Singapore has experienced robust economic growth and increased per capita incomes over the past four decades. Many scholars have attributed this to its growth and development strategy. Singapore is now well integrated with global capital and financial markets, and is part of the global supply chain. Its Free Trade Agreements (FTAs) and minimal business regulations have enabled it to be a hub for business and commerce. In recent years Singapore has faced many challenges in the aftermath of the global economic slowdown and has placed renewed emphasis on increasing the share of manufacturing to national income, as well as improving productivity and energising the manufacturing space. As the Minister for Finance highlighted: “We have been aided by a favourable global environment... This is not a story of an old economy growing quickly, but of a new economy emerging out of the old. Its is about how we are attracting new and cutting edge investments, capitalising on opportunities in new growth industries and markets abroad, upgrading our workers skills and competing at an advantage.” (Government of Singapore, 2008)

A wide range of financial incentives has been made available for businesses to engage with the government’s restructuring agenda. These schemes are managed through SPRING, Singapore and are summarized below. Firms may consider discussing their specific needs with a consultant at SPRING or SiPi to help them select from the following schemes to embark on a journey to improved productivity and innovation practices10:

a. **STP – SMEs Talent Program** – provides for funding to recruit fresh graduates from vocational institutes up to 70 percent of pay for 2 years (and includes training and education support).

b. **ICV - Innovation and Capability Vouchers** – up to 8 vouchers (each of $5000) to improve capabilities in productivity, HRM, financial management and innovation.

c. **iSPRINT – Increase SME Productivity with Infocomm Adoption and Transformation** – 70 percent of expenses to improve (ceiling at $2000) and transform ($20,000) business practices.

d. **IPG - ICT for Productivity and Growth** – matching funding for using wireless and monthly subscription equipment.

e. **PIC - Productivity and Innovation Credit** – 60 percent cash rebate or 400 percent tax rebate on up to S$100,000 on 6 areas: IT and automation, R&D, Training, buying IPRs, registering IPRs, and approved design projects.

f. **WCS - Wage Credit Scheme** – pays for 40 percent of annual wage increments for qualified SME employees who earn a gross wage of $4000.0 or below.

g. Other schemes: Enhanced Training, Work Pro, Market Readiness Assistance Grant, Micro Loan Programme

10 The qualifying conditions and benefits for each of the following program may change in the future.
7. Recommendations

7.6 Improving Leadership & Management Quality

Leadership and management are vital in promoting productivity and cultivating innovation in firms. Sustained improvements in the quality of management are associated with improved organizational performance, and labour productivity. A strong vision and business strategy, clearly identified operational targets, regular performance conversations and employee engagement are examples of practices that improve organizational effectiveness and productivity.

In this study, many SME leaders acknowledged that leadership was critical for the ‘vision and strategy’ of the firm and for influencing productivity and innovation efforts. For their managers, leaders expressed a need for analytical problem solving, careful monitoring of staff performance and the active promotion of productivity improvements. Many leaders reported that only top performing employees are ‘identified, developed and promoted’.

Despite these beliefs, over 33 percent SME leaders (see Fig 5I) expressed that no formal performance appraisal systems was used to guide employees work performance. With this gap existing between leadership beliefs and action, a common theme across all subsectors rightfully identified the difficulty in cultivating senior management talent and reproducing leadership.

Furthermore, research evidence shows that SMEs find it extremely challenging to attract and retain Singaporeans to work in the manufacturing sector. This has resulted in employers being reluctant to invest in a transient workforce and upskilling and management development for senior managers. This has complicated the leadership and management challenge for the SME.

Leaders who model sustainable work practices in the workplace have employees who are better engaged at work (55 percent), more satisfied (77 percent) and live healthier lives (72 percent) (Schwartz and Porath, 2014). Furthermore, international research has shown that authentic leadership, where leaders are able to guide organisations to achieve its vision in the face of uncertainty and complex situations, highly correlates with management and people oriented cultures in HPWS (Boedker et al 2011).

Threshold Score: 0-4.0

Firms at the lower end of this distribution may:

- Consider having performance conversations between senior management and line managers to identify challenges and agree on goals and milestones to work through bottlenecks in the production process.

- Send managers to workshops and executive short courses to develop leadership skill.

- Ensure that managers remain accessible to their staff, and be able to communicate effectively. Suggestion schemes and open-door-policies are useful instruments of communications that managers may use in this context.
7. Recommendations

**Threshold Score: 4.1-6.9**

Firms in the middle of this distribution may:

- Consider investing effort with leadership and management teams in long term planning and scenario exercises to ascertain plausible futures and identify strategies that must be designed to deal with such changes

- Encourage managers to continue to retrain and retain their staff across organizational departments. SME Leaders and senior management may also consider using ambitious stretch targets with clear rewards to their managers

- Benchmark with firms noted for having strong leadership, measure the gap in leadership and identify means to close the gap, which may include replacing non-performing leaders with proven leadership talent

**Threshold Score: 7.0 - 10.0**

- Firms in the upper end of this distribution must continue to create an environment where best practices to improve productivity and innovation are actively pursued, top-performing employees are regularly identified, developed, promoted and retained, and a clear organizational learning and development strategy is pursued

- Firms in this range can take ‘the next step’ by actively identifying leadership deficits across the workforce and developing individualised plans to address these deficits. Firms may also wish to measure the impact of specific investments in ‘leadership’ on firm productivity and financial results
8. Conclusions

The findings of this study help to contextualise and explain the aggregated productivity data for the manufacturing sector and the concerns expressed by the Singapore Government. Productivity is lagging behind international comparators in a number of sectors, including manufacturing. This study (the largest of its type) helps us to understand the underlying reasons for this, and the main challenges faced by SMEs in the sector. It is only by identifying deficits in the key drivers of TFP that we can begin to develop solutions to renew productivity growth. It is important to qualify that while the literature, Delphi study and interviews conducted with local SME leaders clearly identified the six key drivers as instrumental in driving total factor productivity growth, it was beyond the scope of this study to test this hypothesised causality. To do so would require in-depth case studies of a small number of firms examining a large number of data points. However we do note with equal measures of interest and caution, that the composite scores calculated for each of the sub-sectors analysed broadly correlate with measures of labour productivity and value-add for these same sub-sectors.

The key results across the drivers of TFP may be cause for pessimism for some readers however, we are convinced that the gaps, weaknesses and deficits observed, represent a real opportunity for SMEs within the sector to gain considerable productivity gains by implementing relatively modest changes, at little cost. For example, implementing performance management systems that identify and act on under-performers and reward high-achievers is a managerial task that can be implemented at low cost, but with significant potential upside. Similarly, conducting a skills-gap analysis to see whether production staff have the necessary skills to take full advantage of the functionality of machinery, is likely to reveal significant opportunities. Moreover, listening to employees and allowing them to have a genuine say in the workplace might well generate useful ideas that can improve the production process and help build an innovation culture.

For firms prepared to make calculated investments, the productivity dividends may be higher still. For instance, targeted investments in training and development beyond the two days per annum average is likely to keep employees’ technical and soft skills at a level that will enhance productivity. Similarly, the deficits revealed in relation to management training assume that executive education is not a priority, yet the extant research reveals otherwise. Studies referred to in this report have shown that improving the quality of management can have a measurable impact on productivity and innovation. Interestingly, these findings point to opportunities for improvement in adopting technological solutions that may expand a firm’s production frontier. There seems to be a fairly limited penetration of high technology amongst SMEs in Singapore, although there are sub-sector exceptions. This may point to the need for greater uptake of government grants such as those available under the Productivity and Innovation Credit (PIC) scheme or perhaps changing the way in which this scheme operates. A related challenge is for leaders of SMEs to keep abreast of the latest technologies that can assist them to drive productivity. SMEs leaders face considerable competing demands on their time and may be unable to keep up to date with these developments. Trade Associations like the Singapore Manufacturing Federation, consultants and government agencies can therefore play a strong supportive role in connecting SMEs to the latest technology in their subsector. These results point to a limited engagement between SMEs and higher education and research institutes. This may not be a surprising finding, but it does represent a considerable opportunity given the vibrant and world-class universities in Singapore and the extremely well regarded A*STAR (Agency for Science, Technology and Research). Connecting industry and SMEs to Universities and agencies such as A*STAR is likely to yield considerable productivity and innovation gains over the medium to long term.
8. Conclusions

A considerable challenge for the sector, which also represents a tremendous opportunity is to encourage a younger generation of Singaporeans to consider building their careers in manufacturing.

Many of the SME leaders interviewed pointed to the difficulty of attracting capable Singaporeans into the sector, because of the perception that the industry was less attractive than occupations in the services sector. This in turn leads to a high dependence on foreign labour and an increasingly ageing leadership demographic. SPRING’s SME Talent Scheme, which provides an array of incentives to encourage capable younger Singaporeans to develop their careers in SMEs, is a positive step towards addressing this issue. However, more may need to be done to change the perception of the manufacturing sector among the younger generation.

These findings support the strong role that the Singapore Government has played in driving productivity in recent years. There appears to be a near universal awareness of the Government’s productivity agenda and a high awareness and approval of government policy. However, there was a clear sentiment that SMEs were struggling to cope with the changes to foreign worker arrangements, which include restrictions on supply and higher levies. A number of SME leaders expressed that while they understood the need for restructuring the economy in this way, they wished for the Government to make these adjustments over a longer time period. Some respondents also articulated the productivity gains that might emerge through the Singapore Government continuing to strike free trade agreements within and beyond the region. This would create economies of scale and help to overcome the limitations of the relatively small domestic market.

Understanding these challenges and deficits is the first step to advancing productivity growth in manufacturing. The ongoing utility and longevity of this work is to be found in the benchmarking web portal that has been developed to provide further useful insights for SMEs, policy-makers and other stakeholders. The web portal will enable SMEs to benchmark themselves against peers in their sub-sector and against the entire benchmark group; and to track their improvements over the years to come. Additionally, SMEs will receive meaningful feedback on their performance across the key drivers of TFP and recommendations on how they may be able to improve their performance. It is hoped that that this tool will come to play a useful role in restoring the sector’s reputation as a powerhouse of productivity and innovation in Singapore.
9. References


9. References


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