UNIVERSITY OF THE WITWATERSRAND - SCHOOL OF MECHANICAL, INDUSTRIAL AND AERONAUTICAL ENGINEERING

CRITICAL SUCCESS FACTORS FOR IMPLEMENTING A LABOUR PRODUCTIVITY IMPROVEMENT INITIATIVE IN A COMPETITIVE SOUTH AFRICAN MANUFACTURING PLANT FOR GREATER INTERNATIONAL COMPETITIVENESS

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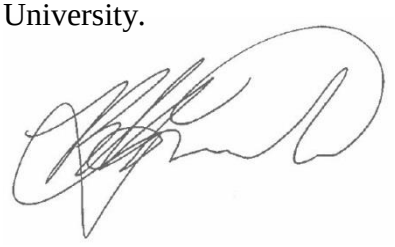
Declaration

I declare that this research report is my own unaided work. It is being submitted to the Degree of Master of Science in Engineering (50/50) to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.



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Abstract

High manufacturing competitiveness in South Africa has the potential to contribute towards mitigating the poor economic performance and high unemployment rate prevailing in the country. However, manufacturing competitiveness is lacking, majorly due to labour productivity issues that are idiosyncratic to South Africa. One of the dilemmas is how to increase manufacturing productivity without major capitalisation, as doing so usually leads to redundancy and retrenchment of employees. A possible solution is to implement manufacturing performance improvement programmes without major capital investment (or capital-labour substitution). Although various programmes exist and are successful elsewhere in the world, these have been found to fail in South African firms due to implementation challenges.

This study assesses the results from implementing a manufacturing performance improvement programme called Integrated Work Systems (IWS) in a South African factory of a multinational company (ABC). IWS has already proven successful in the multinational's factories in other parts of the world. The study aims to determine the critical success-factors and develop a framework for the successful implementation of such a programme in South Africa.

Implementation of IWS in ABC SA's factory was found to be successful in delivering breakthrough results in efficiency and throughput. Critical success-factors established through surveying relevant employees and management in ABC SA were related to the timing and planning of the programme, standardisation of work, regular reviewing and use of leading KPIs, having specific implementation resources and the nature of leadership involvement. The critical success-factors found in ABC SA's implementation were used as a basis for presenting a framework to guide practitioners in implementing manufacturing improvement programmes that aim to deliver higher levels of sustainable performance and improved shop-floor culture.

Contents

List of tables

List of figures

List of abbreviations

BL – Base line

CapEx – Capital expenditure

CEO – Chief Executive Officer

CIL – Clean-inspect-lubricate

CL – Centre-line

CSF – Critical success-factor

DH – Defect handling

DTI – Department of Trade and Industry

FMCG – Fast-moving consumer-goods

IWS – Integrated work systems

KPI – Key performance indicator

MPIP – Manufacturing performance improvement programme

MTBF – Mean time between failures

MTTR – Mean time to repair

OEE – Overall equipment effectiveness

P&G – Proctor and Gamble

PoC – Proof of concept

SF – Success-factor

SME – Small-to-medium enterprises

TPM – Total Productive Maintenance

TQM – Total Quality Management

1. Introduction

1.1 Research background

The manufacturing industry in South Africa is a particularly challenging environment to bring about significant and sustainable performance improvement largely due to labour-related issues such as low productivity, inadequate skills, poor education, political unrest and union dynamics (Chandra, et al, 2001). This results in most manufacturing improvement initiatives failing to make a significant impact, especially where processes are heavily dependent on people to succeed instead of technology or automation. Productivity improvements in South Africa seen in recent decades came largely at the expense of employment through capital investments to overcome labour quality issues, also referred to as capital-labour substitution (McCarthy, 2005).

Workforce characteristics contribute to certain countries gaining a competitive advantage through some or other manufacturing performance dimension such as cost or reliability, for example China and India's leading cost-competitiveness in labour intensive sectors like textiles and fabrics (due to lower labour costs) (Batra and Khan, 2005) and Germany for talent-driven innovation and technological expertise (Parilla, et al, 2015). In South Africa it is acknowledged that competitive advantage does not lie in workforce characteristics, exhibiting one of the lowest labour market efficiencies and highest disconnect between pay and productivity as reported by The Global Competitiveness Report 2012-2013, making the ability of local manufacturers to compete internationally increasingly difficult (Deloitte, 2013).

South Africa is dependent on the manufacturing industry to grow and provide employment (England, 2015), as one of the top contributors to the nation's GDP and income (Statistics South Africa, 2015, pp. 14.2-14.3). Although the weaker rand may increase manufacturing export opportunities with cheaper prices in hard currencies, the benefit is often outweighed depending on where most of the manufacturer's raw materials are sourced from (England, 2015). South Africa's reputation as a supplier is diminishing as demonstrated by the reduced foreign investment rate in favour of countries that offer more attractive investment climates and a declining competitiveness index (World Economic Forum, 2015).

The research is based in a multinational fast-moving consumer goods (FMCG) company ABC that has recently embarked on implementing a manufacturing performance improvement programme in a number of its factories around the world. The method called 'Integrated work systems' (IWS) was developed by P&G (another multinational FMCG company). P&G has factories globally running at 85-90 percent equipment efficiency, which is extremely high compared to ABC. They have achieved this through combining various best practices and partnering with Toyota to develop a customised manufacturing system after over 30 years of development (now called IWS) (Proctor and Gamble Co., 2014).

Broadly summarised, IWS aims at improving equipment efficiency through integrating a set of activities, systems and tools to eliminate manufacturing losses and defects. This is achieved by engaging the entire organisation, and through autonomous maintenance practices, builds the culture and capability of machine operators and the line leadership structure (Proctor and Gamble Co., 2014). The system combines elements of Lean in waste elimination, Six-Sigma in process control, Total Quality Management (TQM) and Total Productive Maintenance (TPM) to drive equipment efficiency (Proctor and Gamble Co., 2014). IWS pillars focus on the production line and involves rigorous monitoring to eliminate line stoppages through daily management systems such as clean-inspect-lubricate (CIL), Centre-line and Defect Handling that serve as preventive countermeasures to any loss or defect experienced (EFESO Consulting, 1999).

A 12-week proof of concept (PoC) was conducted in three ABC factories in 2014 around the world and after being deemed a success (through agreed key performance indicators such as reduced line stops and improved efficiency shown in Table 1 below), the programme was systematically implemented to strategic ABC factories (Switzerland, Brazil, Russia, Poland, Germany and Turkey), with South Africa next on the agenda. It can be seen in the three pilot lines from Russian and Swiss factories in Table 1 below how efficiency is driven through the reduction in unplanned downtime and machine stops, which increases the mean time between failure (MTBF), resulting in higher throughput for the business. These results are quite significant when considering that the best performing factories had been improving only a few percentage points each year before introducing IWS. The results below were seen after 12 to 16 weeks per line, which is the period for implementation of the programme's systems and tools.

Table 1: Proof of concept results in ABC (ABC, 2015)

	Baseline	PoC average	Improvement
Russia Line 19			
Unplanned downtime (%)	31	20.6	34%
MTBF (min)	2.06	3.44	67%
Stops (#)	234	157	33%
Throughput (volume)	382	413	8%
Russia Line 2			
Unplanned downtime (%)	21.3	21.3	0%
MTBF (min)	3	3.8	27%
Stops (#)	154	142	8%
Throughput (volume)	287	348	21%
Switzerland Line Y2			
Unplanned downtime (%)	24.9	20.3	18%
MTBF (min)	5.4	8.6	59%
Stops (#)	960	438	54%
Throughput (unit volume)	251	264	5%

As these are all ABC factories with the same processes, organisational design and structures, policies and KPIs, it is expected that implementing IWS in ABC SA can also improve manufacturing performance but may be affected by the labour characteristics in South Africa previously mentioned above. A close study of the IWS initiative in the South African environment is therefore of particular interest.

Although research is relatively developed in understanding and implementing methods to drive manufacturing excellence, the answers provided are mainly in response to the question 'what to do' rather than 'how to do it' where a picture of success is provided without specific actions to achieve it (Ojha, et al, 2014; Cua, et al, 2006), or developing theoretical frameworks without testing or evaluating them in a real-life setting (van der Merwe, et al, 2014; Bhuiyan and Baghel, 2005), or focusing on contexts outside of South Africa (Ojha, et al, 2014). During a study at an automotive component manufacturing organisation in South Africa it was found that companies practice certain tools and techniques as taught by Lean best practices for example, but do not fully understand what makes the total system work (Rathilall and Singh, 2011). The study found that local organisations often fail to turn theory completely into practice, despite the wide knowledge base with regard to operations

improvement (Rathilall and Singh, 2011). It can be deduced that these shortcomings are particularly prevalent in South Africa, where manufacturing productivity is generally lower than developed countries and below the weighted-average of comparison countries (Edwards and Golub, 2003).

In background, the ABC SA factory has been stagnant in terms of manufacturing performance in recent years despite various initiatives attempting to improve performance. This can be seen in Figure 1 below of the factory's historical overall equipment effectiveness (OEE), perceived as the key indicator of factory competitiveness apart from manufacturing cost. The last four years has seen no significant improvement, while 2008 to 2011 shows an upward trend where each year included capital investments in newer machinery (ABC, 2015).

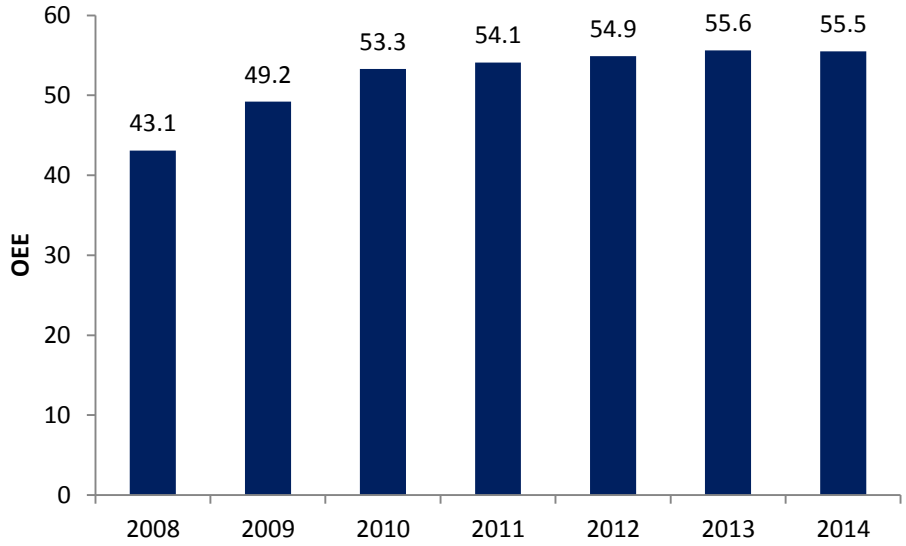

Figure 1: Historical OEE performance at ABC SA (ABC, 2015)

As such, the setting for this study, though focused at ABC SA's factory, may be considered typical of the South African manufacturing environment. More on this is stated in the assumptions provided in section 1.7.

1.2 Problem statement

With South Africa's lack of manufacturing competitiveness contributing to the country's poor economic performance and continuing high unemployment, the successful implementation of manufacturing performance improvement initiatives without major capital investment (or capital-labour substitution) would be a key contributor in remedying the

situation. From the experience of a low success-rate in driving and sustaining manufacturing performance improvements at ABC SA's factory and given South Africa's reports of poor productivity performance trends in the country, identifying the critical success-factors of an effective performance improvement programme that is without major capital investment could be a significant step towards understanding implementation difficulties for manufacturers facing a similar situation as ABC SA and may help develop a framework tailored to succeeding in a South African manufacturing environment.

1.3 Purpose of the study

The purpose of the study is to assess the results of implementing a manufacturing performance improvement programme without major capital investment in a South African factory that has already proven to be successful in similar factories in other parts of the world. This may lead to identifying critical success-factors that may be used for the development of a framework for successfully implementing manufacturing performance improvement initiatives in South Africa without major capital investment.

1.4 Motivation for the study

The study should eventually provide support to local manufacturing managers or practitioners in improving labour productivity without having to substitute labour for capital investment – the shedding of labour to meet business needs should then reduce, assisting South Africa's unemployment rate and at the same time improving the country's manufacturing international competitiveness.

1.5 Research question

What are the critical success-factors for implementing a manufacturing performance improvement initiative that is not technology or automation-related, in a South African manufacturing environment with idiosyncratic labour characteristics such as low productivity, inadequate skills, poor education, and industrial relations dynamism and related unrest?

Proposed hypotheses:

- H1: A manufacturing improvement programme that is not driven by capital investment can achieve significant change in manufacturing performance in a South African plant not withstanding labour constraints characterised by low productivity, inadequate skills, poor education and strong trade union influence

- H2: Critical success-factors for implementing a manufacturing improvement programme that is not driven by capital investment in a South African plant differ from other manufacturing improvement programmes that have been successful elsewhere
- H3: Operators in the selected South African plant will generally demonstrate a different view from senior staff regarding how the improvement programme should be implemented, given their background of poor education and inadequate skills

1.6 Objectives

1. To analyse the impact that the IWS programme has on manufacturing performance in the ABC SA factory by reviewing trends of key performance indicators
2. To develop a framework of critical success-factors in ABC SA for successful implementation of manufacturing performance improvement initiatives applicable to the environment in South Africa, such that firms in a similar situation may improve their manufacturing towards international competitiveness despite local constraints of labour quality and financial strain

1.7 Assumptions

The following assumptions are used:

- That the ABC SA factory is a microcosm of the South African manufacturing environment as the social characteristics and challenges are similar to those faced by other factories in the country. This assumption is discussed and expanded in greater detail in section 4.4.1.
- Environmental influences such as shortage of skilled labour, more cost-competitive international factories and inflexible labour regulations are similarly faced by manufacturers in the country
- Implementation of the IWS project influences the workforce and organisational culture, and implementation of the initiative requires employing change management.
- The limiting factors influencing the manufacturing sector including education levels, skills availability, government support and exchange rates will continue to exist in the foreseeable future.

1.8 Structure of the report

This section summarises the structure of the report by explaining the purpose and contents of each chapter, as well as the flow of the report.

1.8.1 Introduction

The introduction gives background on manufacturing in the South African economy, the IWS programme, and motivation for the study including the problem statement. The research question and objectives are then stated, followed by assumptions made.

1.8.2 Literature review

The second chapter discusses the literature reviewed prior to conducting the study. This includes the relevant KPIs forming part of the research into assessing the impact of a MPIP, as well as challenges facing South African manufacturers with a particular emphasis on labour idiosyncrasies. Similar past studies were then sought to develop a theoretical framework to form the basis of the survey, and assessed to verify the value and novelty of the current study.

1.8.3 Development of the theoretical CSF framework

This chapter illustrates the process of developing the framework of CSFs from the literature reviewed, which was used as a theoretical framework tested in ABC SA by means of a survey.

1.8.4 Methodology

The methodology chapter provides a broad outline of the steps followed in conducting the study. More details on the methodology are discussed for each of the two main components of the study, namely how the MPIP's impact in ABC SA's factory would be assessed, and development of the survey instrument. Reliability and validity of the survey instrument, as well as the overall study are addressed at the end of this chapter.

1.8.5 Results and analysis

The KPIs and corresponding data gathered in assessing the MPIP's impact in ABC SA are presented in the first section of this chapter, followed by the survey results of CSFs for the MPIP. The results presented are outcomes of the processes described in the methodology chapter.

1.8.6 Discussion of results

An assessment is made of the MPIP's impact in ABC SA and the implementation's degree of success. The CSFs of the MPIP with regard to what drove its success and the associated cultural improvements are then discussed for the total survey respondent group, as well as contrasting perspectives of operators and senior staff.

1.8.7 Conclusion

This chapter provides outcomes of the study in relation to its objectives. The chapter ends by stating whether the hypotheses were supported or not.

1.8.8 Recommendations

This chapter makes recommendations on how the framework presented as the outcome of the study can be used by managers and practitioners in South African manufacturing plants to improve the probability of success in implementing manufacturing improvement programmes of this nature, for breakthrough and sustainable productivity improvements without capital-labour substitution. Suggestions for future studies using the proposed framework are also made.

2. Literature review

The study is based on manufacturing improvement and includes an assessment of the improvement during implementation of the programme. It is therefore necessary to confirm industry standards and best practice for measuring this. Performance indicators for manufacturing improvement will be considered first in the literature review. As the study seeks to contribute to South Africa's international manufacturing competitiveness based on labour productivity, literature on how to compare labour productivity of countries and plants will be included.

Another topic looks at reasons for the lack of success in improving performance in South Africa (without capital-labour substitution) to obtain a deeper understanding of the challenges that manufacturing firms have to overcome when operating in the country. This leads to the issue of South Africa's labour supply and supply quality that will be explored with respect to the country's manufacturing workforce characteristics and culture (keeping in mind that each organisation is unique in culture to some extent).

Literature on change management, continuous improvement and frameworks that have already been proposed for effective implementation of manufacturing improvement initiatives such as Lean programmes will be looked at finally as the focal point of this research.

2.1 Indicators of manufacturing performance and competitiveness

Key performance indicators (KPIs) are used by organisations to measure, track and analyse progress or effectiveness with regard to achieving strategic objectives (Abdullah, et al, 2008). To assess a manufacturing process, depending on the level of automation and data availability, some of the most common KPIs include volume count (or throughput), reject ratio (or scrap percentage), production line rate or speed, cycle time, overall equipment effectiveness (OEE) and downtime (Kaganski, et al, 2013; Abdullah, et al, 2008) .

A commonly found measure of manufacturing performance is OEE, which is also used to measure improvement potential or opportunity as it incorporates all sources of performance loss (rate, quality, planned and unplanned downtime) into a single number (Jonsson and Lesshammar, 1999). Seeing that IWS aims to achieve zero losses, this KPI is in line with the study and will be used to assess manufacturing improvement in ABC SA's plant.

One should be cautious when using OEE to compare plants to the difference in specific conditions, even within the same industry, as equipment, products and complexity (or average batch sizes) are usually not exactly the same. The outcomes of OEE analysis should therefore focus on the relative changes and losses within the environment for which the measurement was developed (Jonsson and Lesshammar, 1999).

A notable downside of OEE is that it is often an abstract or incomprehensible concept to operators on the factory floor due to the nature or complexities of the calculation, and so smaller carefully-selected measures should be used for the factory floor (Jonsson and Lesshammar, 1999). As IWS is a very inclusive method that is focused on internal efficiency, Jonsson and Lesshammer (1999) recommend more tangible performance measures for the factory floor. Throughput will therefore be another measurement used in the study, and this also is of major concern to manufacturing firms who aim to produce as much volume as possible in a fixed time period. The third measurement used in the study is the number of line stops. Although this KPI does not appear often in literature, it is fundamental to the IWS way of working (focusing on reducing the most frequent occurring types of line stoppages will drive OEE – to essentially stop the production line from stopping).

The study is a platform for macro-economic benefit through improving international manufacturing competitiveness; hence there is another key measure that needs to be explained in more detail: labour productivity. The basic calculation is shown below (Sauian, 2002):

$$Labour\ productivity = \frac{total\ output\ or\ total\ income}{total\ labour\ input}$$

In the context of this study, labour productivity is the output of a plant (or nation or industry) divided by the hours worked (summed for all employees), driving the efficiency of a process by minimising man-hours and maximising output. The international competitiveness of a company or the manufacturing industry in the case of this study is therefore heavily dependent on how productive the plant or industry is in relation to competitors (Sauian, 2002), as well as the cost of labour, for which unit labour costs can be measured. In this calculation, total compensation is used instead of hours worked. The general aim of manufacturing organisations facing international competition is to remain cost-competitive, so in an environment where low productivity is compensated for by low labour costs the

tendency would be to utilise manual labour over capital investment, as in the cases of India and China mentioned earlier (Batra and Khan, 2005).

2.2 Challenges facing South African manufacturing plants

The South African manufacturing sector is judged to be in decline according to key officially recognised measurements such as the Kagiso Manufacturing Purchasing Managers Index (PMI) (Lings, 2015), the World Economic Forum's (2015) Competitiveness index and Global Manufacturing Indices (Deloitte, 2013). According to a report that surveyed CEOs and senior executives in Manufacturing both worldwide and locally in South Africa, two lists of factors impacting competitiveness were identified (a global view and a local view), ranked according to importance (Deloitte, 2013). Respondents spread across manufacturing sectors, employee numbers, turnover and geography. The South African factors included "cost and availability of labour and materials", "local market attractiveness" and "energy cost and policies" which made up the top three competitiveness drivers respectively, while the global survey indicated "talent-driven innovation", "economic, trade, financial and tax system" and "cost and availability of labour and materials" in that order. Elaborating on these results, the report pointed out that one of the key issues in South Africa is that of labour costs increasing at a faster rate than productivity. Other issues mentioned in relation to this driver of labour costs and availability are "education, skills development, spatial development and community safety" (Deloitte, 2013).

Other issues indirectly impacting productivity in South Africa include discriminatory practices stemming from the Apartheid era and the effects of poverty and income inequality which significantly impacts utilisation of resource (McCarthy, 2005). The inability to transfer knowledge of production techniques and science into performance improvement with a low rate of research and development investment, the lack of investment in physical and human capital and underdevelopment of infrastructure are other key factors (McCarthy, 2005). It should be noted that the labour-related inefficiencies contribute to a vicious-cycle in which there is lower productivity that causes higher operating costs, leading to reduced foreign direct investment in South Africa's manufacturing sector (Deloitte, 2013).

The local manufacturing industry is dependent on local and export demand that is largely influenced by the cost-competitiveness of South African factories, who are largely price-takers in the international market, especially because of the country's inability to shift exports from basic to high-technology products (Alves and Edwards, 2005). One of the reasons for

this is the low investment in manufacturing research and development mentioned earlier, to commercialise production processes for higher-end products that may compete with selling propositions (or product performance dimensions) beyond cost (McCarthy, 2005). With the bulk of South African manufacturers producing basic or low-technology products, competition from countries with lower unskilled labour costs is stronger (Alves and Edwards, 2005). Another issue with the manufacturing product profile largely concentrated in resource-based products with limited diversification into medium technology and more skill-intensive products like vehicles and chemicals is that global demand is relatively weak when compared to high technology products (Alves and Edwards, 2005).

Factors that affect export profitability (mainly manufacturing costs) therefore constrain manufacturing export growth, such as real effective exchange rate, cost of utilities, cost of infrastructure and cost of labour (Alves and Edwards, 2005). Additional challenges to productivity during the tough economic conditions that South Africa is in (Lipton, 2015) includes the availability of capital to invest in technology and automation as firms come under increasing financial strain, as well as the weakening rand that hinders the ability to import equipment and raw materials (England, 2015). The hindered ability to import equipment due to the weaker rand is a notable challenge for manufacturers particularly because of their increased dependence on imported technologies (OxResearch Daily Brief Service, 2011).

Other structural barriers and perceptions of risk have caused a decline in investor confidence in South Africa, especially because generally their impression of South Africa's ANC-led government is that they are unwilling or unable to implement policies that will address these concerns (OxResearch Daily Brief Service, 2011). This view is also reflected in Moody's downgrade of South Africa's credit rating, with one of the key reasons being a lack of confidence in South Africa's current administration (the ANC government) (Natarajan, 2012). Despite efforts from the private sector to improve investor confidence, the view remains that government is not consistently pro-business due to the hostility sometimes shown toward business interests, such as the Wal-Mart/Massmart merger in 2011 (OxResearch Daily Brief Service, 2011). A study on factors deterring investment in South Africa also found "uncertainty concerning the administration, interpretation or enforcement of existing and future regulations" as a prominent deterrent of foreign investment (Venier, 2014, p. 64). Other prominent issues cited in Venier's (2014) study that discouraged investment in South Africa, includes infrastructure shortcomings with power and rail in

particular, as well as labour unrest. Reduced investment (due to lower confidence) in the country has negative direct and indirect impact on South Africa's manufactures because of the reduced capital availability and economic constraints (such as local and export demand).

The challenge therefore remains with local manufacturers to bring about performance improvement despite operating in an environment filled with the above challenges described, to improve cost-competitiveness in the global market.

2.3 South Africa's labour supply idiosyncrasies

Human capital in South Africa is often regarded as a constraint on the economy and particularly the manufacturing sector's productivity (Kleynhans and Labuschagne, 2012; Bhorat, et al, 2013; Go, et al, 2009). According to Kleynhans and Labuschagne (2012), the nature of labour supply quality and availability in South Africa is restrictive. They attribute this to poor workforce education levels and inflexible labour regulations that causes reduced labour mobility, difficulty for employers to terminate employment and additional costs in complying with labour regulations. According to the World Economic Forum (cited by Adcorp (2011)), labour laws and regulations in South Africa are the seventh most restrictive in a comparison of 139 countries. Other authors have noted that there is an increasing trend of industrial action and social unrest that employers face (Go, et al, 2009; Kleynhans and Labuschagne, 2012). Behavioural consequences of firms are noted in their tendencies to minimise permanent employees in favour of temporary labour and sub-contractors (Chandra, et al, 2001). These characteristics in South African labour relations are more common in large firms where bargaining is centralised, while less prevalent in smaller firms where the bargaining process is decentralised (Kleynhans and Labuschagne, 2012). The implication is that employment creation has a higher chance of thriving in small to medium enterprises. However, with 80 percent of the manufacturing sector made up of large firms (Statistics South Africa, 2015) this does not relieve the burden on South Africa's economy.

Another characteristic of the country's labour supply is the mismatch of skills supply and demand (Bhorat, et al, 2013). There is high availability of low and medium skilled workers as indicated by the high level of unemployment at 26.4% (Statistics South Africa, 2015, p. 4.11) comprised of people mainly in this category, while there is inadequate supply of higher skilled labour, hence unmet demand for higher skilled labour (Faulkner, et al, 2013). Moreover, in spite of the skills supply shortage, it is seen that the education system is not helping resolve this problem as it is not providing job-seekers with the necessary skills and

abilities to satisfy the requirements of the current business environment (Bhorat, et al, 2013, p. 17), hence perpetuating the vicious cycle. A key finding of the literature was a study in which it was concluded that "the level and quality of human capital in South Africa are insufficient to support modern industrial development" (Kleynhans and Labuschagne, 2012). It is precisely this view or experienced phenomenon that the current study aims to mitigate.

A recurring theme that can be seen in the literature reviewed that discusses challenges faced by the South African manufacturing industry is labour constraints in terms of high costs and low productivity (Deloitte, 2013; McCarthy, 2005; Alves and Edwards, 2005). This issue was highlighted further during the global recession in 2009 that saw significant contraction of economic activity (resulting in employment loss globally, including South Africa), however real wages in South Africa continued to rise in this period to further disjoint its relationship with productivity (McDonald, 2012). According to McDonald (2012), the misalignment between real wages and labour productivity reflects the impact of South Africa's framework of collective bargaining or trade unions which is seen as a large contributor to the weak link between wages and productivity, and manufacturers' inability to respond to business cycle fluctuations.

In concluding the views on South Africa's labour supply according to the literature reviewed, it is found that the workforce is generally a constraint on South African manufacturers' international competitiveness. The negative effect of labour supply on productivity is caused by the mismatch of skills supply and demand where there is high availability of low to unskilled labour with unmatched demand for greater skills that is partly attributed to the poor education system, inflexible labour laws and regulations that favour employees such that additional difficulties and costs are incurred by employers, as well as increasing events of industrial action and social unrest that directly and indirectly impacts economic and plant productivity.

2.4 Frameworks for implementing manufacturing improvement initiatives

Examples of manufacturing performance improvement initiatives (MPIPs) in the context of this study refer to implementation of Lean, continuous improvement and improvement of organisational culture or change management, all with the purpose of increasing productivity, quality or reliability of the production process. Various frameworks are suggested by studies such as Ahrens (2006) and Jozaffe (2006) on the basis of surveys and investigations into why manufacturing improvement initiatives tend to fail or lack sustainability in South Africa

versus other parts of the world such as Japan and Germany. Much of the literature is focused on Lean implementation, especially the literature on manufacturing improvement specific to South Africa, such as Vermaak (2008). Such literature generally overlaps with change management, changing organisational culture and continuous improvement, all relevant topics to this section of the literature review and is illustrated in the discussions that follow.

The evolution of continuous improvement (CI) was investigated by Bhuiyan and Baghel (2005) to provide a current state of how CI plays a part in various industries. The authors found that Lean manufacturing was the most popular CI programme through a comparative study of improvement programmes, although it was skewed toward the aerospace industry. Bhuiyan and Baghel (2005) concluded that it is difficult to achieve expected results of modern day CI programmes as it requires organisational changes at the various levels, breaking of traditional mind-sets of employees and applying specific efforts to sustain improvement. From their review they found that certain characteristics, organisational behaviours or processes are required to build or develop CI capability. Caffyn (1999) defines CI capability as "the ability of an organisation to gain strategic advantage by extending involvement in innovation to a significant proportion of its members". In their review of different frameworks Bhuiyan and Baghel (2005) refer to the framework developed by Bessant and Caffyn (1997) that outlines the characteristics of successful CI implementation, summarised in the Table 2 below.

Table 2: Characteristics of successful CI implementation (Caffyn, 1999)

1	Employees understand company objectives
2	Improvement activities by groups in the organisation are based on company objectives
3	Enablers of CI are continuously reviewed and adjusted if necessary
4	Company structure, systems and procedures are regularly assessed to ensure the CI system is supported
5	Managers actively demonstrate commitment to the CI programme at all levels
6	Employees are engaged proactively on CI throughout the company
7	Employees work effectively across internal and external boundaries at all levels of the organisation
8	Employees learn from personal and colleagues' positive and negative experiences
9	Individual and group learning is captured and deployed systematically

According to the study, the CSFs for sustaining a CI programme require the presence of a facilitator, a recognition system and complementary company policies. These are referred to as enablers of the CI system in the framework (Bhuiyan and Baghel, 2005). The authors in their review observe that CI elements often revolve around problem-solving tools, the simplification or standardisation of work, and performance monitoring, but point out that there is a lack of literature around hybrid CI methodologies. This study uses IWS, which is a hybrid of CI methodologies, as the improvement programme it focuses on.

Another study, that was undertaken internationally, was conducted to investigate the successful implementation of organisational change with regard to Lean principles, using the Toyota Production System (TPS) as the theoretical basis (Ahrens, 2006). The investigation of CSFs for sustainable Lean implementation also included an assessment of the change in philosophy and management system (including behavioural issues) that should accompany Lean tools. According to Ahrens (2006), from TPS philosophy the relevant CSF is "understanding the focus on people first" (p23), which is further defined as the development and role of teams and individuals being the key element of Lean production (the other five CSFs mentioned are related to specifics of the tools and business results). Ahrens (2006) uses the Henley Transformational Framework published by Henley Management College (Herbolzheimer, 2003) to categorise the CSFs found from various literature sources on Lean implementation, seeing that most authors provide a generalised list of factors rather than specific groupings. The CSFs given in Table 3 below are discussed by Ahrens (2006) to form a more comprehensive list of CSFs for Lean implementation.

Table 3: Critical factors for successful Lean implementation during the transformation process (Ahrens, 2006)

Henley Transformation Framework	Success Factor	Convis TPS Framework Category
Mobilise for change	**Stakeholder expectations**	
	- getting managers on board	**Management**
	- involving operators through empowered kaizen teams	**Philosophy**
	Lead the change	
	- strong top management leadership	**Management**
	- establishing a sense of urgency: find a lever by seizing the crises, or by creating one	**Management**
	- remove obstacles, i.e. managers who simply can not accept lean ideas	**Management**
	What culture?	
	- forming a powerful guiding coalition with managers acting as enablers	**Management**
	- building trust	**Philosophy**
	- customer first focus	**Philosophy**
Translate strategy into objectives and initiatives	**Determine the nature of change**	
	- convert from top-down leadership to bottom-up initiatives	**Philosophy**
	Define initiatives	
	- mapping the value streams	**Tools and Techniques**
	- applying standard tools and techniques: 5S, production smoothing, SMED, One Piece Flow, Takt time, Kanban	**Tools and Techniques**
	- convincing suppliers and customers to become lean	**Tools and Techniques**
	- planning for and creating short-term Kaizen wins	**Management**
	Establish performance parameters	
	- utilising policy deployment	**Tools and Techniques**
Design the change process	**Set implementation agenda**	
	- setting a kaizen agenda	**Tools and Techniques**
Align the organisation	**Organisational structure**	
	- reorganising the firm by product family and value stream	**Philosophy**
	- making the change stick: spread lean throughout the organization (engineering, quality, finance, HR, sales and marketing, purchasing)	**Philosophy**
	- internal customer - supplier relationships	**Tools and Techniques**
	Internal organisation	
	- reward and incentive system	**Tools and Techniques**
	Skills, capabilities and resources	
	- teaching lean thinking and lean skills to everyone	**Philosophy**
	- expert training and support: finding good change agents	**Management**
Organisational learning	**Build the learning organisation**	
	- striving for perfection	**Philosophy**
	Manage innovation/knowledge and training	
	- creating a lean promotion office	**Tools and Techniques**

Using a survey he asks managers experienced in Lean production to rate the factors and observed the results shown in Table 4 below. It is worth noting that in scoring each CSF Ahrens (2006) incorporates the respondents' experience in fulfilling or falling short of expectations during Lean implementation efforts in their respective organisations i.e. the opinions of those that experienced greater success counted more towards the score of each CSF.

Table 4: Critical management factors for successful Lean implementation (Ahrens, 2006)

#	Succes Factor	Score	% of Top Score
1	Board and top management actively driving and supporting change	232	89%
2	Strong leadership	223	86%
3	Getting shop floor commitment and employee trust	219	84%
4	Involving operators through empowered Kaizen teams	214	82%
5	Communication of the transformation process, goals etc.	209	80%
6	Finding a good change agent	208	80%
7	Beginning as soon as possible with an important and visible activity	205	79%
8	Top management presence and availability on the shop floor	200	77%
9	Enrolment of stakeholders for commitment, i.e. workers' council	196	75%
10	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value rather than to tell them what to do	196	75%
11	Managerial push (mandatory participation in workshops & training)	195	75%
12	Employee pull (employees fully understand the benefits on lean and improvement for themselves independent from management's support)	192	74%
13	Teaching lean thinking and lean skills to everyone	192	74%
14	Avoidance of any linkage between lean practices and layoffs	189	73%
15	Building internal customer - supplier relationships	189	73%
16	Elimination of managers, who would not cooperate in order to get commitment to lean	186	72%
17	Lean champions removing blocks in the organization	186	72%
18	Integrating suppliers and customers into the lean transformation	181	70%
19	Employees are free to allocate time to improvement (empowerment)	177	68%
20	Executives join kaizen events on a regular basis	176	68%
21	Resources freed up by productivity gains are reinvested into the search for still greater improvements	174	67%
22	Planning for and creating short-term Kaizen wins	174	67%
23	Converting from top-down leadership to bottom-up initiatives	173	67%
24	Availability of a crises that motivates the organization to change	170	65%
25	Demonstration of senior management impatience by regularly reviewing progress reports	166	64%
26	Striving for perfection	162	62%
27	Setting a Kaizen agenda for the organisation	157	60%
28	Creating a lean promotion office for organisation and training	156	60%
29	Utilising policy deployment	145	56%
30	Implementing a reward and incentive system for successful lean projects	143	55%

It can be seen that “mobilising for change” is considered one of the most critical areas of Lean transformation, as the top four CSFs fall into this category. Ahrens (2006) work may be summarised as highlighting that to successfully implement a Lean programme, the organisation should be trained such that everyone understands the philosophy; board members and top management should spend a significant amount of time in the rollout; the organisation needs a change agent that is experienced, very knowledgeable, engaging and inspiring, and fully dedicated to the transformation; an improvement agenda should be set that is effectively communicated and developed through operator involvement; the programme should begin as soon as possible with an important and visible activity, although rolling out at the appropriate speed for the organisation is important; support functions should be integrated through developing internal customer and supplier relationships.

In an empirical study conducted by survey method, Jozaffe (2006) investigating how to improve production efficiency at a pharmaceuticals manufacturing facility in South Africa using Lean manufacturing principles sought to determine how effectively the Lean system was implemented in relation to CI and productivity improvement.

His study found that although there was improvement in performance of over 50 percent reduction in lead times, the productivity gains in particular were not provided and so it could not be known exactly what factors to attribute this improvement to.

Jozaffe (2006) identifies shortcomings in implementation and made recommendations for improving implementation as shown in Table 5 below.

Table 5: Relevant outcomes of Jozaffe (2006)

Key reasons for shortcomings in the Lean system implementation:
Employees did not understand the systems, tools or the concepts
A perceived lack of training and understanding
The organisational structure
Organisational resistance to change
Total employee resistance
Recommendations to improve implementation:
Top management support should be established before communicating or beginning implementation
Support functions like production planning and the quality control laboratory should become part of the value stream
Each organisation is different and managers need to identify which elements of Lean will work best in their organisation
Each stage of implementation needs to have clearly defined expectations before fully rolling out the Lean system
Every organisation may have varying implementation requirements, particularly in light of the barriers or shortcomings found in this study

Vermaak (2008) conducted a study on CSFs based on a survey of experienced Lean practitioners and academics with Lean experience and found that CSFs are related to the role of people and leadership during Lean implementation, having an experienced facilitator and a strategic driver of Lean thinking. His indicators for successful implementation were cost reduction and customer satisfaction. He found that the majority of respondents (around 65 percent) did not experience positive results in their experiences, while about 30 percent had some elements of Lean successfully implemented. His study also found that executive

leadership is thought to have the most influence on successful implementation while trade unions had a 'limited positive impact' (Vermaak, 2008). These are provided in Table 6 below.

Table 6: Critical-success factors for sustainable Lean success (Vermaak, 2008)

HR Partnership with production management with involvement in issues and concerns of people on the shop floor
Executive or senior manager appointed to oversee the project
Experienced Lean facilitator or creation of Lean office dedicated to implementation
Leadership commitment to the Lean implementation
Lean as a strategic business objective
HR Policies that engage people and create buy-in
Organisational stability at each stage of implementation before advancing implementation
Discipline in adhering to standardised work
The organisation should be trained such that everyone understands the philosophy

Vermaak's (2008) findings emphasises the importance of the human factor in successful Lean implementation, which he termed "people or soft issues".

A more recent study looked at the relationship between organisational culture and effective implementation of Lean manufacturing, in an effort to develop a "theoretical Lean culture causal framework" (van der Merwe, et al, 2014). The study observes that companies may implement Lean techniques and processes but struggle to impact the organisational culture in a way that enables the full benefits of Lean implementation. The study analysed the role of leadership as a source of organisational culture change, defining leaders as management who possess the characteristics necessary to drive the organisational culture positively toward its vision. It divides management into three distinct levels, namely first-line management (generally team leaders or supervisors directly responsible for producing goods or services), middle management (responsible for turning the broad strategies, policies and direction into plans for first-line management to implement) and top management (executives responsible for setting overall strategies and direction). He argues that while both top and middle management play a critical role in changing organisational culture by identifying what activities to do and how to go about executing them, implementing a Lean culture is the focus of middle management (van der Merwe, et al, 2014).

Van der Merwe's et al (2014) framework produced in Table 7 below consists of 12 categories of activities that may form a theoretical guideline that a practitioner could follow.

Table 7: Summary of the Lean culture change causal categories and activities (van der Merwe, et al, 2014)

CATEGORY	ACTIVITIES
1. Justification	1.1 Identify the need for change 1.2 Develop a communication plan 1.3 Communicate the reasons for change
2. Vision	2.1 Create the vision 2.2 Develop the vision attainment plan 2.3 Communicate the vision and the plan
3. Successes	3.1 Identify areas where rapid success can be achieved 3.2 Plan interventions in these areas 3.3 Communicate the ensuing success 3.4 Link the success to the overall change
4. Structure	4.1 Identify structures that support the 'old way' 4.2 Develop alternatives 4.3 Replace inhibiting structures with enabling structures
5. Teamwork	5.1 Define team objectives based on the vision 5.2 Align objectives with skills required 5.3 Identify optimal team configurations
6. Training	6.1 Conduct a skills inventory 6.2 Identify the skills gap at all levels 6.3 Procure/arrange for appropriate training
7. Performance	7.1 Develop objectives and goals aligned with the vision 7.2 Identify critical processes 7.3 Define appropriate measures 7.4 Link incentives to objective-aligned performance
8. Communication and co-ordination	8.1 Develop a communication plan 8.2 Implement the plan 8.3 Co-ordinate all activities
9. Awareness	9.1 Identify the value streams 9.2 Decide what information is important to each value stream 9.3 Develop tools that create situational awareness
10. Engagement	10.1 Develop structures and behaviours aimed at engaging employees 10.2 Challenge employees 10.3 Create structures to harvest suggestions
11. Consistency	11.1 Develop a layered Lean leadership plan 11.2 Institutionalise the plan 11.3 Consistently make decisions aligned to the stated objectives
12. Accountability	12.1 Assign corrective actions to teams and individuals 12.2 Follow-up on completion commitments

To elaborate on the framework, 'Justification' is the first causal category of organisational culture change, given greater importance in the study because the acceptance of change in the organisation is thought to be proportional to the strength of the argument for change (van der Merwe, et al, 2014). Vermaak's (2008) study had a similar finding in which this point was embodied in 'strategic driver' as a CSF for Lean implementation.

A number of activities in the framework go hand-in-hand for successful organisational cultural change, such as a vision of where or what the company would like to be in response to the issues contributing to the argument for change, as well as a revised organisational structure and performance measure to support the attainment of the new vision and eliminate the shortcomings related to the previous structure (van der Merwe, et al, 2014). Development

or training interventions should upskill people to perform required duties in the new structure and close the gaps related to previous structural shortcomings (van der Merwe, et al, 2014). According to the study, if these elements are not integrated into company activities and supplemented by effective communication, the result could be counter-productive by unsettling employees that could lead to negative organisational impact.

The aforementioned framework was developed in two parts by van der Merwe et al (2014), the first part being categories one to seven, summarising the findings from literature on cultural change in organisations in a generic sense, while categories nine to twelve was added after narrowing down on Lean culture specifically. According to the authors, findings from other Lean practitioners were investigated including "Lean culture" by Berstem (2005), "Toyota culture" by Liker and Hoseus (2008), and "Creating a Lean culture" by Mann's (2005) (van der Merwe, et al, 2014), to ascertain the additional causal activities for Lean culture implementation.

In the framework of Table 7 above, the category of awareness refers to visual controls that reflect the performance indicators of manufacturing characteristics chosen to indicate the success of the Lean system, and should require input from employees to stimulate understanding and accountability, leading to a sense of ownership fundamental to a Lean culture (van der Merwe, et al, 2014). Employee engagement activities should be conducted by management in ways that communicate trust to employees in their ability to make valuable contributions to the organisation's success, and includes an additional element of interaction between management and employees closest to where the value is added, such as the shop floor (van der Merwe, et al, 2014). With leadership integral to the success of Lean culture implementation, part of the consistency category in van der Merwe's table is the standardisation of a portion of a manager's work day, over and above that for operators or lower level employees. This is to include all levels of management in Lean culture efforts and to create a standardised management system to ensure continuity in driving the organisation towards chosen Lean objectives, and through enforcing accountability of role players in each step of the process (van der Merwe, et al, 2014).

In summary, Van der Merwe's, et al (2014) theoretical framework is based on the premise that organisational culture is the effect of certain activities, and so the study recommends the aforementioned causal activities to successfully implement a Lean culture. The framework developed by Van der Merwe, et al (2014) may be used by practitioners or managers in

implementing manufacturing improvement initiatives. However it has not been tested in a South African manufacturing plant with proven results and various elements are generic to the extent that a significant amount of conceptual thinking and planning is required between steps, which could limit the effectiveness of the framework. This study attempts to fill this gap.

2.5 Outcomes of the literature review

From the literature review undertaken only a few studies could be found that are similar to those described above that are related to manufacturing in South Africa. Based on the findings of the studies, there is some indication that CI or manufacturing improvement initiatives that affect the ways of work or culture of a plant's workforce have a very low success rate both locally and internationally (in some cases little to no tangible cultural improvement). Following review of the literature, a positive cultural impact that can be directly related to a quantified labour productivity measure (continuous improvement philosophy e.g. Lean thinking) for a South African manufacturing plant could not be found and is therefore scarce.

It follows that a study in a large South African manufacturing plant that can demonstrate a measured productivity improvement, without capital-labour substitution, while incorporating the critical success-factors identified from the literature and confirmed through empirical methods, could make a contribution in providing a solution for advancing South Africa's agenda of economic stimulation through job creation in the manufacturing sector.

The next chapter considers the development of a CSF framework from the literature reviewed, which will then be tested in ABC SA's plant that has been selected for this study.

3. Development of the theoretical CSF framework

A thematic method of content analysis was used to develop the survey from frameworks reviewed in the literature (Wilkinson and Birmingham, 2003). The CSFs from literature were grouped according to themes, such that duplicates can be identified and removed, and consolidation done where CSFs are closely related. Table 8 below gives examples of how CSFs from the literature were grouped into themes, which will enable refining and consolidation. According to Wilkinson and Birmingham (2003), this flexible and dynamic approach to thematic analysis enables a higher quality and inclusive, comprehensive output. The type and number of themes were not fixed, as they were iterated throughout the data classification process. An element of relational analysis (Wilkinson and Birmingham, 2003) was used in grouping, combining and eliminating duplicate CSFs.

Table 8: Examples of attributing themes to CSFs from literature

Source	#	Critical success-factor	Theme
Bhuiyan and Baghel (2005)	13	Simplification or standardisation of work	Work standards
Bhuiyan and Baghel (2005)	14	Performance monitoring	Regular review of performance
Ahrens (2006)	15	Board and top management actively driving and supporting change	Leadership commitment
Ahrens (2006)	16	Strong leadership	Leadership commitment
Ahrens (2006)	17	Getting shop floor commitment and employee trust	Employee engagement

It should be noted that the number under column '#' is given arbitrarily to identify and subsequently track the particular CSFs as the CSFs in general are grouped and rearranged.

Table 9: Examples of grouping CSFs according to themes from literature

Source	#	CSF	Theme
Ahrens (2006)	34	Executives join kaizen events on a regular basis	Leadership commitment
Vermaak (2008)	56	Leadership commitment to the Lean implementation	Leadership commitment
Bhuiyan and Baghel (2005)	12	Employee recognition system	Recognition and reward
Ahrens (2006)	44	Implementing a reward and incentive system for successful Lean projects	Recognition and reward
van der Merwe et al (2014)	68	Link incentives to objective-aligned performance	Recognition and reward

Table 10 of CSFs was a key output of the literature review, developed through the process described above. The full list of CSFs from the literature reviewed, followed by the list of CSFs where duplicates are removed, and then followed by the list of CSFs with only those applicable to ABC's IWS implementation are provided in Table 23, Table 24 and Table 25 respectively of Appendix A. The authors or literature sources of each CSF are also maintained in the tables indicated to provide authenticity and traceability of the information extracted. The list of CSFs was analysed for applicability and relatability with regard to implementation and terminology respectively in developing the survey content in Table 10 below, to be used in ABC SA for this study. The questionnaire used to survey respondents was based on Table 10 and is provided in Appendix B, Table 26.

Table 10: CSFs from the literature review (theoretical framework)

#	Critical success-factor	Theme
1	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value rather than to tell them what to do	Bottom-up approach
2	Employee pull (employees fully understand the benefits of the programme for themselves)	Bottom-up approach
3	Employees are free to allocate time to improvement (empowerment)	Bottom-up approach
4	Resources freed up by productivity gains are reinvested into the search for still greater improvements	Bottom-up approach
5	Converting from top-down leadership to bottom-up initiatives	Bottom-up approach
6	Getting shop floor commitment and employee trust	Employee engagement
7	Involving operators through empowered Kaizen teams	Employee engagement
8	Enrolment of stakeholders for commitment, i.e. workers' council	Employee engagement
9	Avoidance of any linkage between the project and headcount reduction	Employee engagement
10	Employees understand company objectives	Employee engagement
11	Employees are engaged proactively on the project throughout the company	Employee engagement
12	Employees learn from personal and colleagues' positive and negative experiences	Employee engagement
13	Creation and communication of a vision attainment plan	Employee engagement
14	Linking successes experienced to the project	Employee engagement
15	Employee input for measuring performance to stimulate understanding and accountability	Employee engagement
16	Management demonstration of trust in employees' abilities	Employee engagement
17	Finding a good change agent or champions to remove blocks in the organisation	Key resource
18	Experienced and full time programme facilitator	Key resource
19	Organisational structure should enable the programme to succeed	Key resource
20	Executive or senior manager appointed to oversee the project	Key resource
21	Creation of a programme office or Lean promotion office to support implementation	Key resource
22	Board and top management actively driving and supporting change	Leadership

		commitment
23	Top management presence and availability on the shop floor, engaging with employees	Leadership commitment
24	Managerial push (mandatory participation in workshops and training)	Leadership commitment
25	Executives join kaizen events on a regular basis	Leadership commitment
26	Managers actively demonstrate commitment to the CI programme at all levels	Leadership commitment
27	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across boundaries at all levels of the organisation	Organisational integration
28	Integrating suppliers and customers into the transformation	Organisational integration
29	Employees have a shared set of cultural values that influence the way CI is incorporated in everyday work	Organisational integration
30	HR Partnership with production management with involvement in issues and concerns of people on the shop floor	Organisational integration
31	Employee recognition or reward system linked to the programme	Recognition and reward
32	Performance monitoring	Regular review of performance
33	Define measures for critical processes	Regular review of performance
34	Availability of a crises or strategic need that motivates the organisation to change	Strategic importance
35	Top management support should be established before communicating or beginning implementation	Strategic importance
36	Company structure, systems and procedures are regularly assessed to ensure the CI system is supported	Support system
37	Beginning as soon as possible with an important and visible activity	Timing and planning
38	Setting a Kaizen agenda for the organisation	Timing and planning
39	Management identification of which tools will work best in their organisation	Timing and planning
40	Target areas of rapid success first and communication of successes	Timing and planning
41	Organisational stability at each stage before advancing implementation	Timing and planning
42	Comprehensive training such that everyone has necessary skills and understands the philosophy	Training
43	Standardised portion of a manager's work day	Work standards
44	Standardisation of work for operators and lower-level employees	Work standards
45	Standardised management system	Work standards
46	Discipline in adhering to standardised work	Work standards
47	Individual and group learning is captured and deployed systematically	Work standards

The next chapter describes the methodology of the study, including how the framework developed above is utilised.

4. Methodology

Survey research is primarily used to determine certain characteristics in a population, and to an extent, ex post facto research where the characteristics have a relationship to performance trends already witnessed (Leedy and Ormrod, 2013). The core of this study is quantitative because it seeks to measure an objective reality, where there is a certain amount of related literature on continuous improvement, Lean implementation and improving workforce culture available and so the aim is to confirm or test theory (Leedy and Ormrod, 2013). This type of research is referred to as descriptive quantitative research, and is a study of insubstantial phenomena where no standard or ready-made measuring instrument exists (Leedy and Ormrod, 2013).

The first section broadly describes the research method, while the next section describes how data gathered from ABC SA is used to determine the impact of the MPIP. The third section provides the methodology of the survey instrument with details of the process followed from development of the instrument to determining the critical success-factors. The fourth section addresses reliability and validity of the overall study and of the survey instrument itself.

4.1 Method

The steps below outline the method followed in conducting the research, arranged in parts that correspond to the objectives.

1. To analyse the impact that the IWS programme has on manufacturing performance in ABC SA by reviewing trends of key performance indicators
    a. Weekly calculation and tracking of:
        i. overall equipment efficiency (OEE)
        ii. number of machine stops
        iii. throughput
    b. Trend analysis of OEE for the observation period versus previous months and years before implementation (machine stops is an indicator key to the IWS methodology and was therefore not tracked before implementation, while OEE is a measure of performance already in use at ABC SA); capital expenditure in manufacturing in recent years is also reviewed to identify OEE improvements through technology investments (capital-labour substitution)
2. To develop a framework of critical success-factors of the programme in ABC SA for successful implementation of manufacturing performance improvement initiatives

that may be applicable to the environment that other manufacturers in South Africa also face

a. Existing relevant frameworks of CSFs from literature were reviewed and consolidated into one list of CSFs from various sources (section 3)
b. Each CSF was assigned a theme to enable grouping as far as possible
c. Grouped CSFs were compared to combine similar concepts and remove duplicates
d. CSFs that were not applied in any form by ABC SA and could not be interpreted as applicable by any respondent were then removed
e. Terminology used in the CSFs was standardised and adjusted to align with terminology used in ABC SA where applicable, to improve respondents' understanding and the consequent quality of data received
f. The questionnaire's list of success-factors was assessed through a set of interviews with a sample of the population of ABC SA employees that was to eventually complete the survey. They were asked for approximately ten CSFs from their perspective, to be checked against the questionnaire's list of CSFs to confirm completeness and applicability of the success-factors in the survey.
g. Surveys were subsequently given to all employees of the organisation involved with the programme, to identify which success-factors are critical according to ABC SA.
h. Final analysis of the survey results indicated which success-factors were applied in ABC SA and which had a high impact on the results achieved in the study and the inherent cultural change – thus deemed critical success-factors, and the basis for the framework recommended by the study.

4.2 Determining the impact of MPIP in ABC SA

OEE (discussed in section 2.1) is measured along with total number of brand changes per week because of the inversely proportional relationship between the two attributes. A brand change causes OEE losses (increased planned downtime) due to changing machine parts, materials and setup time in order to produce a different brand. As the production line is considered agile (relatively high number of brand changeovers) by ABC SA, tracking brand changes is necessary with OEE reporting for a complete picture of performance.

Since throughput is not a measure specific to the IWS methodology, it was not measured weekly like the above KPIs, however it was measured monthly and included in a summary of KPIs. As discussed in section 2.1 of the literature review, throughput is an important performance dimension to the business as it measures the amount of product manufactured for a given time period, hence increasing throughput generally translates to reduced overheads.

A trend of the overall factory's OEE performance from 2008 to quarter three of 2015 is undertaken to depict past performance. This was preferred since the production line E chosen by ABC SA as the lead line for IWS implementation was commissioned only in 2014 hence a historical trend analysis for this line in particular is not applicable and so would not illustrate the impact of IWS.

Since efficiency or productivity trends can be misleading without a comparative picture of technology investment, automation or an indicator of capital-labour substitution as discussed in the introduction of the study, capital expenditure for ABC SA is taken into consideration alongside manufacturing efficiency to supplement the trend of OEE.

In summary, to determine the impact of the MPIP (IWS) in ABC SA's factory, the following information is provided:

- Weekly OEE and brand changes, average weekly number of stops, and throughput since implementation of IWS on Line E
- Past OEE performance of ABC SA's factory
- Planned versus actual capital expenditure in ABC SA's factory

4.3 Determination of critical success-factors

To determine the CSFs of the IWS programme in ABC SA, the views of personnel involved in the programme were sought with regard to what drove the success of the programme and their views were then analysed to produce a list of CSFs. To obtain their views, the simplest and most effective approach was considered to be through a survey using a questionnaire.

4.3.1 Survey population and participants

The target respondent group included all personnel in ABC SA directly involved in the MPIP. This includes operators of two production lines, technicians responsible for both lines,

Shift Leads (supervisors), the line structure responsible for this section of the factory including Line Lead, Process Lead and Maintenance Leads, Manufacturing Manager, IWS Programme Manager, and programme coaches. Everyone directly involved in the programme therefore contributed to the findings. This gave a total of 38 respondents, although one survey was returned late and therefore omitted. This means that the total population of the study was surveyed, eliminating the need for a representative sample. Therefore, the structure of the population consists of separate homogenous layers differing in size.

4.3.2 Survey development

There are three basic types of questionnaires, the 'mail survey', 'household drop-off survey' and 'group-administered questionnaire' (Wilkinson and Birmingham, 2003). The mail survey is a questionnaire delivered through post or email for respondents to complete and return in their own time. This method is advantageous in that one may collect large amounts of data, but is impersonal and may lead to misinterpretation of questions or content in the survey. The group-administered questionnaire is personally conducted by the researcher such that issues can be clarified and responses are received immediately. It ensures a high response rate and quality of data but may be time consuming to obtain large amounts of data. The household drop-off survey is a hybrid of the first two methods, allowing issues to be clarified through personal interaction by the researcher before the survey is completed, but does contain the risk of lower response rates and data quality. (Wilkinson and Birmingham, 2003)

For this research, it was decided to use the household drop-off survey for senior staff, including the line structure, supervisors and managers because they have access to email, while the operators and technicians would partake in group-administered surveys as greater clarity, explanation or translations may be required on the success-factors. This approach should maximise the response rate and quality of data received. The questionnaires were closed-ended and scaled using a Likert scale.

4.3.2.1 Content development

The content of the questionnaire was based on the theoretical framework of CSFs developed from literature in chapter 3.

4.3.2.2 Questionnaire design

The questionnaire was designed with the intention to shorten the list of CSFs as much as possible without losing any factors such that the questionnaire is user-friendly and can be

completed within 20 to 30 minutes, resulting in quality data from respondents who are able to concentrate on the questionnaire as much as possible (Wilkinson and Birmingham, 2003).

The survey maintains anonymity of respondents, and respondents are coded into four groups such that insights may be gained as to how the different perspectives of each group affected their view of CSFs. It is anticipated that analysis of the separated groups may provide additional insight. Respondents were required to indicate which group they belong to, from 'manager or supervisor', 'technician', 'operator Line E' or 'operator Line O'. The reason for the separation of operators between the two lines that have implemented the programme was that Line E, being the pilot line in ABC SA, is more experienced with IWS than Line O at the time of surveying (by approximately six months). With regard to technicians, the same group of technicians is responsible for both lines and therefore separate codes were not required.

A Likert scale is used for respondents to rate each success-factor on the level of impact it had on transforming culture or improving performance. To improve the quality of answers given, respondents were additionally asked the extent to which each success-factor was applied in ABC SA. This was to mitigate the risk of respondents rating a success-factor highly because they like the idea of the factor itself even though it wasn't a prevalent feature in ABC's implementation. This becomes useful during analysis as a check for consistency whereby factors that were deemed by respondents to be partially applied or not applied are given a lower impact on the results, regardless of the Likert rating given. The outcomes should therefore be success-factors considered to be prominent in ABC SA's implementation, and thought to have a highly positive impact on the results and/or culture.

4.3.2.3 Piloting the questionnaire

Piloting the survey is an important step before complete execution in order to confirm that the estimated completion time is within expected time limits, to check for potential misinterpretation, complexity or ambiguity in the survey content (Wilkinson and Birmingham, 2003), and in addition for this study, to affirm the completeness of CSFs presented to the respondents. The questionnaire was piloted to selected respondents comprising of one member of each subgroup of respondents, namely operator, technician, supervisor and manager. Usability and content validity (see section 4.4.2) were key concerns addressed through this step.

4.3.3 Survey analysis

This section describes the process followed in analysing survey responses. Data were captured in respondent groups (and subgroups in the case of operators) including demographics as previously indicated with the possibility that this may provide additional insight into the different perspectives of CSFs. This is known as response partitioning (Sincero, 2012). A detailed description of the process followed conducted in analysing the survey feedback is provided below.

4.3.3.1 Data collection and preparation

Before tabulating and analysing survey results it is necessary to ensure the data obtained is cleaned. This is done by checking if the data for all variables fall within the rules of the survey. There are two categories of variables in this study, namely the respondents and the success-factors (SFs), which will be treated separately. The first check was conducted on the 94 SF variables with 37 cases (responses). Each of the two categories was checked against the following rules:

- All items must be ranked from 1 to 5
- Maximum percentage of missing values of 20 percent (although SPSS recommends 70 percent, a stricter value of 20 percent was chosen because this equates to seven out of 37 cases without a ranking, which would bring the measure of central tendency for that SF into question with under 30 data points)
- Maximum percentage of cases in a single category of 95 percent (a violation of this rule would not cause item exclusion because the rankings are given by 37 different people but would be flagged as suspicious for further investigation)
- No duplicate items or cases

On this check no violations to the rules was found. All the SFs used were therefore considered acceptable and could be subjected to analysis

The second check was conducted on the 37 respondents as variables with 94 cases (two answers for each of 47 SFs). In this instance two violations were found against the rule of maximum percentage of cases in a single category. One operator from Line O and one manager gave a ranking of 5 for at least 84 of the 94 items, which raised suspicion with regards to the above respondents' credibility or understanding of the task among other

possible causes, resulting in an unacceptably high level of bias. These two respondents were therefore removed from the data, resulting in 94 items and 35 cases for further analyses.

Checking the data further, it was also found that three data points were missing out of all the surveys completed. Nevertheless, the impact in a set of 3,290 data points was deemed to be negligible and no method was used to fill in the missing data. The identification of CSFs as rated by ABC SA would not be hindered by this issue.

A test for unusual cases in the data was then conducted using SPSS to identify any cases that may warrant further examination. This procedure creates a model to identify clusters within the data and then isolates cases outside the clusters as anomalous cases (IBM, 2011). The benefit of this procedure with regards to the current study is that it also assigns cases to peer groups through its analysis of relationships between the variables that are the basis of the clustering process (IBM, 2011). In conducting the procedure the chosen outputs included peer group norms, anomaly indices by measuring how unusual a case is in comparison to the peer group, reasons for an unusual case and a summary of the cases processed. The cut-off anomaly index was chosen to be two as recommended by the SPSS tool, and the maximum number of peer groups to identify was set at four because this was the number of groups the respondents were split into. All 94 items were used as inputs in the variable analysis, with the outcomes shown in Table 11 below.

Table 11: Test for unusual cases summary

Case Processing Summary

		N	% of Combined	% of Total
Peer ID	1	17	48.6%	48.6%
	2	18	51.4%	51.4%
Combined		35	100.0%	100.0%
Total		35		100.0%

No anomalies were found in the 35 cases, which were statistically split into two peer identification groups. A graphical view of group clusters can be seen in Figure 3 below the case processing summary. This indicates that there is little value in analysing the CSFs in more than two respondent groups.

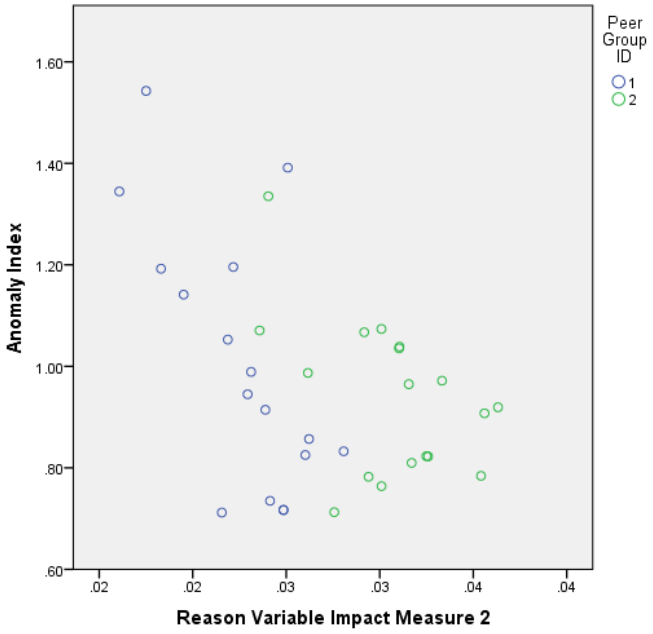

Figure 3: Clustering of peer groups

The interest then lies in how the respondents were grouped by the model. This can be seen in Table 12 below, organised according to the groups each respondent was identified to. It can be seen that there is no significant differentiation between operators from Line O or Line E as they are almost evenly split within each group.

Table 12: Peer group identification

Peer group ID 1			Peer group ID 2		
Respondent	Respondent group	Peer ID	Respondent	Respondent group	Peer ID
OpLineO	Op O	1	OpLineO_A	Op O	2
OpLineO_B	Op O	1	OpLineO_C	Op O	2
OpLineO_D	Op O	1	OpLineO_E	Op O	2
OpLineO_F	Op O	1	OpLineE_C	Op E	2
OpLineO_G	Op O	1	OpLineE_D	Op E	2
OpLineO_H	Op O	1	OpLineE_G	Op E	2
OpLineO_I	Op O	1	Tech	Tech	2
OpLineE	Op E	1	Tech_B	Tech	2
OpLineE_A	Op E	1	Tech_C	Tech	2
OpLineE_B	Op E	1	Tech_F	Tech	2
OpLineE_E	Op E	1	Tech_G	Tech	2
OpLineE_F	Op E	1	Tech_H	Tech	2
OpLineE_H	Op E	1	Manager	Manager	2
Tech_A	Tech	1	Manager_C	Manager	2
Tech_D	Tech	1	Manager_D	Manager	2
Tech_E	Tech	1	Manager_E	Manager	2

Manager_B	Manager	1	Manager_F	Manager	2
			Manager_G	Manager	2
Total		17			18

The key observation from this Table 12 is that all but one of the managers is grouped together in peer group two with majority of technicians. The implication is that in assessing the CSFs it would be worth noting the consolidated view of management and technicians compared to the operators. This could be expected when considering the characteristics of operators compared to supervisors, technicians and management in terms of education level, skills level and job grade. The latter group of employees will be referred to as 'senior staff' going forward. Table 13 below summarises the number of responses that were accepted for analysis after cleaning the data and grouping into two main categories.

Table 13: Summary of total responses accepted per category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Operator	19	54.3	54.3	54.3
	Senior	16	45.7	45.7	100.0
	Total	35	100.0	100.0	

4.3.3.2 Nature of the survey data

Before employing statistical procedures to gain insights to the data, it is important to understand the nature of the data at hand as this affects necessary conditions for using certain methods and compatibility of test methods. The following points describe the data as defined by Leedy (2013):

- Multi-group data (parallel sets of data about two or more groups)
- Both types of variables are discrete (Operator, technician, manager and rankings one to five)
- Ordinal data (the SFs are given numerical rankings but the magnitude between each ranking is not necessarily equal)
- Non-normal distribution of data (as is usually the case with ordinal survey data due to the ranking system) – the distribution is flat to skewed negatively (toward the upper end of the rankings)
- Nonparametric statistics – the data is not scaled and not normally distributed

- It should be noted that some parametric statistical procedures are robust enough for applicability to nonparametric statistics depending on certain assumptions or requirements that must be met

4.3.3.3 Analysing the survey for SFs

Due to the nature of the data discussed above (ordinal, non-normal distribution), the recommended measure of central tendency for overall ranking of each SF is the median (Leedy and Ormrod, 2013). However, the median is unable to serve the purpose of comparing SFs in the context of this study because it is an integer that can only be one of five numbers (according to the ranking scale). Instead, the arithmetic mean for each SF is used as the measure for differentiating the SFs. Using this approach a maximum score would be a mean of five for both degree of application and criticality of SF. Each mean result obtained per SF is converted to a percentage of the maximum score for both questions i.e. 4.20 out of a maximum of 5.00 is 84 percent.

It should be noted that two rankings were required by respondents for each SF to reduce bias and intended to prompt the respondent into thinking more objectively about each SF and the role it played at ABC SA. Scatter plots such as Figure 11 are used to compare the CSFs by showing the extent to which CSFs were applied in ABC SA (horizontal axis) as well as their criticality as viewed by respondents (vertical axis).

SFs placed in the top-right quadrant of the graph are those that are deemed high in criticality (green area) while also deemed applied to a high degree in ABC SA's implementation. These SFs are identified and deemed to be the CSFs forming the basis of the framework recommended by this study. Those SFs ranked in the lower part of the graph with low criticality are disregarded for the framework development going forward (red area). A framework is meant to provide a "broad overview, outline, or skeleton of interlinked items which supports a particular approach to a specific objective, and serves as a guide that can be modified as required by adding or deleting items" (Business Dictionary, 2015).

The CSFs identified are therefore split into two categories, primary and secondary. Both the mean and its corresponding percentage are displayed for each CSF. The primary CSFs are the top 10 according to criticality score and the second 10 are considered secondary (still important enough in the context of this study to be identified and reviewed). The decision to choose the top 10 CSFs is made to limit the amount of information included in the framework such that the end-user or practitioner is able to focus on the key areas. The second 10 are not

disregarded because the scores were closely grouped between the first and second 10 and it was decided that the value in the second 10 is still significant enough to include and discuss. Although this configuration is somewhat arbitrary, discretion is used to achieve simplicity of the framework and ensure end-users or practitioners are not deterred by something that seems complex or cluttered.

4.3.3.4 Analysing the survey for themes

It was discussed in section 3 how each SF was categorised by a theme. An aggregated analysis of the survey results according to the themes behind each SF in various ways provides further insights into where industry practitioners and managers should focus their efforts, as well as greater direction when planning improvement initiatives. Two types of graphs were developed to provide these insights, a pie chart such as Figure 14 and a bar graph such as Figure 16.

The pie chart of CSF themes for each respondent group takes the top 20 CSFs (such as Table 18: CSFs for total respondents) according to the themes assigned to each and shows which themes appear most frequently as a percentage, where a frequency of 20 would be 100 percent. This shows which themes the respondent group was most drawn to in answering the survey (even though they did not know which CSF belonged to which theme), indicating the areas that industry practitioners and managers should focus on when implementing initiatives like IWS. For example, if four out of the top 20 CSFs were categorised by the same theme, that theme would show as 20 percent in the pie chart. The theoretical framework of CSFs developed in section 3 is analysed in the same way, except themes represented by all 47 CSFs rather than just the top 20 were aggregated to form the pie chart in Figure 14 (as an analysis seeking relative importance was not conducted).

Because themes that were allocated to a greater number of CSFs would have a higher probability of showing up in the pie chart with a higher percentage, a bar graph was developed to indicate out of the frequency of a certain theme in the 47 CSFs, how many times did this theme appear in the 20 most critical CSFs for a given respondent group. This is to highlight for example a theme ‘A’ with only three CSFs represented in the theoretical framework of 47 CSFs, yet all three CSFs were ranked in the top 20. While a theme ‘B’ may have had eight CSFs in the total of 47, yet only three were ranked in the top 20. Theme ‘A’ would have 100 percent representation in the bar graph like Figure 16, while theme ‘B’ just 38 percent.

4.4 Reliability and validity

This section discusses the theory of reliability and validity related to this research, beginning with internal and external validity. Validity and reliability of the measuring instrument itself (the survey) is then discussed including measures taken to enhance and assess these attributes, which are critical in giving the study credibility and promoting its value.

4.4.1 Internal and external validity

Validity refers to the extent or degree to which a measurement tool performs the measurement it is designed for (Biddix, 2009). A researcher can ensure internal validity by taking precautions to eliminate noise or all other possible explanations for the results observed other than the variables that are part of the study (Leedy and Ormrod, 2013). The following are ways that internal validity in the current study was addressed:

- Although the shop floor personnel were aware that the study was being conducted, the survey was packaged as part of the performance improvement efforts that form part of the business's standard agenda and therefore the measurements may be considered to have been unobtrusive (from an ethics perspective ethics clearance was gained before undertaking the research)
- The MPIP and study began after the factory's annual wage negotiations that concluded in March, and therefore possible union influences on shop-floor performance is considered to have been minimal and negligible if any
- Triangulation is incorporated into the research design where multiple sources of data are used in the observations made, such as document review of actual production performance and conducting a survey to gather information on the same event

External validity of research is its applicability to generalised contexts apart from the particular situation of the study itself (Leedy and Ormrod, 2013). As this is a single case study, generalizability cannot be claimed. Nevertheless, following Yin's (2013) argument, there are attributes of the firm selected (i.e. ABC SA) that suggest that the outcomes of this study are repeatable to other manufacturing firms in South Africa, as observed below.

ABC SA's factory may be considered a microcosm of the South African manufacturing environment for the following reasons: The social characteristics and challenges are similar to those facing most factories in the country. This is a fairly safe assumption to make seeing that it is a large organisation with around 1000 people walking in and out the premises each

day (ABC, 2015), with workforce demographics similar to the country's workforce population in manufacturing. The ratio of black to coloured to Indian to white employees of 16:5:1:5 according to Stats SA's report (Statistics South Africa, 2015) is closely mirrored in ABC SA. South Africa's issues, trends, challenges and moods are likely to manifest themselves in this work environment with a diverse workforce that closely mirrors that of the country and hence in a manner representative of the country. In addition, there is strong trade union presence, with FAWU (Food and Allied workers Union) enjoying strongest recognition in the factory, which is a leading affiliate of COSATU (Congress of South African Trade Unions) (ABC, 2015). It is common knowledge that trade unions are one of the biggest role-players in South Africa's economy and especially manufacturing and industrial sectors.

The staff of ABC SA vary in education levels similar to the South African workforce characterised in the literature of section 2.3, where operators have basic education (matric) or less if they have worked in the company for many years and technicians and managers have some form of tertiary qualification (ABC, 2015). Labour sources for the factory include predominantly the local nearby township and less predominantly the main city and surrounding areas, which is a similar situation for other major manufacturers in the country. There is also a very small expatriate group occupying certain senior management roles, as is the case in most multinational organisations (ABC, 2015).

Further, Deloitte (2013) did a survey of member companies of the Manufacturing Circle in which respondents were classified in various ways to provide a picture of South Africa's manufacturers. From the survey and considering size by number of employees, 20 percent of companies are bigger than ABC SA and 80 percent of the manufacturing sector is made of large enterprises (in which ABC SA falls); by turnover ABC SA is within the top 7 percent of manufacturers due to high value-density of the manufactured product; and 34 percent of the respondents were also global or multinationals (just like ABC SA), with 51 percent South African only and 15 percent Pan-African. (Deloitte, 2013)

It can be seen in the above points that ABC SA has several aspects that favour it to be considered a microcosm of South Africa's manufacturing environment, as it is representative of the manufacturing environment in so many ways. Although it is on the higher end in terms of financial resources when compared to most manufacturers in South Africa, this study is focused on labour productivity improvement without heavy capital investments, and so the fact that ABC SA's industry makes relatively more money not relevant to the study. In

addition, ABC SA is exposed to the same internal, external and environmental influences such as shortage of skilled labour, more cost-competitive international factories and inflexible labour regulations respectively, as other manufacturers in the country.

4.4.2 Validity of the survey

There are four basic types of instrument validity according to Leedy and Ormrod (2013), namely face validity, content validity, criterion validity and construct validity.

Face validity is simply the extent to which the instrument looks or seems as if it will obtain required results correctly and the views or judgment by a panel of experts could be used to assess face validity of the survey, however because it is completely subjective in nature, this is not accepted as a dependable indicator (Leedy and Ormrod, 2013). Face validity in this study was addressed in piloting of the survey with relevant personnel in ABC SA.

Content validity refers to the appropriateness of the content in the survey in assessing the subject-matter of the study (Biddix, 2009) i.e. does the survey items adequately cover the topic of CSFs for manufacturing performance and cultural improvement. Content validity in this study is addressed by firstly reviewing relevant literature and ensuring the list of CSFs drawn as the basis of the survey is comprehensive enough, and then conducting interviews with a sample of participants to obtain their views of CSFs to compare and augment those listed in the survey. As the CSFs can be rephrased in a number of ways, aligning the terminology to that used in ABC SA and piloting the survey with the same sample group to reduce risks of misinterpretation, complexity and ambiguity also improves validity.

Criterion validity correlates instrument results with another related measure or criterion of interest (Phelan and Wren, 2005) – the validity of this study is further enhanced by the improved manufacturing performance observed through implementing the IWS programme (OEE, throughput, stops), indicating that the CSFs as viewed by ABC SA are more meaningful than the views of participants that have not experienced as much success.

Construct validity is the extent to which there is a correlation between measures of the same trait or construct (Leedy and Ormrod, 2013). Statistical assessment of content validity will be done using factor analysis.

Content validity was enhanced through a pilot study consisting of interviews with three key personnel of ABC SA to obtain their unconstrained and unprompted opinion of CSFs to ensure the comprehensiveness and applicability of the list before administering the survey.

The outcome of this procedure is shown in Table 14 below. The column 'CSF already listed' refers to the CSF identification number that already includes the idea put forward by the interviewee. A number in this column therefore means that no further augmentation of the CSF list is required to incorporate the idea. The column 'augmentation/addition to list' indicates which CSF identification number will incorporate it by augmenting that particular CSF or creating a new one altogether.

Table 14: Pilot-test outcome for content validity of the survey

Name	Role	CSFs provided by interviewees	CSF already listed	Augmentation /addition to list
NM	IWS Programme manager	Leadership buy-in	18	
		Dedicated line structure to support the project	16	
		Discipline in following the process	42	
		Formalised training for each process	24	
		Continuous coaching of gaps in process	1	
		Reliable data	Not covered	18
		Visual management around processes (e.g. CLs)	Not covered	45
		Visibility created in the factory (internal communications)	10	
		Senior managers/executives attending process-related meetings	20	
		Commitment of line structure to the process	6	
		KPIs reviewed daily	33	
		KPIs are simple and relatable for shop floor	33	
		Clear vision communicated before deployment	9	
		Financial investment to ensure success	Not covered	19
		Level of detail analysed on a daily basis	Not covered	18
NE	Manufacturing manager	Leadership presence on the floor	19	
		Discipline across all levels, especially line structure level	43	
		Clear vision (CBN, etc.)	9	
		Empowering shop floor to be able drive improvements	7	
		Measuring and reviewing KPIs	33	
		Structured way of making improvements (standardisation)	25	
		Addition of leading indicators of KPI (MTBF leads OEE)	Not covered	36

BN	Operator	Top-down communication of implementation	36	
		Continuous coaching until everyone understands	1	
		Simple and clear KPIs	33	
		Clear work standards	41	
		Employees motivated, aligned vision	28	

It can be seen above that 27 CSFs were provided by three interviewees ranging from the Manufacturing Manager (senior or executive manager in charge), the IWS Programme Manager (project manager responsible for managing implementation and coaching for the factory), and operator on the pilot production line. Of this list, the content of 22 CSFs (81 percent) was covered by the list from the literature (fourth column of Table 14), and five CSFs were new, requiring four additional SFs to be added to the survey items (‘reliable data and ‘level of detail analysed on a daily basis’ was combined as CSF 18 on the revised survey).

During this pilot stage there was exclusion of two CSFs from the original list obtained from the literature. Another two CSFs were combined into other CSFs as the ideas were very similar and the benefits of a shorter survey outweighed that of having these two additional standalone items i.e. “Creation and communication of a vision attainment plan” was combined with “employees understand company objectives” to form a new CSF “Employees understand company objectives through a clearly communicated vision”. The CSFs that were however completely excluded were:

- Avoidance of any linkage between the project and headcount reduction
- Creation of a programme office or Lean promotion office to support implementation

The first CSF was discarded due to the sensitivity of the issue. Seeing that the shop floor were key respondents in the survey, it was decided to exclude the idea of headcount reduction to avoid risk of unsettling employees. The second CSF was excluded because ABC SA simply did not create an office specifically for the programme, but did assign a programme manager or facilitator which relates to another CSF that was kept as a survey item. In this way, the original content compiled from the literature was modified to suit the local conditions at ABC SA. This ensured that content was valid for application within ABC SA.

An attempt was made to assess construct validity using factor analysis as a test of underlying structure but this was not successful due to the facts that the data is not interval or ratio

(scaled) in nature, and does not exhibit a bivariate normal distribution as required by the factor analysis method (IBM, 2011). This was expected to some extent because one of the steps in developing the survey items involved removing duplicate SFs with a criterion that items similar in idea or construct should not be repeated. The themes allocated to each SF are much broader than a single construct.

4.4.3 Reliability of the survey

Reliability is the extent or degree to which a measurement tool produces stable and consistent results (Phelan and Wren, 2005), or how consistently a tool measures what it is supposed to measure. There are four main methods of determining instrument reliability. These are observer or inter-rater reliability, test-retest reliability, equivalent forms or parallel forms reliability and internal consistency reliability. Researchers do not typically apply all four methods and only one is generally selected for determining reliability.

Observer or inter-rater reliability is the degree of consistency in answers from different observers (Biddix, 2009), or the extent to which two or more people give the same judgement or ranking to the same characteristic or product (Leedy and Ormrod, 2013). It may be assessed by correlating the rankings given by the different respondents where the respondents are the dependent variables.

Test-retest reliability compares results of the same tool for the same participant or participant sample at separate points in time, to evaluate stability (Phelan and Wren, 2005). A test-retest reliability procedure could not be conducted due to impracticalities such as the anonymity promised to survey respondents to minimise bias.

Equivalent-forms or parallel-forms reliability is the extent to which different versions of the same instrument yield similar results (Leedy and Ormrod, 2013). This will not be statistically tested in this study due to the impracticality of producing two questionnaires of identical constructs with a large number of items as well as the issue of anonymity mentioned above.

Internal consistency reliability is the extent to which all items within a single instrument yield similar results (Leedy and Ormrod, 2013). Being the most crucial form of reliability in this study, it was the one adopted and was statistically tested using Cronbach's alpha.

Cronbach's alpha is the most common single summary statistic that indicates the reliability of a survey (IBM, 2011). This coefficient is used for multi-number rating scales such as the current survey in question (Leedy and Ormrod, 2013). Table 15 below provides a guideline to

how Cronbach's alpha values could be interpreted with regards to the reliability of the measuring instrument.

Table 15: General guidelines for reliability coefficients (IBM, 2011)

Reliability coefficient value	Interpretation
.90 and up	Excellent
.80 - .89	Good
.70 - .79	Adequate
below .70	May have limited applicability

It is a descriptive statistics function for inter-item correlations, where the procedure performs reliability analysis for the success-factors (SFs), treating both answers to each SF as separate variables (total of 94 items). The output provides a case processing summary, reliability statistics and the inter-item correlation matrix. This can be referred to as an indicator of internal consistency reliability.

5. Results and analysis

Results of the study are presented in this chapter, first from analysing the performance records at ABC SA, followed by the CSF results of the survey.

5.1 Impact of MPIP in ABC SA

This section presents productivity-related results from implementation of IWS in ABC SA to quantify the impact of the programme on manufacturing performance.

Figure 4 and Figure 5 below and Table 16 indicate key performance results for the duration of the study on the pilot production line in ABC SA including OEE and average number of stops per day and throughput. Note that baseline (BL) results at the start of each graph indicate the average weekly performance of the total month's data before implementation of the programme.

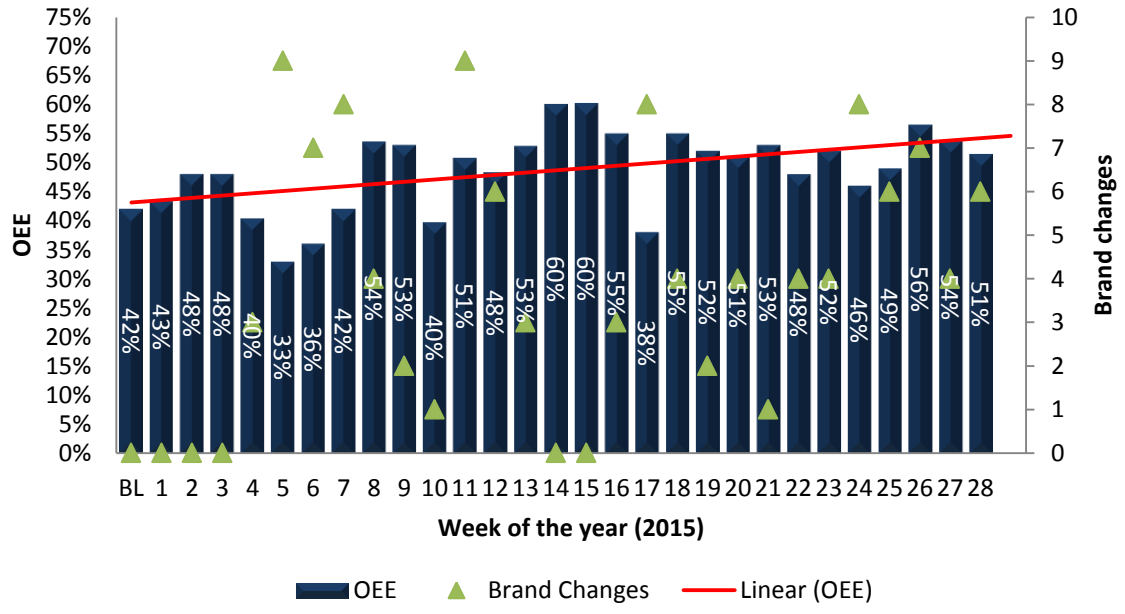

Figure 4: Weekly OEE and brand changes since IWS implementation (ABC, 2015)

Figure 5 below shows the average number of times the production line stopped per day for the given week from baseline to 28 weeks from implementation.

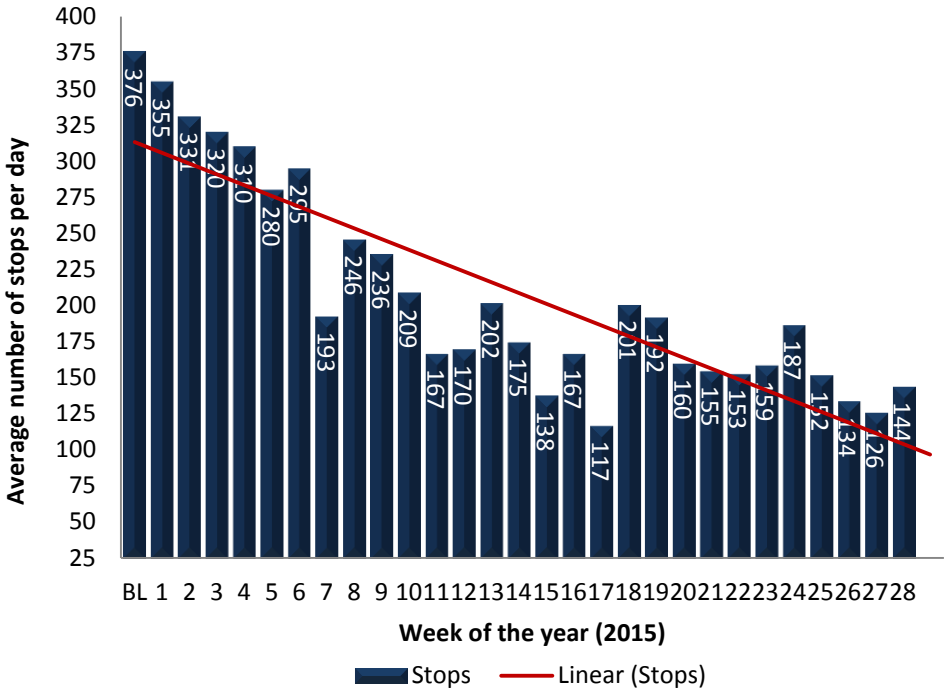

Figure 5: Weekly average number of stops per day since IWS implementation (ABC, 2015)

Trend lines of the above graphs, with their corresponding equations for OEE and stops are shown in Figure 6 below.

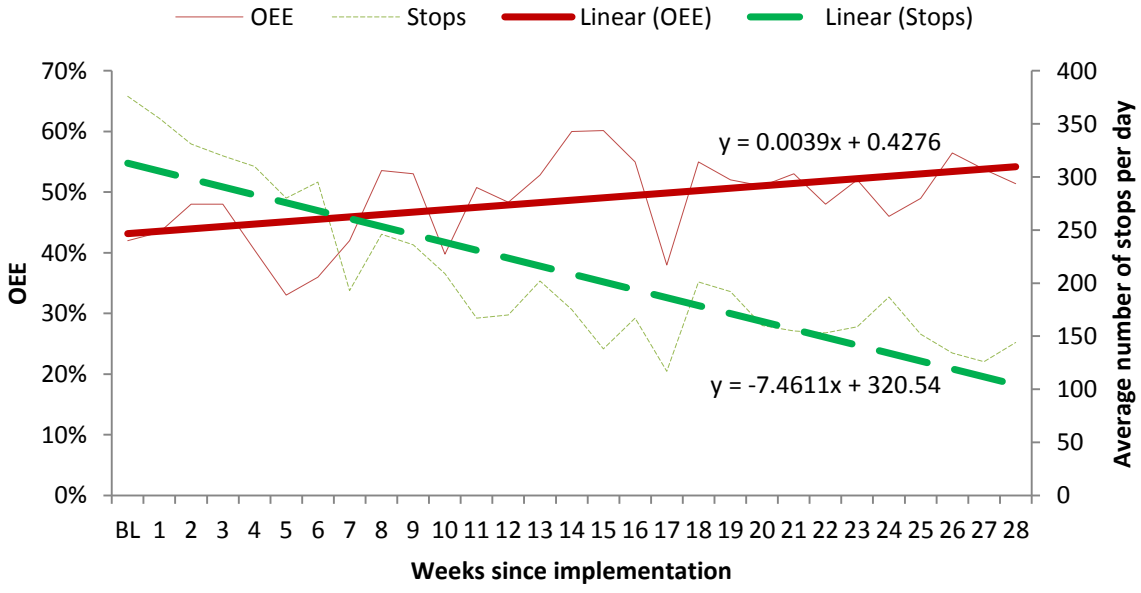

Figure 6: Trends of OEE and Stops for Line E in ABC SA (ABC, 2015)

Table 16 below summarises the trend of key performance results for the 16 week implementation period (time taken to implement the IWS methodology on a single

production line), including a column showing percentage improvements per KPI from 'baseline' to 'weeks 13-16 average'.

Table 16: Analysis of KPIs since IWS implementation (ABC, 2015)

Line E	Baseline	Weeks 1-12 average	Weeks 13-16 average	Improvement
OEE (%)	42	45	54	29%
Average stops per day (#)	376	235	150	60%
Throughput (volume)	4.61	4.73	5.42	18%

Implementation of IWS began in April (quarter two) of 2015, with roll out onto three lines out of 27 by quarter three and a number of IWS principles partly applied throughout the factory in this period (ABC, 2015). This background information relates to Figure 7 below that shows OEE results from 2008. This is followed by a graph in Figure 8 of capital expenditure in the factory year-on-year (planned shown as the blue left-hand side bar of each year, with actual on the right in red and crosshatched).

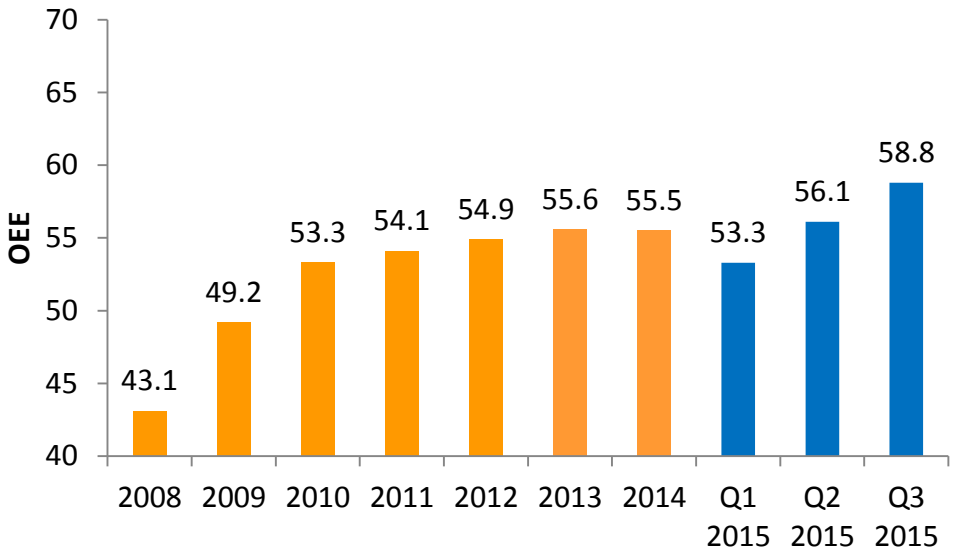

Figure 7: Historical OEE Trend for ABC SA (ABC, 2015)

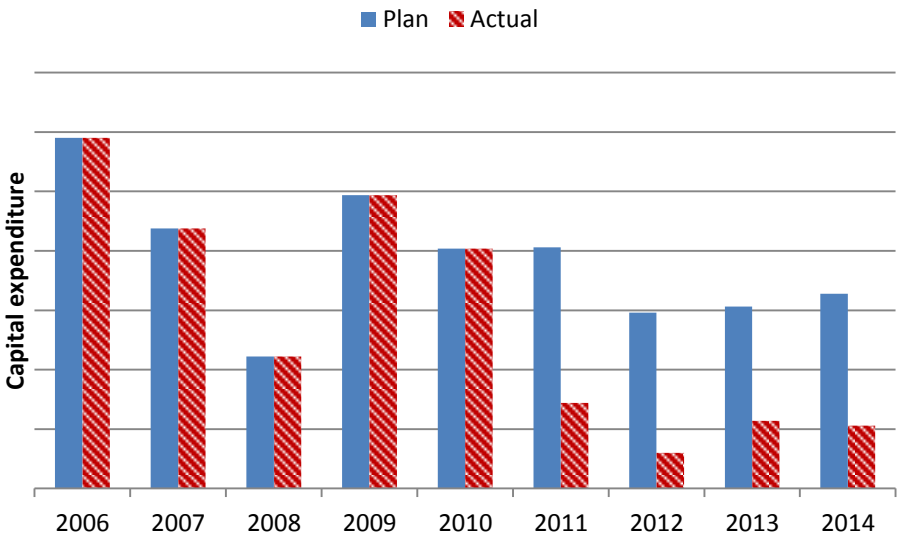

Figure 8: Capital expenditure in ABC SA

Comparing trends of OEE and capital expenditure shows a particular relationship in the graph of Figure 9 below. Figure 10 then shows year-on-year OEE improvement from 2011, which is the period where capital expenditure decreased significantly. The behaviour of the graph is explained in section 6.1.

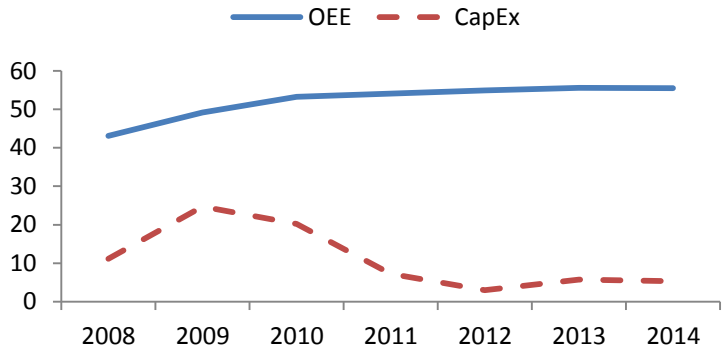

Figure 9: Comparing OEE and Capital Expenditure

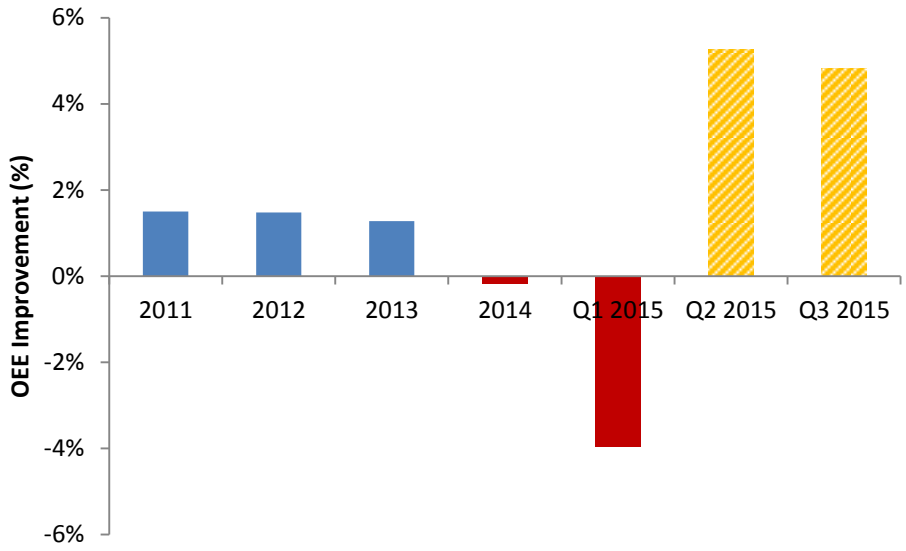

Figure 10: OEE Improvement in ABC SA from 2011 till quarter 3 2015

5.2 CSFs of the MPIP implementation in ABC SA

As described in section 4.1, this section presents the outcomes of applying the framework developed in Chapter 3 that formed the basis for the questionnaire used in the survey. Results of the survey are shown after rigorous analysis of the data.

5.2.1 Survey results – CSFs

Before presenting results of the survey and identifying the CSFs of the MPIP implemented, it is necessary to provide assessment results for the reliability of the survey as a measuring instrument, discussed in section 4.4.3.

Table 17: Internal consistency reliability of the survey

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.984	.984	94

In light of the recommended Cronbach alpha minimum value for acceptable reliability (0.7), the above test with the coefficient value of 0.984 gives the survey a relatively high level of credibility from an internal consistency reliability perspective.

For each respondent group (total respondents, operators, and senior staff) a graph of results for both questions of the survey is shown below, namely criticality and degree of application in ABC SA for each SF. This is accompanied by a table of the top 20 CSFs according to the survey results, as explained in section 4.3.3 of the Methodology.

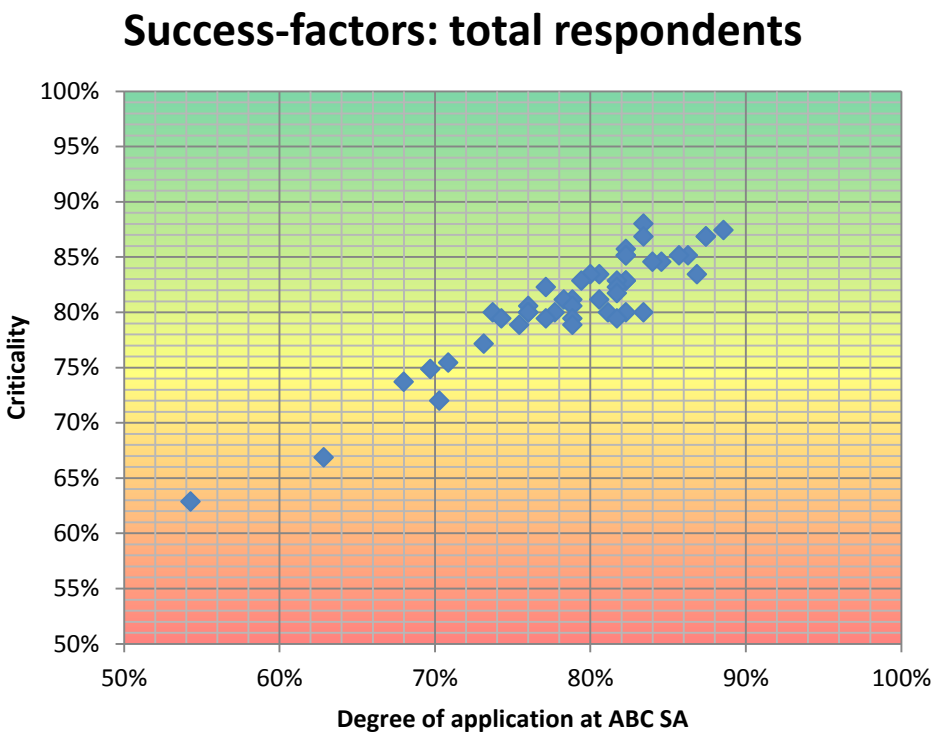

Figure 11: Comparing SFs - Total respondents

Table 18: CSFs for total respondents

Ranking	Success-factor description	Application		Criticality	
1	Top management joins improvement events/meetings on a regular basis	4.17	83%	4.40	88%
2	Addition of leading KPIs that operators understand (stops, MTBF)	4.43	89%	4.37	87%
3	Clearly defined measures for key performance areas, with regular monitoring	4.37	87%	4.34	87%
4	Targeting areas of rapid success first	4.37	87%	4.34	87%
5	Clearly defined measures for critical processes, with regular monitoring	4.17	83%	4.34	87%
6	Management identification of which tools will work best in their organisation	4.11	82%	4.29	86%
7	Financial investment to support programme success	4.31	86%	4.26	85%
8	Setting and communicating an improvement agenda and roll-out plan	4.29	86%	4.26	85%
9	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	4.11	82%	4.26	85%
10	Standard work with visual management	4.11	82%	4.26	85%

11	Standardised management system	4.23	85%	4.23	85%
12	Managers actively demonstrate commitment to the programme at all levels	4.20	84%	4.23	85%
13	Executive or senior manager appointed to oversee the project	4.34	87%	4.17	83%
14	Discipline in adhering to standardised work	4.03	81%	4.17	83%
15	Organisational structure should enable the programme to succeed	4.00	80%	4.17	83%
16	Reliable data enabling regular detailed analyses	4.11	82%	4.14	83%
17	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)	4.11	82%	4.14	83%
18	Comprehensive training such that everyone has necessary skills and understands the philosophy	4.09	82%	4.14	83%
19	Standardisation of part of a manager's work day	3.97	79%	4.14	83%
20	Employees learn from personal and colleagues' positive and negative experiences	4.09	82%	4.11	82%

The same results are presented below as sub-components of the overall results shown above. The first is the collective view of operators separately, and the second is that of senior staff (technicians plus managers). The survey results for each question (application and criticality of each SF) were also reviewed in terms of standard deviation to identify SFs with a notable spread of views. It was found that the spread of responses was generally not significant and would not affect the survey outcomes, with only five SFs for 'criticality' and 11 for 'application' exhibiting standard deviations marginally greater than one, out of the total of 47. Table 30 of standard deviation for each SF is provided in Appendix D: Spread of CSF rankings.

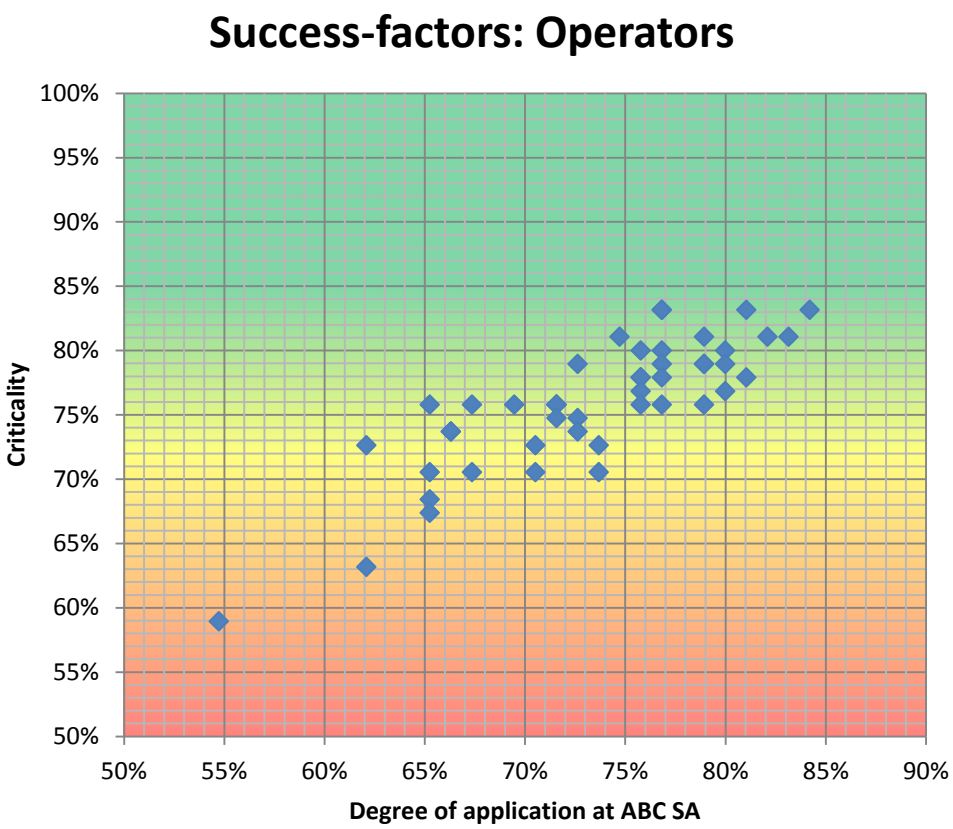

Figure 12: Comparing SFs – Operators

Table 19: CSFs for Operators

Ranking	Success-factor description	Application		Criticality	
1	Addition of leading KPIs that operators understand (stops, MTBF)	4.21	84%	4.16	83%
2	Management identification of which tools will work best in their organisation	4.05	81%	4.16	83%
3	Top management joins improvement events/meetings on a regular basis	3.84	77%	4.16	83%
4	Setting and communicating an improvement agenda and roll-out plan	3.84	77%	4.16	83%
5	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	4.16	83%	4.05	81%
6	Targeting areas of rapid success first	4.11	82%	4.05	81%
7	Managers actively demonstrate commitment to the programme at all levels	3.95	79%	4.05	81%
8	Clearly defined measures for critical processes, with regular monitoring	3.74	75%	4.05	81%

9	Clearly defined measures for key performance areas, with regular monitoring	4.00	80%	4.00	80%
10	Standard work with visual management	3.84	77%	4.00	80%
11	Comprehensive training such that everyone has necessary skills and understands the philosophy	3.79	76%	4.00	80%
12	Top management presence and availability on the shop floor, engaging with employees	4.00	80%	3.95	79%
13	Involving operators through empowered task teams to analyse specific issues and make improvements	3.95	79%	3.95	79%
14	Financial investment to support programme success	3.95	79%	3.95	79%
15	Company systems, policies and procedures are regularly assessed to ensure the programme is supported	3.84	77%	3.95	79%
16	Organisational structure should enable the programme to succeed	3.63	73%	3.95	79%
17	Executive or senior manager appointed to oversee the project	4.05	81%	3.89	78%
18	Employees understand company objectives through clearly communicated vision	3.84	77%	3.89	78%
19	Resources freed up by productivity gains are reinvested into the search for still greater improvements	3.79	76%	3.89	78%
20	Employees are engaged proactively on the project throughout the company	3.79	76%	3.89	78%

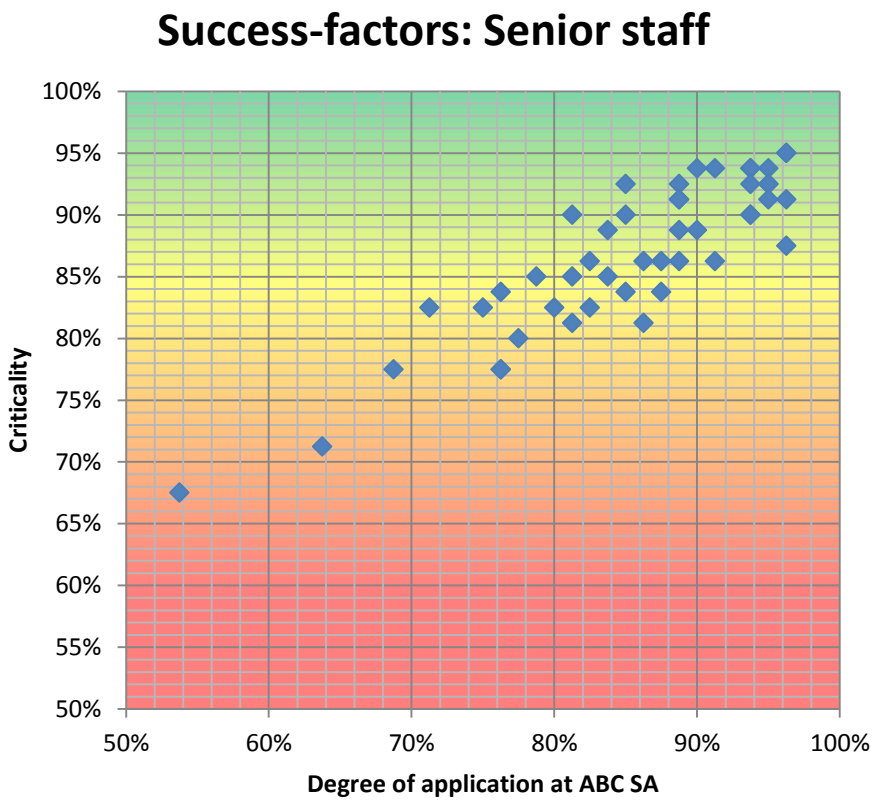

Figure 13: Comparing SFs – senior staff

Table 20: CSFs for senior staff

Ranking	Success-factor description	Application		Criticality	
1	Clearly defined measures for key performance areas, with regular monitoring	4.81	96%	4.75	95%
2	Reliable data enabling regular detailed analyses	4.81	96%	4.75	95%
3	Standardisation of work for operators and non-management employees	4.75	95%	4.69	94%
4	Clearly defined measures for critical processes, with regular monitoring	4.69	94%	4.69	94%
5	Targeting areas of rapid success first	4.69	94%	4.69	94%
6	Top management joins improvement events/meetings on a regular basis	4.56	91%	4.69	94%
7	Standardised management system	4.50	90%	4.69	94%
8	Financial investment to support programme success	4.75	95%	4.63	93%
9	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)	4.75	95%	4.63	93%

10	Addition of leading KPIs that operators understand (stops, MTBF)	4.69	94%	4.63	93%
11	Converting from top-down leadership to bottom-up initiatives	4.44	89%	4.63	93%
12	Discipline in adhering to standardised work	4.25	85%	4.63	93%
13	Standardisation of part of a manager's work day	4.81	96%	4.56	91%
14	Top management actively driving and supporting change (with buy-in established before implementation)	4.75	95%	4.56	91%
15	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value (operators and technicians) rather than giving instructions	4.44	89%	4.56	91%
16	Standard work with visual management	4.44	89%	4.56	91%
17	Executive or senior manager appointed to oversee the project	4.69	94%	4.50	90%
18	Employees learn from personal and colleagues' positive and negative experiences	4.69	94%	4.50	90%
19	Linking successes experienced to the project (celebrating successes)	4.25	85%	4.50	90%
20	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	4.06	81%	4.50	90%

5.2.2 Survey results – CSF themes

The survey, based on the theoretical framework developed, had 47 SFs that were categorised into 11 themes and depicted in the pie chart of Figure 14 below (the theme 'support system' with one CSF was combined with 'organisational integration'). The pie chart represents information derived from the literature (theoretical framework developed in section 3) with regards to the CSFs for implementing a large-scale MPIP that aims to influence shop-floor culture and thinking. Results according to the total group of survey respondents in ABC SA with regards to IWS implementation is shown in Figure 15. The bar graph in Figure 16 shows the percentage of CSF themes in the top 20 CSFs out of the total number of themes in the survey for the total group of respondents. The same analyses were conducted for the respondent groups of operators (Figure 17 and Figure 18) and senior staff (Figure 19 and Figure 20). Greater explanation of below figures is provided in section 4.3.3.4.

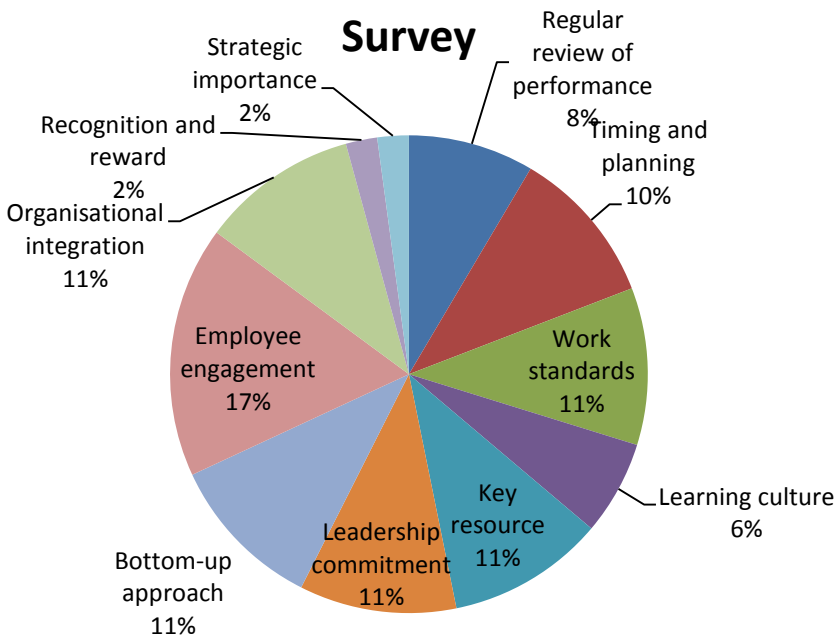

Figure 14: CSF themes from literature (theoretical framework)

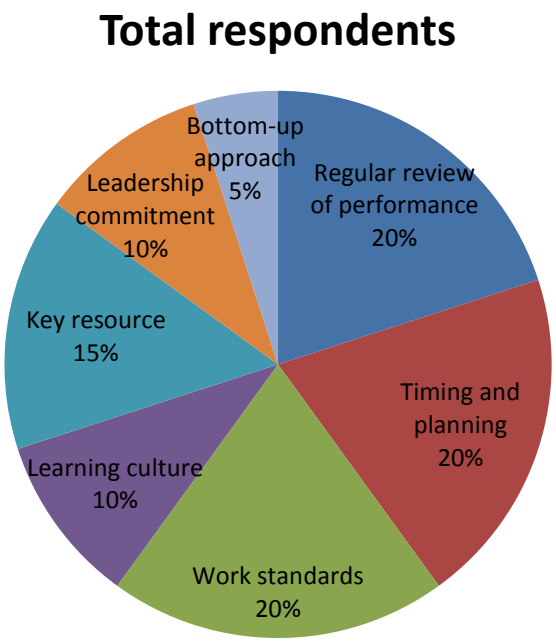

Figure 15: CSF Themes for total respondents

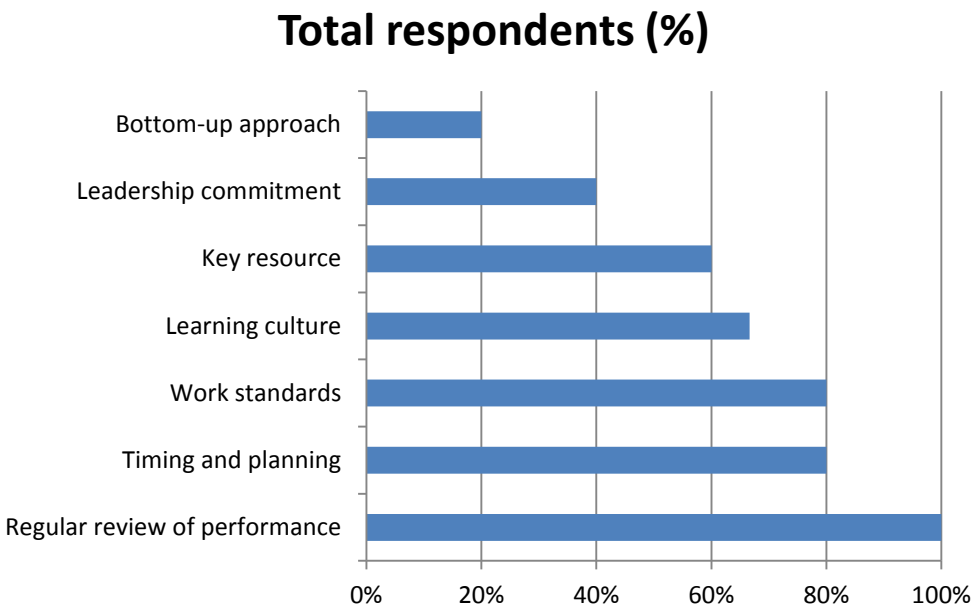

Figure 16: Percentage of items per theme considered critical by total respondents

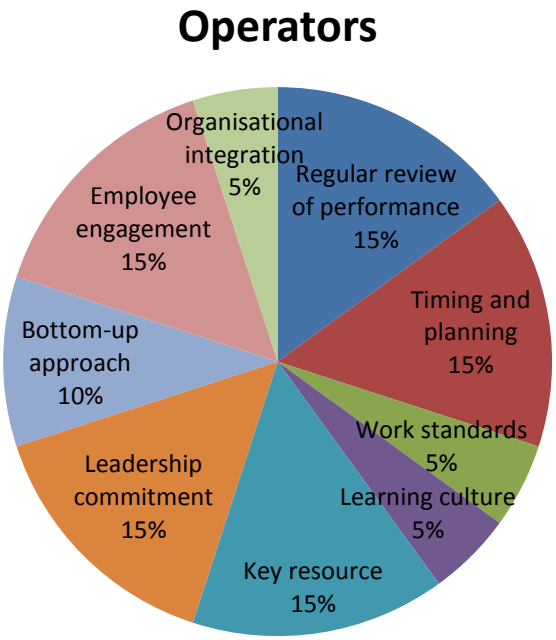

Figure 17: CSF Themes for operators

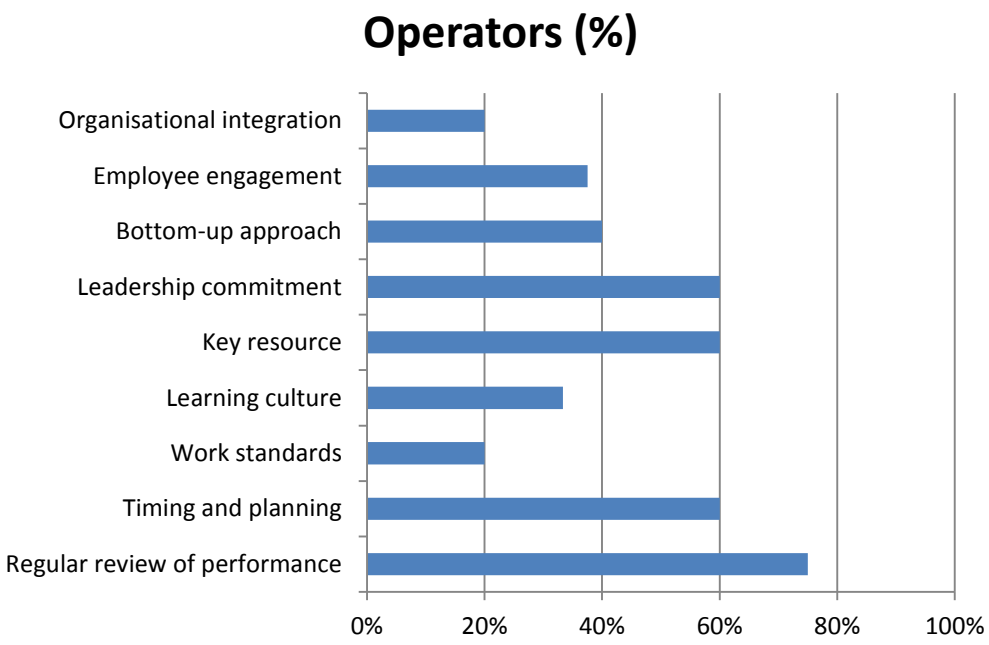

Figure 18: Percentage of items per theme considered critical by operators

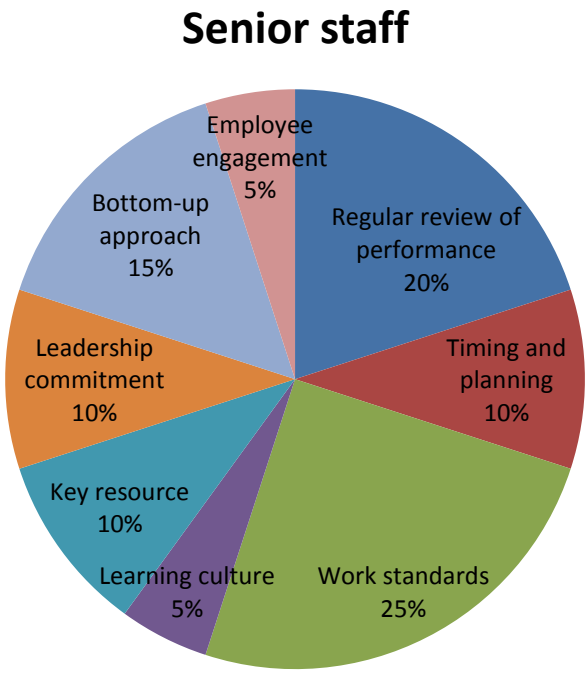

Figure 19: CSF Themes for senior staff

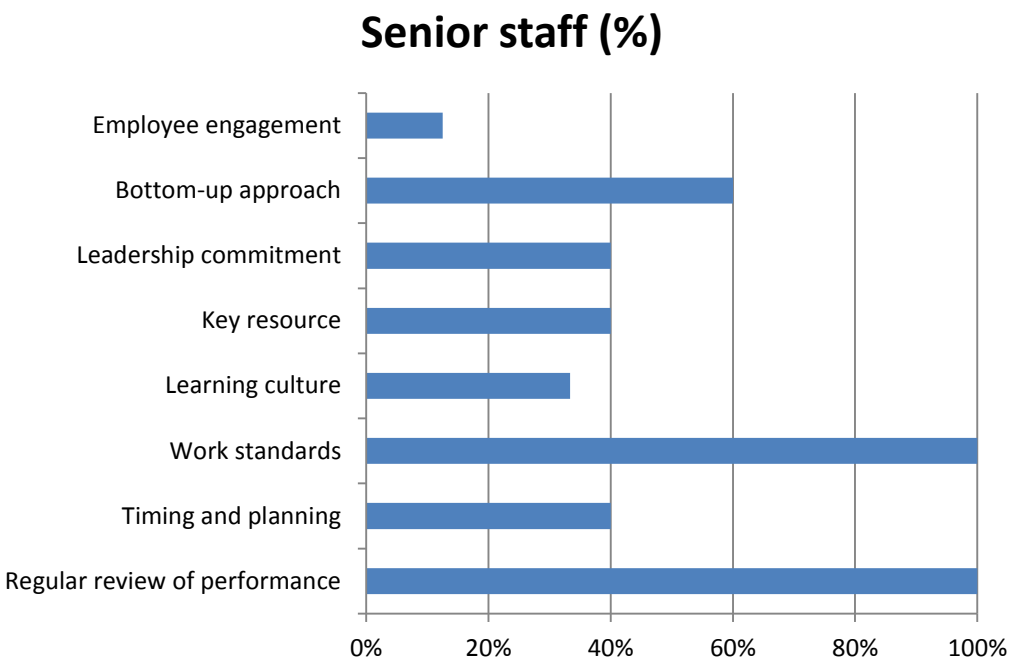

Figure 20: Percentage of items per theme considered critical by senior staff

5.2.3 Survey results – Comparing operators and senior staff

Table 21 below shows the top 10 CSFs for operators and senior staff in adjacent columns.

Table 21: Comparing CSFs for operators and senior staff

Operators		Senior staff	
Ranking	Success-factor description	Ranking	Success-factor description
1	Addition of leading KPIs that operators understand (stops, MTBF)	1	Clearly defined measures for key performance areas, with regular monitoring
2	Management identification of which tools will work best in their organisation	2	Reliable data enabling regular detailed analyses
3	Top management joins improvement events/meetings on a regular basis	3	Standardisation of work for operators and non-management employees
4	Setting and communicating an improvement agenda and roll-out plan	4	Clearly defined measures for critical processes, with regular monitoring
5	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	5	Targeting areas of rapid success first
6	Targeting areas of rapid success first	6	Top management joins improvement events/meetings on a regular basis
7	Managers actively demonstrate commitment to the programme at all levels	7	Standardised management system
8	Clearly defined measures for critical processes, with regular monitoring	8	Financial investment to support programme success
9	Clearly defined measures for key performance areas, with regular monitoring	9	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)
10	Standard work with visual management	10	Addition of leading KPIs that operators understand (stops, MTBF)

The next chapter discusses the results in relation to the study's objectives.

6. Discussion of results

Analysing the impact of IWS at ABC SA by measuring the success through aforementioned methods that includes performance data is the first part of this section. The survey results are then reviewed with commentary on the CSFs identified, the themes behind these CSFs for the different respondent groups, as well as contrasting views of operators and senior staff. Images of charts have been imported from the previous chapter to supplement the discussion.

6.1 Impact of MPIP in ABC SA

The trend lines in Figure 6 of increasing OEE and decreasing number of daily stops show that the programme had a significant and almost immediate positive effect on manufacturing performance of the lead line in ABC SA.

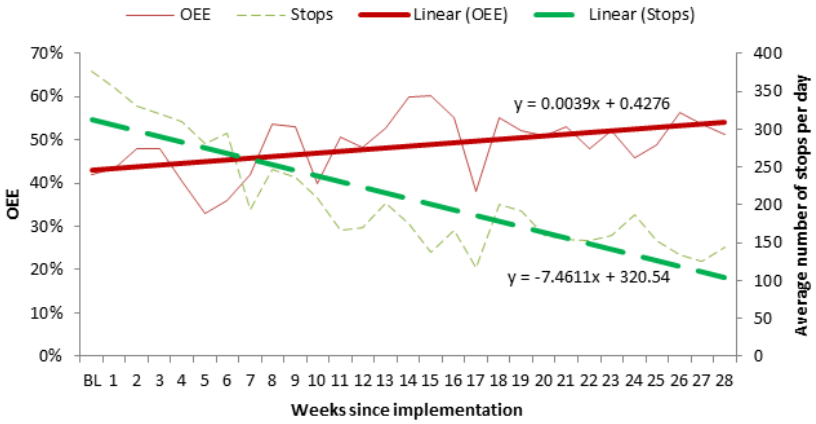

Figure 6: Trends of OEE and Stops for Line E in ABC SA (ABC, 2015)

The gradients of the trend lines for 'OEE' and 'stops' in Figure 6 indicate that 'stops' (the downward trend) improved at a faster rate than OEE (the upward trend) for observed period of 28 weeks after implementation commenced. This is understandable because the IWS methodology is focussed on reducing the most frequent type of stops or 'top stops' on a daily basis that should in turn increase OEE (Proctor & Gamble Co., 2014). 'Number of stops' is a leading indicator of efficiency or performance (less stoppages equals higher running or uptime), while OEE is a lagging indicator in relation. The survey results for the total respondent group found "the addition of a leading indicator that operators understand" to be second most highly ranked CSF (Table 18: CSFs for total respondents). This could indicate that 'stops' is a measure or KPI that is more effective on the production floor than OEE possibly because operators find it more tangible and easier to understand and influence instead of OEE. This notion was also alluded to from the literature reviewed on KPIs.

Another explanation for the slower OEE growth could be explained by the number of brand changes executed per a week, seen in Figure 4 of OEE and brand changes per week – where brand changes affect OEE by causing downtime but not the number of stops (according to the explanation of OEE provided in section 2.1 of the literature review).

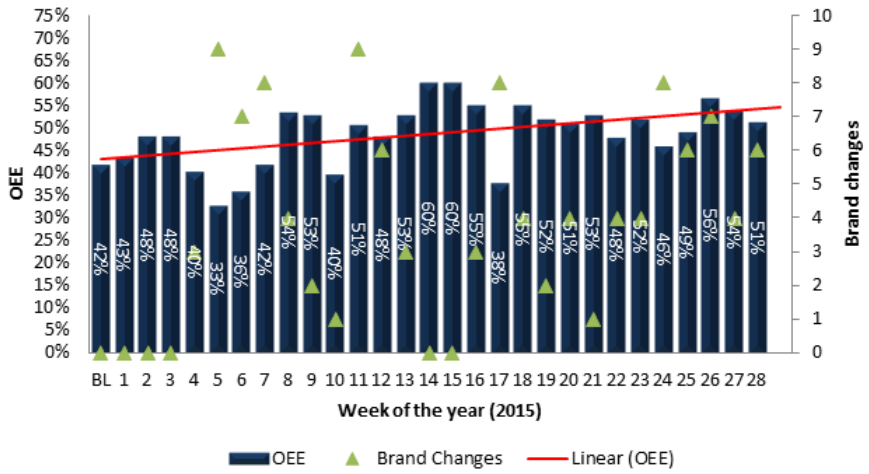

Figure 4: Weekly OEE and brand changes since IWS implementation (ABC, 2015)

According to the factory's historical OEE trend in Figure 7, the OEE improvement shown in the upward trend line of OEE in Figure 6 is still in itself high for such a short period of time without any automation or technology improvements.

Ultimately, the key business benefit lies in the 18 percent improvement of throughput shown in Table 16 that summarises the KPIs after the implementation period – as defined in section 2.1 of the literature review for throughput, the production line is able to produce 18 percent more product in a given time period than before implementing the programme. Significant throughput improvement in a factory generally enables the reduction of overheads such as energy usage, overtime and crewing optimisation opportunities. The other major benefit reducing the number of line stoppages is the time gained and strain reduced for an operator running the line, who has to intervene and get the line restarted less frequently (reduction in stops), allowing him to focus on other aspects of production while the line is running such as product quality inspections and housekeeping. This is dependent on the nature of the production line and the machine's particular demand on operator intervention in restarting the line. Table 16 (summarising KPI results before and after implementation) shows a reduction from 376 to 150 stops on average per day. This less tangible benefit could hypothetically have a positive impact on employee morale as operators would exert less energy in repairing line stoppages throughout their shift.

The graph in Figure 7 shows the historical OEE trend for ABC SA up to quarter three of 2015 (end of the observation period for the study), followed by Figure 8 of capital expenditure (CapEx) per year up to 2014. Both attributes are combined in Figure 9 to analyse the historic relationship between OEE and CapEx at ABC SA. In the first few years until 2011 it can be seen that OEE improves significantly with increased capital investment and then tapers toward a horizontal line as investments seem to be stifled.

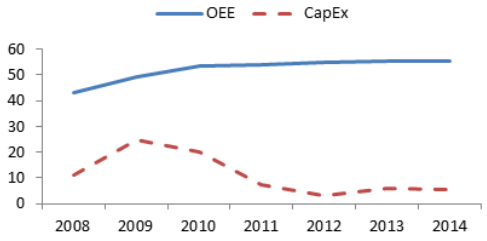

Figure 9: Comparing OEE and Capital Expenditure

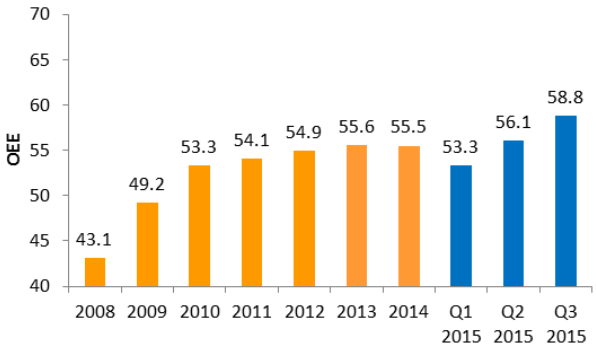

Figure 7: Historical OEE Trend for ABC SA (ABC, 2015)

Knowing that ABC factories are constantly pursuing OEE improvements as part of their strategic agenda (ABC, 2015), it is evident from Figure 9 (of OEE and CapEx) that OEE improvements came largely as a result of capital expenditure in ABC SA and efforts in more recent years to improve OEE were largely unsuccessful and resulted in stagnating performance from 2010 to 2014. Understanding the role CapEx played in influencing OEE enables the correlation of OEE progression in 2015 (seen in Figure 7 with quarterly OEE performance progression) to be largely attributed to the implementation of IWS. There is no other variable or phenomenon that could explain the upward trend from Q1 to Q3 2015. The decline in OEE to 53.3 in Q1 2015 was the result of load-shedding and power cuts by South Africa's power utility, Eskom, which was particularly prevalent in South Africa during this period (ABC, 2015). The power outages are the only significant noise having an effect in the analysis. This is indicated in the graph of Figure 10 showing year-on-year OEE improvement after the period of heavy capital investment, where the red bar shows the power outage effect and the orange bars showing the performance improvements since beginning IWS implementation.

Figure 10: OEE Improvement in ABC SA from 2011 till quarter 3 2015

From the OEE results in Figure 7 showing an increase from 55.5 in 2014 to 58.8 in Q3 2015 and the positive bars in 2015 of Figure 10, evidence of performance data indicate that the MPIP of IWS is delivering breakthrough performance improvements in light of ABC SA's recent history, and without capital-labour substitution (indicated by the lack of CapEx after 2010 in Figure 9). This is heavily supported by the KPIs tracked for the lead line in ABC SA for OEE, number of stops and throughput, shown in Table 16.

Table 16: Analysis of KPIs since IWS implementation (ABC, 2015)

Line E	Baseline	Weeks 1-12 average	Weeks 13-16 average	Improvement
OEE (%)	42	45	54	29%
Average stops per day (#)	376	235	150	60%
Throughput (volume)	4.61	4.73	5.42	18%

In light of these results, the research value seems quite significant in understanding what the CSFs were that drove these KPI improvements in ABC SA for managers and practitioners in the South African manufacturing community.

6.2 CSFs of the MPIP implementation in ABC SA

This section discusses the results of section 5.2, the CSFs identified through the survey. The underlying themes were also analysed for additional insights.

6.2.1 Reviewing the CSFs

Table 18 presents the CSFs for the total group of respondents. Top management is seen to have the biggest influence on results and driving the culture of improvement by regularly joining meetings or programme events. Even though this factor was not applied to its fullest extent in relation to other factors according to the respondents (application score of 83 percent), the criticality score of 88 percent indicates that if more of this were to happen then results of the programme in ABC SA could be further improved.

Table 18: CSFs for total respondents

Ranking	Success-factor description	Application		Criticality	
1	Top management joins improvement events/meetings on a regular basis	4.17	83%	4.40	88%
2	Addition of leading KPIs that operators understand (stops, MTBF)	4.43	89%	4.37	87%
3	Clearly defined measures for key performance areas, with regular monitoring	4.37	87%	4.34	87%
4	Targeting areas of rapid success first	4.37	87%	4.34	87%
5	Clearly defined measures for critical processes, with regular monitoring	4.17	83%	4.34	87%

It is interesting to see that 'having leading KPIs that operators understand' was placed as the second most critical factor because this SF did not stem from literature but rather the pilot testing of the survey for content validity (section 4.4.2). This may contribute to the explanation of why according to the literature reviewed in section 2.4 improvement initiatives in South African factories have a high failure rate i.e. the lack of this factor as a key consideration in their MPIP efforts. In the case of ABC SA, this refers to the number of production line stoppages per day as the number one KPI for production teams as stipulated by the IWS methodology (ABC, 2015). Analysis of this KPI is shown in Figure 6 (graph of OEE and 'stops' trend lines) where there is a steep downward trend of average number of stops per day, resulting in a 60 percent improvement rate in 16 weeks (seen in Table 16). This reinforces the value in defining a leading indicator that operators understand.

Clarity of what performance areas to focus on in CSF 3 and of which processes are most critical in CSF 5, both with clearly defined measures, is another factor deemed vital for successful implementation by ABC SA. With knowledge of the IWS methodology it is logical that the survey results say there was a greater application of this point for 'performance areas' (CSF 3) rather than 'processes' (CSF 5), with 87 versus 83 percent application scores respectively. This is because it was only the project implementation team with senior staff that worked closely with the critical process measures while everyone involved including operators interacted consistently with the KPIs.

'Targeting areas of rapid success first' as a CSF ranked in the top five is understandable when implementing a programme that aims to drive a certain culture and requires operator buy-in to succeed (as stated in the third assumption of section 1.7 and when reviewing frameworks from literature in section 2.4). This is because it gives the opportunity to everyone associated with the project to see positive results and experience performance improvements early in the implementation, which in turn may drive motivation and belief in the programme. This factor

is similar to the idea of Pareto analysis to identify which key issues contribute to 80 percent of the losses. In the context of IWS in ABC SA, the area targeted each morning was the top stop or most frequently occurring machine stoppage of the previous day. This factor is possibly related to CSF 9 on the list ("Employees 'pull' the new ways of working as they understand the benefits of the programme for themselves"). Employees will more happily adapt and embrace the new ways of working if they see and experience improved results that they know are driven by the programme in particularly. Although respondents did not rate this factor highest in terms of application (score of 82 percent), the criticality score of 85 percent highlights how important it was in enabling the programme's success. Related to employee motivation is CSF 17, where it is possible that "conducting an important and visible activity in the early stages of implementation" may have been to generate excitement of the programme inside the factory. This should boost morale for those employees that are involved in the programme, as a foundation upon which to implement more operational and less visible elements of the programme that may otherwise cause employees to lose interest.

'Standardisation of work' and 'standardisation of the management systems' as CSFs 10 and 11 speak to notions of routine and discipline, where everyone knows what to do and for everyone to do it in the same way by following the same routine. Standardisation builds individual capability by adopting best practices or lessons learnt into a standardised way of working and training each person to work in that way. In the IWS methodology, this is seen in the way CIL standards may be changed based on a newly discovered dirty part of the machine that needs to be cleaned or lubricated to eliminate a certain stop or address a product quality issue – each operator across all shifts working on that production line now needs to learn how to clean this part of the machine because it is now part of the standard procedure. Such features of the IWS methodology were discussed in section 1.1 of the report. Standardisation of work is purely a theoretical notion if execution is not consistent, and this factor is seen in CSF 14 'Discipline in adhering to standardised work'. Respondents acknowledged that discipline in ABC SA has room for improvement with an application score of 81 percent, but is critical to the programme's success due its criticality score of 83 percent and ranking in the top 20 CSFs.

A final comment on the CSFs is the observation that the survey outcomes seem to support the philosophies of the IWS methodology, as discussed in examples above. It was mentioned in section 4.4.1 that triangulation would be employed to improve internal validity. Such evidence is discussed throughout this chapter where relationships are seen in how the various

sources of data support one another, from the literature reviewed to the documented performance records describing the MPIP results, as well as the survey results.

6.2.2 Analysing the underlying themes

From Figure 14 (the pie chart of theoretical framework themes) it is worth noting the prominence of the various themes of the CSFs found from the literature reviewed (as described by the process in Chapter 3). Employee engagement is seen as the biggest area to consider when implementing a MPIP with 17 percent of the SFs, followed equally by organisational integration, bottom-up approach, leadership commitment, key resources and work standards all with 11 percent.

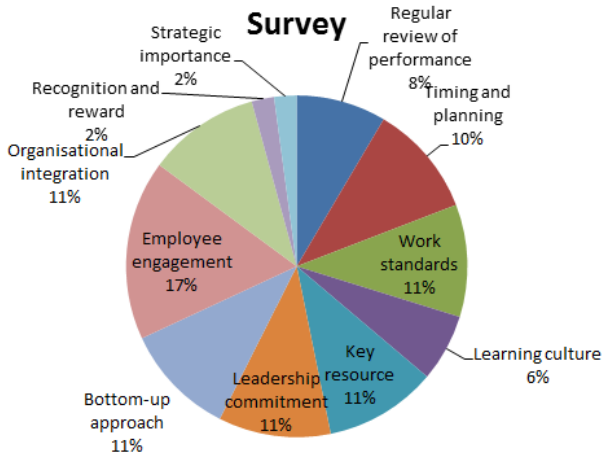

Figure 14: CSF themes from literature (theoretical framework)

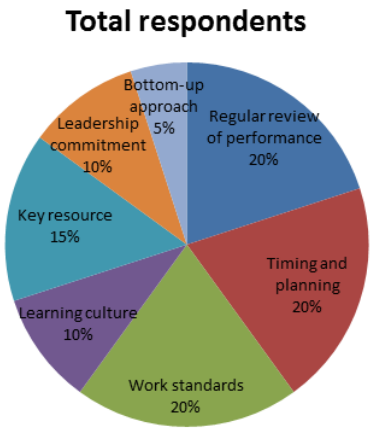

Figure 15: CSF Themes for total respondents

However, according to the total group of survey respondents in ABC SA with regards to IWS implementation, the results of Figure 15 depict a contrasting picture. Note that this chart (Figure 15) is a view of CSF themes derived from the top 20 SFs only, as rated by the respondent group. Only seven out of the 11 themes derived from the theoretical framework are seen from the survey results to feature in the 20 CSFs. A notable absence is 'employee engagement' that is seen by the respondents in ABC SA as less critical. 'Standardisation of work', 'timing and planning the way the programme is executed' and 'focusing regularly on key processes and performance dimensions' are deemed the most critical areas to consider, with each theme represented by 20 percent. It should be noted that all of the seven themes indicated in Figure 15 are critical according to respondents, given that 27 of the least critical SFs (as rated by survey respondents) were eliminated from the list before presenting the pie chart.

One aspect of bias in the above analysis is present in that all themes were not represented equally in the list of SFs in the survey. A different analysis was therefore sought to show from the available list of SFs per theme, what percentage was deemed critical by respondents. The process of developing this graph is described at the end of section 4.3.3.4. The bar graph in Figure 16 illustrates this analysis for the total group of respondents.

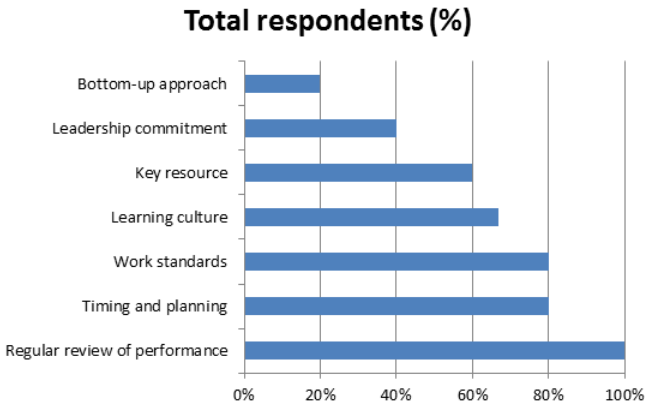

Figure 16: Percentage of items per theme considered critical by total respondents

Figure 16 indicates that four out of four SFs under the theme 'regular review of performance' were deemed critical by appearing in the top 20 CSFs by the total group of respondents (100 percent). This factor has a possible correlation with South Africa's labour supply idiosyncrasies where it was discussed in the literature review of section 2.3 that skill and education levels are low, implying that closer management control may be required as a consequence. The survey results indicate that this is achieved by reviewing key processes and performance dimensions on a regular basis, which could be seen as something that worked well in ABC SA to influence results and culture positively. This is possibly a less critical requirement in workforces in countries with higher education and skill levels due to the inherently higher levels of autonomy and self-sufficiency employees would exhibit. Work standardisation, particularly for non-management employees appears to be a vital factor for the achievement of discipline (and potentially other improved cultural aspects) and productivity improvement and in a workforce with low skills and education levels – this is reflected in Figure 16 with 80 percent of items of the theme considered critical. Another notable feature of the above analysis is that adopting a 'bottom-up approach' has only 20 percent of items representing it considered critical by respondents. The discrepancy with the theoretical framework (5 versus 11 percent when comparing the pie charts of Figure 14 and Figure 15) could perhaps also be explained by the aforementioned weakness associated with South African labour and discussed in section 2.3 – a stronger management tendency toward

a top-down approach is possibly more effective than bottom-up approaches in a South African manufacturing environment, based on these observations in ABC SA.

In the same analysis of CSFs by the operator respondent group shown in Figure 17, the picture is slightly different with nine out of the 11 themes featuring. Recognition and reward in the form of an 'incentive scheme linked to the programme', and 'emphasis on a strategic motivation for the programme' are seen as less critical. Employee engagement, regular review of key processes and performance indicators, timing and planning of the programme, key resources and leadership commitment all feature equally as 15 percent of the CSFs.

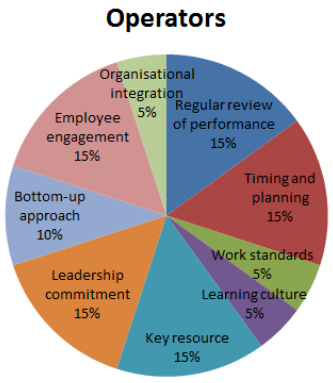

Figure 17: CSF Themes for operators

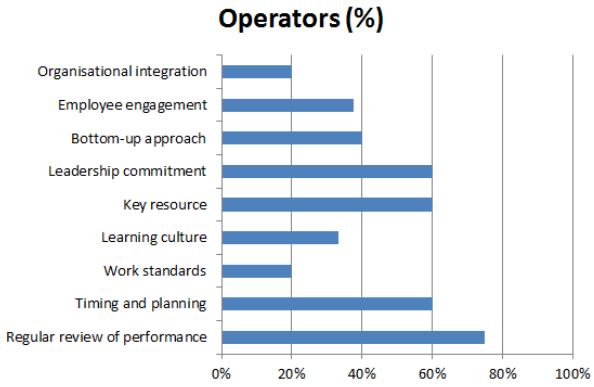

Figure 18: Percentage of items per theme considered critical by operators

The graph of theme representation in Figure 18 for operators indicates which themes or areas of consideration are more prominent from the view of the operator base in ABC SA. The regular review of key processes and performance indicators is most highly represented as 75 percent of the listed CSFs in this category. It is interesting that work standardisation has only 20 percent of its SFs chosen as critical by the operators and having committed leadership is more of a concern for them. The inference is that operators place a heavy reliance and onus on strong leadership in ABC SA.

From Figure 19 (the pie chart of themes for senior staff shown below) standardisation of work was found to be the most critical area of focus in delivering a successful MPIP at ABC SA according to senior staff, making 25 percent of the CSFs chosen in the top 20. Regular review of critical indices is second with 20 percent, followed by moving from a top-down to a bottom-up approach. These themes feature most prominently in the survey answers of senior staff, with 100 percent of the 'work standards' and 'review of performance' SFs deemed critical (seen in the bar graph of Figure 20 for senior staff). A possible interpretation from this graph of results is that senior staff in ABC SA feel that management closeness and

control of the programme should be in the form of regular performance and process reviews, while action and direction should come from the shop floor upwards (bottom-up).

Figure 19: CSF Themes for senior staff

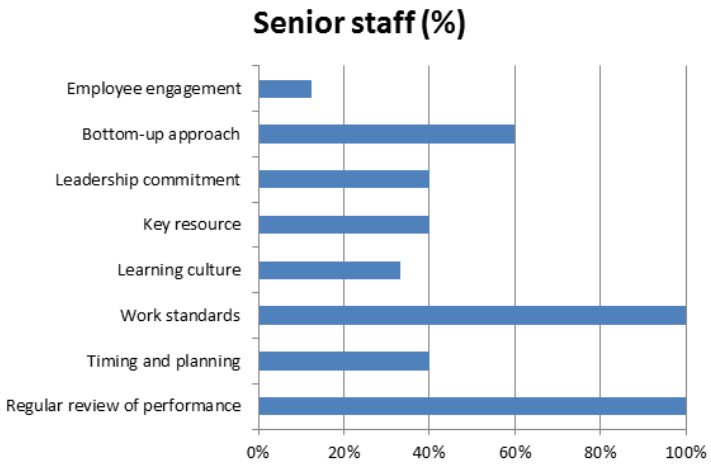

Figure 20: Percentage of items per theme considered critical by senior staff

6.2.3 Comparing the views of operators and senior staff

It can be seen in Figure 12 and Figure 13 of SFs plotted against degree of application and criticality on the scatter plots that operators were less generous with their ratings than senior staff (average criticality for top 10 CSFs of 82 versus 94 percent respectively). A possible explanation for this could be that senior staff saw value in most SFs while operators gave higher rankings only when a SF was closely relatable. Regardless of this observation, there is greater interest in how similar or dissimilar their chosen CSFs are. The top 10 SFs chosen to be most critical for both the operator and senior staff group are compared in Table 21.

Table 21: Comparing CSFs for operators and senior staff

Operators		Senior staff	
Ranking	Success-factor description	Ranking	Success-factor description
1	Addition of leading KPIs that operators understand (stops, MTBF)	1	Clearly defined measures for key performance areas, with regular monitoring
2	Management identification of which tools will work best in their organisation	2	Reliable data enabling regular detailed analyses
3	Top management joins improvement events/meetings on a regular basis	3	Standardisation of work for operators and non-management employees
4	Setting and communicating an improvement agenda and roll-out plan	4	Clearly defined measures for critical processes, with regular monitoring
5	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	5	Targeting areas of rapid success first
6	Targeting areas of rapid success first	6	Top management joins improvement events/meetings on a regular basis
7	Managers actively demonstrate commitment to the programme at all levels	7	Standardised management system
8	Clearly defined measures for critical processes, with regular monitoring	8	Financial investment to support programme success
9	Clearly defined measures for key performance areas, with regular monitoring	9	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)
10	Standard work with visual management	10	Addition of leading KPIs that operators understand (stops, MTBF)

50 Percent of the CSFs are common to both operators' and senior staff's top 10, as indicated in green above (numbers 1, 3, 6, 8, 9 on the left, and numbers 1, 4, 5, 6, 10 on the right). It could be argued that the two CSFs marked in orange (number 10 on the left and 3 on the right) are also common as they are similar in construct in that both speak to standardisation of work. The only difference is that the one includes visual management and the other emphasises non-management. In any case it is noteworthy to find both operators and senior staff with significantly similar views of CSFs, indicating alignment between managers and the shop floor in understanding the programme and what the perceived drivers of success are thus far, despite different perspectives.

Differences are to be expected in the above comparison, specifically where operators and senior staff are exposed to different elements of the programme (like any programme or project). This can be seen in CSFs two and eight of the senior staff's list, where for example operators work shifts probably do not get as involved in technical analysis of data.

6.2.4 Summary of the discussion

Discussing the performance trends of ABC SA's plant in juxtaposition of the results achieved in the period of IWS implementation shows that the programme had a significant, if not major, positive impact on productivity performance in a relatively short time period. The top ranked CSFs according to criticality scores in the survey results were discussed to find links to the literature reviewed, performance data observed and IWS methodology. Analysing the themes behind the CSFs provided useful insight when comparing ABC SA's implementation as perceived by staff involved in the programme to themes of the theoretical framework developed. It highlighted some different areas of focus and potentially indicates where South African plants should place more emphasis in their MPIPs. Comparing views of the two respondent groups as clustered by the statistical tool such that one was predominantly operators while the other predominantly senior staff, provided insight into the way management and the shop-floor perceived the IWS programme, and where they agreed and differed on what drove performance improvements.

7. Conclusion

The outcomes of the study are summarised in this section with reference to the research question and hypotheses that were to be tested through the objectives of the study in section 1.5 and 1.6 of the report.

- H1: A manufacturing improvement programme that is not driven by capital investment can achieve significant change in manufacturing performance in a South African plant not withstanding labour constraints characterised by low productivity, inadequate skills, poor education and strong trade union influence
    - At 16 weeks after the start of implementation of the IWS programme, performance improvements from baseline for the lead production line was 29 percent for OEE, 60 percent for average number of stops per day and 18 percent throughput
    - After OEE for the entire plant remained stagnant for five years (less than one percent to no improvement per year from 2010 to 2014), it improved by over three percent by quarter three of 2015, the period after implementing IWS
    - Apart from initiatives related to the IWS programme, no other significant improvement initiatives, technology investments, leadership or structural changes were made in the plant during the course of 2015
    - H1 was therefore supported
- H2: Critical success-factors for implementing a manufacturing improvement programme that is not driven by capital investment in a South African plant differ from other manufacturing improvement programmes that have been successful elsewhere
    - CSFs of manufacturing improvement programmes elsewhere is represented by the theoretical framework derived from the literature with regard to implementing a large-scale MPIP that aims to influence shop-floor culture and thinking
    - CSFs of a manufacturing improvement programme in a South African plant is represented by the survey results of CSFs in ABC SA
    - The theoretical framework consists of 11 CSF themes with employee engagement seen as the theme most emphasised in 17 percent of the CSFs, while in the results of ABC SA, employee engagement does not feature in the top 20 CSFs

- Of the top three CSF themes in the ABC SA survey results, only ‘work standards’ features in the top five themes of the theoretical framework. The other two, being ‘Regular review of performance’ and ‘timing and planning’ are only the sixth and seventh most represented themes in the theoretical framework.
- H2 was therefore supported

- H3: Operators in the selected South African plant will generally demonstrate a different view from senior staff regarding how the improvement programme should be implemented, given their background of poor education and inadequate skills
  - The statistical clustering process separated to an extent the views of operators and senior staff (technicians, supervisors and managers), which were then compared based on each group’s ranking of CSFs
  - 50 Percent of CSFs were common in both lists of top 10 CSFs, with 60 percent being very similar
  - The most represented operator CSF themes were found to be ‘regular review of performance’, ‘timing and planning’, ‘key resource’ and ‘leadership commitment’, while in the senior staff results these were found to be ‘work standards’, ‘bottom-up approach’ and ‘regular review of performance’ as the only common theme
  - Although many of the CSFs ranked in the top 10 were common for both employee groups, comparing the themes indicates a significant difference as to what factors each group would emphasise in implementation of the improvement programme
  - H3 was therefore supported to an extent

8. Recommendations

The most tangible outcome of the study is provided in the recommendation for managers and practitioners below. It is followed by recommendations for future studies to further develop outcomes of the study, as well as limitations to note.

8.1 Recommendation for managers and practitioners

The framework proposed in Table 22 below should be used by managers and practitioners in South African manufacturing plants when implementing MPIPs (manufacturing performance improvement programmes) that require a change in mind-set or shift in culture on the factory floor for new processes, ways of working or systems to succeed. The CSFs (critical-success factors) obtained from the survey results is used as the basis of the framework to form understandable and succinct guidelines.

Table 22: Framework for implementing a MPIP

Item number	Critical success-factor description	Impact (1 = highest)
Timing and planning		
1	Target areas of rapid success first	4
2	Management should identify which tools will work best in the organisation	6
3	Set and communicate an improvement agenda and roll-out plan	8
4	Conduct an important and visible activity of the programme as soon as possible to create excitement	17
Work standards		
5	Standardise the work of employees and support it with visual management aids	10
6	Standardise the way implemented systems are managed in terms of dealing with issues or 'out-of-limit' results	11
7	Consistently enforce employee discipline in adhering to standardised work	14
8	Standardise part of the manager's daily routine within the new ways of working	19
Regular review of performance		
9	Establish leading KPIs that operators understand	2
10	Clearly define KPIs and regularly monitor them	3
11	Each critical process should have a clearly defined KPI	5
12	Performance data should be reliable and enable regular detailed analyses	16
Key resources		
13	Adequate financial investment should be made to support the programme's success	7
14	An executive or senior manager must be appointed to oversee the project	13

15	Organisational structure should be reviewed to enable the programme to succeed	15
Other critical success-factors		
17	Top management should join improvement events/meetings on a regular basis	1
16	Invest enough time and coaching for employees to 'pull' or embrace the new ways of working as they understand the benefits of the programme for themselves	9
18	Managers should actively demonstrate commitment to the programme at all levels (and across functions)	12
19	Comprehensive training should be conducted such that everyone has the necessary skills and understands the new philosophy	18
20	Provide a platform for employees learn from personal and colleagues' positive and negative experiences	20

Based on the success of the IWS programme's implementation in ABC SA's factory, using the above framework when preparing for and implementing a MPIP should improve the probability of success.

8.2 Further development

The framework proposed in Table 22 should be tested in other South African factories, with documented results that are produced in line with the method used for this study (section 4.2 and 5.1).

Depending on the success achieved, it is suggested that a task team of experienced managers and practitioners is set up by a South African manufacturing organisation or society (such as the Manufacturing Circle or South African Institute for Industrial Engineers) to publicise or institutionalise the framework and assist local factories with desires to implement such programmes with deployment. This can be done via mentoring or coaching relationships, training seminars supplemented with exposure to successful factories such as ABC SA, or more hands-on approaches such as consulting.

Bringing such ideas into fruition is dependent on resource availability such as time and funding, and so partnerships with corporates or government entities such as the Department of Trade and Industry (DTI) in particular may prove most beneficial. The DTI's first strategic objective is to "facilitate transformation of the economy to promote industrial development, investment, competitiveness and employment creation" (DTI, 2003), hence there is alignment with the motivation for this study as discussed in chapter 1.4.

It is also recommended that the framework be redeveloped for small-to-medium enterprises (SMEs) that contain manufacturing or assembly lines. It was discussed in the literature review (section 2.2) that majority of manufacturing sector consists of large enterprises; however SMEs have a significant role to play in job creation (with generally less restrictive union presence and less capital availability). A similar framework and task-team setup to focus on smaller manufacturing enterprises would therefore be of significant benefit to the South African economy. The approach used in this study could be replicated, from researching challenges faced by SME manufacturers in South Africa to developing and testing a MPIP framework.

8.3 Limitations

One of the key limitations of the framework recommended is that initiatives similar to the IWS programme are dependent on managers or practitioners with strong leadership capabilities to succeed, however the intent of the framework is to improve the leadership of such initiatives by applying the guidelines rigorously. The framework is also open to interpretation and so its effectiveness is dependent on the user's understanding and ability to apply the guidelines provided to his or hers organisation and production processes. This shortcoming is inherent in the nature of a framework; hence the recommendations that followed in section 8.2 regarding task teams and facilitation. Another limitation of the framework is that certain CSFs may not be applicable or translatable into the implementation process of certain manufacturers, such as the establishment of a leading indicator that operators understand and have constant access to. This could be due to the nature of the process, production infrastructure, and technology or system capabilities. Such a limitation may dilute the effectiveness of a MPIP.

The presence of bias in the survey of CSFs must be noted in that some factors may be influenced by ones education level, interest in the topic and the different points in time in which surveys were completed (Leedy and Ormrod, 2013). Another limitation to note is the assessment of sustainability of the IWS programme's success in ABC SA due to the time period for which results were gathered. Even though the evidence of performance trends indicated sustainable, improved results, greater confidence in the outcomes would be achieved by assessing performance over a number of years that included destabilising factors such as the changing of managers or key personnel, new equipment and other related impacts. This was not possible due to the timeline of the study.

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Appendices

Appendix A: Development of CSF framework

Table 23: All CSFs from the literature reviewed (grouped)

Source	#	CSF	Theme
Ahrens (2006)	24	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value rather than to tell them what to do	Bottom-up approach
Ahrens (2006)	26	Employee pull (employees fully understand the benefits on Lean and improvement for themselves independent from management's support)	Bottom-up approach
Ahrens (2006)	33	Employees are free to allocate time to improvement (empowerment)	Bottom-up approach
Ahrens (2006)	35	Resources freed up by productivity gains are reinvested into the search for still greater improvements	Bottom-up approach
Ahrens (2006)	37	Converting from top-down leadership to bottom-up initiatives	Bottom-up approach
Bhuiyan and Baghel (2005)	2	Improvement activities by groups in the organisation are based on company objectives	Department integration and alignment
Bhuiyan and Baghel (2005)	7	Employees work effectively across internal and external boundaries at all levels of the organisation	Department integration and alignment
Bhuiyan and Baghel (2005)	10	Employees have a shared set of cultural values that influence the way CI is incorporated in everyday work	Department integration and alignment
Ahrens (2006)	29	Building internal customer-supplier relationships (by integrating support functions)	Department integration and alignment
Ahrens (2006)	32	Integrating suppliers and customers into the Lean transformation	Department integration and alignment
Jozaffe (2006)	47	Support functions like production planning and the quality control laboratory should become part of the value stream	Department integration and alignment
Vermaak (2008)	54	HR Partnership with production management with involvement in issues and concerns of people on the shop floor	Department integration and alignment
Bhuiyan and Baghel (2005)	1	Employees understand company objectives	Employee engagement
Bhuiyan and Baghel (2005)	6	Employees are engaged proactively on CI throughout the company	Employee engagement
Bhuiyan and Baghel (2005)	8	Employees learn from personal and colleagues' positive and negative experiences	Employee engagement
Ahrens (2006)	17	Getting shop floor commitment and employee trust	Employee engagement
Ahrens (2006)	18	Involving operators through empowered Kaizen teams	Employee engagement

Ahrens (2006)	19	Communication of the transformation process, goals, etc.	Employee engagement
Ahrens (2006)	23	Enrolment of stakeholders for commitment, i.e. workers' council	Employee engagement
Ahrens (2006)	28	Avoidance of any linkage between Lean practices and layoffs	Employee engagement
Jozaffe (2006)	50	Total employee involvement	Employee engagement
van der Merwe et al (2014)	62	Creation and communication of a vision attainment plan	Employee engagement
van der Merwe et al (2014)	64	Link successes to the project	Employee engagement
van der Merwe et al (2014)	69	Employee input for measuring performance to stimulate understanding and accountability	Employee engagement
van der Merwe et al (2014)	70	Employee engagement activities conducted by management	Employee engagement
van der Merwe et al (2014)	71	Management demonstration of trust in employees' abilities	Employee engagement
van der Merwe et al (2014)	72	Management interaction with employees on the shop floor	Employee engagement
Bhuiyan and Baghel (2005)	11	Experienced and full time facilitator	Key resource
Ahrens (2006)	20	Finding a good change agent	Key resource
Ahrens (2006)	31	Lean champions removing blocks in the organisation	Key resource
Ahrens (2006)	42	Creating a Lean promotion office for organisation and training	Key resource
Jozaffe (2006)	51	Organisational structure should enable the programme to succeed	Key resource
Vermaak (2008)	57	Executive or senior manager appointed to oversee the project	Key resource
Vermaak (2008)	58	Experienced Lean facilitator or creation of Lean office dedicated to implementation	Key resource
van der Merwe et al (2014)	65	Review organisation structure to support the project	Key resource
Bhuiyan and Baghel (2005)	5	Managers actively demonstrate commitment to the CI programme at all levels	Leadership commitment
Ahrens (2006)	15	Board and top management actively driving and supporting change	Leadership commitment
Ahrens (2006)	16	Strong leadership	Leadership commitment
Ahrens (2006)	22	Top management presence and availability on the shop floor	Leadership commitment
Ahrens (2006)	25	Managerial push (mandatory participation in	Leadership

		workshops and training)	commitment
Ahrens (2006)	34	Executives join kaizen events on a regular basis	Leadership commitment
Vermaak (2008)	56	Leadership commitment to the Lean implementation	Leadership commitment
Bhuiyan and Baghel (2005)	12	Employee recognition system	Recognition and reward
Ahrens (2006)	44	Implementing a reward and incentive system for successful Lean projects	Recognition and reward
van der Merwe et al (2014)	68	Link incentives to objective-aligned performance	Recognition and reward
Bhuiyan and Baghel (2005)	14	Performance monitoring	Regular review of performance
van der Merwe et al (2014)	67	Define measures for critical processes	Regular review of performance
Ahrens (2006)	38	Availability of a crises that motivates the organisation to change	Strategic importance
Jozaffe (2006)	46	Top management support should be established before communicating or beginning implementation	Strategic importance
Vermaak (2008)	55	Lean as a strategic business objective	Strategic importance
van der Merwe et al (2014)	61	Justification for project and effective communication	Strategic importance
Bhuiyan and Baghel (2005)	3	Enablers of CI are continuously reviewed and adjusted if necessary	Support system
Bhuiyan and Baghel (2005)	4	Company structure, systems and procedures are regularly assessed to ensure the CI system is supported	Support system
Ahrens (2006)	43	Utilising policy deployment	Support system
Vermaak (2008)	53	HR Policies that engage people and create buy-in	Support system
Bhuiyan and Baghel (2005)	9	Individual and group learning is captured and deployed systematically	Systematic learning
Ahrens (2006)	21	Beginning as soon as possible with an important and visible activity	Timing and planning
Ahrens (2006)	36	Planning for and creating short-term Kaizen wins	Timing and planning
Ahrens (2006)	41	Setting a Kaizen agenda for the organisation	Timing and planning
Jozaffe (2006)	48	Each organisation is different and managers need to identify which elements of Lean will work best in their organisation	Timing and planning
Jozaffe (2006)	49	Each stage of implementation needs to have clearly defined expectations before fully rolling out the Lean system	Timing and planning
Vermaak (2008)	59	Organisational stability at each stage of implementation before advancing implementation	Timing and planning
van der Merwe et al	63	Target areas of rapid success first and communication success	Timing and planning

(2014)			
Ahrens (2006)	27	Teaching Lean thinking and Lean skills to everyone (such that everyone understands the philosophy)	Training
	45	The organisation should be trained such that everyone understands the philosophy	Training
Jozaffe (2006)	52	Comprehensive training	Training
van der Merwe et al (2014)	66	Identify and close skills gap at all levels in relation to project objectives	Training
Bhuiyan and Baghel (2005)	13	Simplification or standardisation of work	Work standards
Vermaak (2008)	60	Discipline in adhering to standardised work	Work standards
van der Merwe et al (2014)	73	Standardised portion of a manager's work day	Work standards
van der Merwe et al (2014)	74	Standardisation of work for operators and lower-level employees	Work standards
van der Merwe et al (2014)	75	Standardised management system	Work standards
Ahrens (2006)	30	Elimination of managers, who would not cooperate in order to get commitment to Lean	
Ahrens (2006)	39	Demonstration of senior management impatience by regularly reviewing progress reports	
Ahrens (2006)	40	Striving for perfection	

Table 24: CSFs from the literature reviewed (duplicates removed)

Source	# (original)	# (new)	Critical success-factor	Theme
Ahrens (2006)	24	1	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value rather than to tell them what to do	Bottom-up approach
Ahrens (2006)	26	2	Employee pull (employees fully understand the benefits of the programme for themselves)	Bottom-up approach
Ahrens (2006)	33	3	Employees are free to allocate time to improvement (empowerment)	Bottom-up approach
Ahrens (2006)	35	4	Resources freed up by productivity gains are reinvested into the search for still greater improvements	Bottom-up approach
Ahrens (2006)	37	5	Converting from top-down leadership to bottom-up initiatives	Bottom-up approach
Ahrens (2006)	17	6	Getting shop floor commitment and employee trust	Employee engagement
Ahrens (2006)	18	7	Involving operators through empowered Kaizen teams	Employee engagement

Ahrens (2006)	23	8	Enrolment of stakeholders for commitment, i.e. workers' council	Employee engagement
Ahrens (2006)	28	9	Avoidance of any linkage between the project and headcount reduction	Employee engagement
Bhuiyan and Baghel (2005)	1	10	Employees understand company objectives	Employee engagement
Bhuiyan and Baghel (2005)	6	11	Employees are engaged proactively on the project throughout the company	Employee engagement
Bhuiyan and Baghel (2005)	8	12	Employees learn from personal and colleagues' positive and negative experiences	Employee engagement
van der Merwe et al (2014)	62	13	Creation and communication of a vision attainment plan	Employee engagement
van der Merwe et al (2014)	64	14	Linking successes experienced to the project	Employee engagement
van der Merwe et al (2014)	69	15	Employee input for measuring performance to stimulate understanding and accountability	Employee engagement
van der Merwe et al (2014)	71	16	Management demonstration of trust in employees' abilities	Employee engagement
Ahrens (2006)	20	17	Finding a good change agent or champions to remove blocks in the organisation	Key resource
Bhuiyan and Baghel (2005)	11	18	Experienced and full time programme facilitator	Key resource
Jozaffe (2006)	51	19	Organisational structure should enable the programme to succeed	Key resource
Vermaak (2008)	57	20	Executive or senior manager appointed to oversee the project	Key resource
Vermaak (2008)	58	21	Creation of a programme office or Lean promotion office to support implementation	Key resource
Ahrens (2006)	15	22	Board and top management actively driving and supporting change	Leadership commitment
Ahrens (2006)	22	23	Top management presence and availability on the shop floor, engaging with employees	Leadership commitment
Ahrens (2006)	25	24	Managerial push (mandatory participation in workshops and training)	Leadership commitment
Ahrens (2006)	34	25	Executives join kaizen events on a regular basis	Leadership commitment
Bhuiyan and Baghel (2005)	5	26	Managers actively demonstrate commitment to the CI programme at all levels	Leadership commitment

Ahrens (2006)	29	27	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across boundaries at all levels of the organisation	Organisational integration
Ahrens (2006)	32	28	Integrating suppliers and customers into the transformation	Organisational integration
Bhuiyan and Baghel (2005)	10	29	Employees have a shared set of cultural values that influence the way CI is incorporated in everyday work	Organisational integration
Vermaak (2008)	54	30	HR Partnership with production management with involvement in issues and concerns of people on the shop floor	Organisational integration
Bhuiyan and Baghel (2005)	12	31	Employee recognition or reward system linked to the programme	Recognition and reward
Bhuiyan and Baghel (2005)	14	32	Performance monitoring	Regular review of performance
van der Merwe et al (2014)	67	33	Define measures for critical processes	Regular review of performance
Ahrens (2006)	38	34	Availability of a crises or strategic need that motivates the organisation to change	Strategic importance
Jozaffe (2006)	46	35	Top management support should be established before communicating or beginning implementation	Strategic importance
Bhuiyan and Baghel (2005)	4	36	Company structure, systems and procedures are regularly assessed to ensure the CI system is supported	Support system
Ahrens (2006)	21	37	Beginning as soon as possible with an important and visible activity	Timing and planning
Ahrens (2006)	41	38	Setting a Kaizen agenda for the organisation	Timing and planning
Jozaffe (2006)	48	39	Management identification of which tools will work best in their organisation	Timing and planning
van der Merwe et al (2014)	63	40	Target areas of rapid success first and communication of successes	Timing and planning
Vermaak (2008)	59	41	Organisational stability at each stage before advancing implementation	Timing and planning
Jozaffe (2006)	52	42	Comprehensive training such that everyone has necessary skills and understands the philosophy	Training
van der Merwe et al (2014)	73	43	Standardised portion of a manager's work day	Work standards
van der Merwe et al (2014)	74	44	Standardisation of work for operators and lower-level employees	Work standards
van der	75	45	Standardised management system	Work standards

Merwe et al (2014)				
Vermaak (2008)	60	46	Discipline in adhering to standardised work	Work standards
Bhuiyan and Baghel (2005)	9	47	Individual and group learning is captured and deployed systematically	Work standards

Table 25: CSFs from the literature reviewed (applicable in ABC's MPIP)

Source	#	CSF	Theme
Ahrens (2006)	1	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value (operators and technicians) rather than giving instructions	Bottom-up approach
Ahrens (2006)	2	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	Bottom-up approach
Ahrens (2006)	3	Employees are free to allocate time to improvement (empowerment)	Bottom-up approach
Ahrens (2006)	4	Resources freed up by productivity gains are reinvested into the search for still greater improvements	Bottom-up approach
Ahrens (2006)	5	Converting from top-down leadership to bottom-up initiatives	Bottom-up approach
Ahrens (2006)	6	Getting shop floor commitment and employee trust	Employee engagement
Ahrens (2006)	7	Involving operators through empowered task teams to analyse specific issues and make improvements	Employee engagement
Ahrens (2006)	8	Establish stakeholder commitment, i.e. workers' council	Employee engagement
Bhuiyan and Baghel (2005)	9	Employees understand company objectives	Employee engagement
Bhuiyan and Baghel (2005)	10	Employees are engaged proactively on the project throughout the company	Employee engagement
van der Merwe et al (2014)	11	Creation and communication of a vision attainment plan	Employee engagement
van der Merwe et al (2014)	12	Linking successes experienced to the project (celebrating successes)	Employee engagement
van der Merwe et al (2014)	13	Employee input for measuring performance to stimulate understanding and accountability	Employee engagement
van der Merwe et al (2014)	14	Management demonstration of trust in employees' abilities	Employee engagement
Ahrens (2006)	15	Finding a good change agent or champions to remove negativity or obstacles in the organisation	Key resource
Bhuiyan and	16	Experienced and full time programme facilitator	Key resource

Baghel (2005)			
Jozaffe (2006)	17	Organisational structure should enable the programme to succeed	Key resource
Vermaak (2008)	18	Executive or senior manager appointed to oversee the project	Key resource
Ahrens (2006)	19	Top management actively driving and supporting change (with buy-in established before implementation)	Leadership commitment
Ahrens (2006)	20	Top management presence and availability on the shop floor, engaging with employees	Leadership commitment
Ahrens (2006)	21	Top management joins improvement events/meetings on a regular basis	Leadership commitment
Ahrens (2006)	22	Managerial push (mandatory participation of employees in workshops and training)	Leadership commitment
Bhuiyan and Baghel (2005)	23	Managers actively demonstrate commitment to the programme at all levels	Leadership commitment
Bhuiyan and Baghel (2005)	24	Employees learn from personal and colleagues' positive and negative experiences	Learning culture
Jozaffe (2006)	25	Comprehensive training such that everyone has necessary skills and understands the philosophy	Learning culture
Bhuiyan and Baghel (2005)	26	Individual and group learning is captured and deployed systematically	Learning culture
Ahrens (2006)	27	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across boundaries at all levels of the organisation	Organisational integration
Ahrens (2006)	28	Integrating external suppliers and customers into the transformation	Organisational integration
Bhuiyan and Baghel (2005)	29	Employees have a shared set of values that influence the way new concepts are incorporated into everyday work	Organisational integration
Vermaak (2008)	30	HR Partnership with production management with involvement on issues and concerns of people on the shop floor	Organisational integration
Bhuiyan and Baghel (2005)	31	Company systems, policies and procedures are regularly assessed to ensure the programme is supported	Organisational integration
Bhuiyan and Baghel (2005)	32	Employee recognition or reward system linked to the programme	Recognition and reward
van der Merwe et al (2014)	33	Clearly defined measures for critical processes and performance, with regular monitoring	Regular review of performance
Ahrens (2006)	34	Availability of a crisis or strategic need that motivates the organisation to change	Strategic importance
Ahrens (2006)	35	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)	Timing and planning

Ahrens (2006)	36	Setting an improvement agenda and roll-out plan	Timing and planning
Jozaffe (2006)	37	Management identification of which tools will work best in their organisation	Timing and planning
van der Merwe et al (2014)	38	Targeting areas of rapid success first	Timing and planning
Vermaak (2008)	39	Organisational stability at each stage before advancing implementation	Timing and planning
van der Merwe et al (2014)	40	Standardisation of part of a manager's work day	Work standards
van der Merwe et al (2014)	41	Standardisation of work for operators and non-management employees	Work standards
van der Merwe et al (2014)	42	Standardised management system	Work standards
Vermaak (2008)	43	Discipline in adhering to standardised work	Work standards

Appendix B: The questionnaire (based on the theoretical CSF framework)

Table 26: Questionnaire

Tick your role: Manager/Supervisor □ Technician □ Operator Line E □ Operator Line O □			
#	**INSTRUCTIONS FOR SURVEY ON IWS SUCCESS-FACTORS:** Q1. To what extent was it applied? (1 - not applied, 2 - negligible, 3 - unsure, 4 - partially, 5 - fully applied) Q2. What impact did it have on improving culture/results? (1 - no impact, 2 - negligible, 3 - unsure, 4 - significant impact, 5 - major impact)	**Q1**	**Q2**
1	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value (operators and technicians) rather than giving instructions		
2	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves		
3	Employees are free to allocate time to improvement (empowerment)		
4	Resources freed up by productivity gains are reinvested into the search for still greater improvements		
5	Converting from top-down leadership to bottom-up initiatives		
6	Getting shop floor commitment and employee trust		
7	Involving operators through empowered task teams to analyse specific issues and make improvements		
8	Establish stakeholder commitment, i.e. workers' council		
9	Employees understand company objectives through clearly communicated vision		
10	Employees are engaged proactively on the project throughout the company		
11	Linking successes experienced to the project (celebrating successes)		
12	Employee input for measuring performance to stimulate understanding and accountability		
13	Management demonstration of trust in employees' abilities		
14	Finding a good change agent or champions to remove negativity or obstacles in the organisation		
15	Experienced and full time programme facilitator		
16	Organisational structure should enable the programme to succeed		
17	Executive or senior manager appointed to oversee the project		
18	Reliable data enabling regular detailed analyses		
19	Financial investment to support programme success		
20	Top management actively driving and supporting change (with buy-in established before implementation)		
21	Top management presence and availability on the shop floor, engaging with employees		
22	Top management joins improvement events/meetings on a regular basis		
23	Managerial push (mandatory participation of employees in workshops and training)		

24	Managers actively demonstrate commitment to the programme at all levels		
25	Employees learn from personal and colleagues' positive and negative experiences		
26	Comprehensive training such that everyone has necessary skills and understands the philosophy		
27	Individual and group learning is captured and deployed systematically		
28	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across boundaries at all levels of the organisation		
29	Integrating external suppliers and customers into the transformation		
30	Employees have a shared set of values that influence the way new concepts are incorporated into everyday work		
31	HR and Production management partner to address issues and concerns of people on the shop floor		
32	Company systems, policies and procedures are regularly assessed to ensure the programme is supported		
33	Employee recognition or reward system linked to the programme		
34	Clearly defined measures for critical processes, with regular monitoring		
35	Clearly defined measures for key performance areas, with regular monitoring		
36	Addition of leading KPIs that operators understand (stops, MTBF)		
37	Availability of a crisis or strategic need that motivates the organisation to change		
38	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)		
39	Setting and communicating an improvement agenda and roll-out plan		
40	Management identification of which tools will work best in their organisation		
41	Targeting areas of rapid success first		
42	Organisational stability at each stage before advancing implementation		
43	Standardisation of part of a manager's work day		
44	Standardisation of work for operators and non-management employees		
45	Standard work with visual management		
46	Standardised management system		
47	Discipline in adhering to standardised work		

Appendix C: Complete CSF ranking for all respondent groups

Table 27: CSF ranking (total respondents)

Theme	Ranking	Success-factor description	Application		Criticality	
Leadership commitment	1	Top management joins improvement events/meetings on a regular basis	4.17	83%	4.40	88%
Regular review of performance	2	Addition of leading KPIs that operators understand (stops, MTBF)	4.43	89%	4.37	87%
Regular review of performance	3	Clearly defined measures for key performance areas, with regular monitoring	4.37	87%	4.34	87%
Timing and planning	4	Targeting areas of rapid success first	4.37	87%	4.34	87%
Regular review of performance	5	Clearly defined measures for critical processes, with regular monitoring	4.17	83%	4.34	87%
Timing and planning	6	Management identification of which tools will work best in their organisation	4.11	82%	4.29	86%
Key resource	7	Financial investment to support programme success	4.31	86%	4.26	85%
Timing and planning	8	Setting and communicating an improvement agenda and roll-out plan	4.29	86%	4.26	85%
Bottom-up approach	9	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	4.11	82%	4.26	85%
Work standards	10	Standard work with visual management	4.11	82%	4.26	85%
Work standards	11	Standardised management system	4.23	85%	4.23	85%
Leadership commitment	12	Managers actively demonstrate commitment to the programme at all levels	4.20	84%	4.23	85%
Key resource	13	Executive or senior manager appointed to oversee the project	4.34	87%	4.17	83%
Work standards	14	Discipline in adhering to standardised work	4.03	81%	4.17	83%
Key resource	15	Organisational structure should enable the programme to succeed	4.00	80%	4.17	83%
Regular review of performance	16	Reliable data enabling regular detailed analyses	4.11	82%	4.14	83%
Timing and planning	17	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)	4.11	82%	4.14	83%
Learning culture	18	Comprehensive training such that everyone has necessary skills and understands the philosophy	4.09	82%	4.14	83%
Work standards	19	Standardisation of part of a manager's work day	3.97	79%	4.14	83%
Learning culture	20	Employees learn from personal and colleagues' positive and negative experiences	4.09	82%	4.11	82%

Work standards	21	Standardisation of work for operators and non-management employees	3.86	77%	4.11	82%
Employee engagement	22	Employees understand company objectives through clearly communicated vision	4.09	82%	4.09	82%
Bottom-up approach	23	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value (operators and technicians) rather than giving instructions	4.03	81%	4.06	81%
Employee engagement	24	Employee input for measuring performance to stimulate understanding and accountability	3.94	79%	4.06	81%
Leadership commitment	25	Top management presence and availability on the shop floor, engaging with employees	3.91	78%	4.06	81%
Bottom-up approach	26	Converting from top-down leadership to bottom-up initiatives	3.94	79%	4.03	81%
Employee engagement	27	Management demonstration of trust in employees' abilities	3.80	76%	4.03	81%
Leadership commitment	28	Top management actively driving and supporting change (with buy-in established before implementation)	4.17	83%	4.00	80%
Employee engagement	29	Involving operators through empowered task teams to analyse specific issues and make improvements	4.11	82%	4.00	80%
Learning culture	30	Individual and group learning is captured and deployed systematically	4.06	81%	4.00	80%
Bottom-up approach	31	Resources freed up by productivity gains are reinvested into the search for still greater improvements	3.89	78%	4.00	80%
Employee engagement	32	Getting shop floor commitment and employee trust	3.80	76%	4.00	80%
Strategic importance	33	Availability of a crisis or strategic need that motivates the organisation to change	3.80	76%	4.00	80%
Employee engagement	34	Employees are engaged proactively on the project throughout the company	3.69	74%	4.00	80%
Key resource	35	Experienced and full time programme facilitator	4.09	82%	3.97	79%
Timing and planning	36	Organisational stability at each stage before advancing implementation	3.94	79%	3.97	79%
Organisational integration	37	Company systems, policies and procedures are regularly assessed to ensure the programme is supported	3.86	77%	3.97	79%
Employee engagement	38	Linking successes experienced to the project (celebrating successes)	3.71	74%	3.97	79%
Organisational integration	39	Employees have a shared set of values that influence the way new concepts are incorporated into everyday work	3.94	79%	3.94	79%

Organisational integration	40	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across boundaries at all levels of the organisation	3.77	75%	3.94	79%
Leadership commitment	41	Managerial push (mandatory participation of employees in workshops and training)	3.66	73%	3.86	77%
Bottom-up approach	42	Employees are free to allocate time to improvement (empowerment)	3.54	71%	3.77	75%
Organisational integration	43	Integrating external suppliers and customers into the transformation	3.49	70%	3.74	75%
Key resource	44	Finding a good change agent or champions to remove negativity or obstacles in the organisation	3.40	68%	3.69	74%
Recognition and reward	45	Employee recognition or reward system linked to the programme	3.51	70%	3.60	72%
Employee engagement	46	Establish stakeholder commitment, i.e. workers' council	3.14	63%	3.34	67%
Organisational integration	47	HR and Production management partner to address issues and concerns of people on the shop floor	2.71	54%	3.14	63%

Table 28: CSF ranking (operators)

Theme	Ranking	Success-factor description	Application		Criticality	
Regular review of performance	1	Addition of leading KPIs that operators understand (stops, MTBF)	4.21	84%	4.16	83%
Timing and planning	2	Management identification of which tools will work best in their organisation	4.05	81%	4.16	83%
Leadership commitment	3	Top management joins improvement events/meetings on a regular basis	3.84	77%	4.16	83%
Timing and planning	4	Setting and communicating an improvement agenda and roll-out plan	3.84	77%	4.16	83%
Bottom-up approach	5	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	4.16	83%	4.05	81%
Timing and planning	6	Targeting areas of rapid success first	4.11	82%	4.05	81%
Leadership commitment	7	Managers actively demonstrate commitment to the programme at all levels	3.95	79%	4.05	81%
Regular review of performance	8	Clearly defined measures for critical processes, with regular monitoring	3.74	75%	4.05	81%
Regular review of performance	9	Clearly defined measures for key performance areas, with regular monitoring	4.00	80%	4.00	80%
Work standards	10	Standard work with visual management	3.84	77%	4.00	80%

Learning culture	11	Comprehensive training such that everyone has necessary skills and understands the philosophy	3.79	76%	4.00	80%
Leadership commitment	12	Top management presence and availability on the shop floor, engaging with employees	4.00	80%	3.95	79%
Employee engagement	13	Involving operators through empowered task teams to analyse specific issues and make improvements	3.95	79%	3.95	79%
Key resource	14	Financial investment to support programme success	3.95	79%	3.95	79%
Organisational integration	15	Company systems, policies and procedures are regularly assessed to ensure the programme is supported	3.84	77%	3.95	79%
Key resource	16	Organisational structure should enable the programme to succeed	3.63	73%	3.95	79%
Key resource	17	Executive or senior manager appointed to oversee the project	4.05	81%	3.89	78%
Employee engagement	18	Employees understand company objectives through clearly communicated vision	3.84	77%	3.89	78%
Bottom-up approach	19	Resources freed up by productivity gains are reinvested into the search for still greater improvements	3.79	76%	3.89	78%
Employee engagement	20	Employees are engaged proactively on the project throughout the company	3.79	76%	3.89	78%
Work standards	21	Standardised management system	4.00	80%	3.84	77%
Employee engagement	22	Employee input for measuring performance to stimulate understanding and accountability	3.79	76%	3.84	77%
Key resource	23	Experienced and full time programme facilitator	3.95	79%	3.79	76%
Work standards	24	Discipline in adhering to standardised work	3.84	77%	3.79	76%
Organisational integration	25	Employees have a shared set of values that influence the way new concepts are incorporated into everyday work	3.79	76%	3.79	76%
Learning culture	26	Employees learn from personal and colleagues' positive and negative experiences	3.58	72%	3.79	76%
Strategic importance	27	Availability of a crisis or strategic need that motivates the organisation to change	3.58	72%	3.79	76%
Timing and planning	28	Organistional stability at each stage before advancing implementation	3.58	72%	3.79	76%
Employee engagement	29	Getting shop floor commitment and employee trust	3.47	69%	3.79	76%
Employee engagement	30	Management demonstration of trust in employees' abilities	3.37	67%	3.79	76%
Work standards	31	Standardisation of part of a manager's work	3.26	65%	3.79	76%

		day				
Learning culture	32	Individual and group learning is captured and deployed systematically	3.63	73%	3.74	75%
Timing and planning	33	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)	3.58	72%	3.74	75%
Organisational integration	34	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across bounderies at all levels of the organisation	3.63	73%	3.68	74%
Bottom-up approach	35	Employees are free to allocate time to improvement (empowerment)	3.32	66%	3.68	74%
Leadership commitment	36	Managerial push (mandatory participation of employees in workshops and training)	3.32	66%	3.68	74%
Bottom-up approach	37	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value (operators and technicians) rather than giving instructions	3.68	74%	3.63	73%
Regular review of performance	38	Reliable data enabling regular detailed analyses	3.53	71%	3.63	73%
Work standards	39	Standardisation of work for operators and non-management employees	3.11	62%	3.63	73%
Leadership commitment	40	Top management actively driving and supporting change (with buy-in established before implementation)	3.68	74%	3.53	71%
Bottom-up approach	41	Converting from top-down leadership to bottom-up initiatives	3.53	71%	3.53	71%
Key resource	42	Finding a good change agent or champions to remove negativity or obstacles in the organisation	3.37	67%	3.53	71%
Employee engagement	43	Linking successes experienced to the project (celebrating successes)	3.26	65%	3.53	71%
Organisational integration	44	Integrating external suppliers and customers into the transformation	3.26	65%	3.42	68%
Recognition and reward	45	Employee recognition or reward system linked to the programme	3.26	65%	3.37	67%
Employee engagement	46	Establish stakeholder commitment, i.e. workers' council	3.11	62%	3.16	63%
Organisational integration	47	HR and Production management partner to address issues and concerns of people on the shop floor	2.74	55%	2.95	59%

Table 29: CSF ranking (senior staff)

Theme	Ranking	Success-factor description	Application		Criticality	
Regular review of performance	1	Clearly defined measures for key performance areas, with regular monitoring	4.81	96%	4.75	95%
Regular review of performance	2	Reliable data enabling regular detailed analyses	4.81	96%	4.75	95%
Work standards	3	Standardisation of work for operators and non-management employees	4.75	95%	4.69	94%
Regular review of performance	4	Clearly defined measures for critical processes, with regular monitoring	4.69	94%	4.69	94%
Timing and planning	5	Targeting areas of rapid success first	4.69	94%	4.69	94%
Leadership commitment	6	Top management joins improvement events/meetings on a regular basis	4.56	91%	4.69	94%
Work standards	7	Standardised management system	4.50	90%	4.69	94%
Key resource	8	Financial investment to support programme success	4.75	95%	4.63	93%
Timing and planning	9	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)	4.75	95%	4.63	93%
Regular review of performance	10	Addition of leading KPIs that operators understand (stops, MTBF)	4.69	94%	4.63	93%
Bottom-up approach	11	Converting from top-down leadership to bottom-up initiatives	4.44	89%	4.63	93%
Work standards	12	Discipline in adhering to standardised work	4.25	85%	4.63	93%
Work standards	13	Standardisation of part of a manager's work day	4.81	96%	4.56	91%
Leadership commitment	14	Top management actively driving and supporting change (with buy-in established before implementation)	4.75	95%	4.56	91%
Bottom-up approach	15	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value (operators and technicians) rather than giving instructions	4.44	89%	4.56	91%
Work standards	16	Standard work with visual management	4.44	89%	4.56	91%
Key resource	17	Executive or senior manager appointed to oversee the project	4.69	94%	4.50	90%
Learning culture	18	Employees learn from personal and colleagues' positive and negative experiences	4.69	94%	4.50	90%
Employee engagement	19	Linking successes experienced to the project (celebrating successes)	4.25	85%	4.50	90%
Bottom-up approach	20	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	4.06	81%	4.50	90%

Leadership commitment	21	Managers actively demonstrate commitment to the programme at all levels	4.50	90%	4.44	89%
Key resource	22	Organisational structure should enable the programme to succeed	4.44	89%	4.44	89%
Timing and planning	23	Management identification of which tools will work best in their organisation	4.19	84%	4.44	89%
Timing and planning	24	Setting and communicating an improvement agenda and roll-out plan	4.81	96%	4.38	88%
Learning culture	25	Individual and group learning is captured and deployed systematically	4.56	91%	4.31	86%
Learning culture	26	Comprehensive training such that everyone has necessary skills and understands the philosophy	4.44	89%	4.31	86%
Employee engagement	27	Employees understand company objectives through clearly communicated vision	4.38	88%	4.31	86%
Employee engagement	28	Management demonstration of trust in employees' abilities	4.31	86%	4.31	86%
Employee engagement	29	Employee input for measuring performance to stimulate understanding and accountability	4.13	83%	4.31	86%
Employee engagement	30	Getting shop floor commitment and employee trust	4.19	84%	4.25	85%
Strategic importance	31	Availability of a crisis or strategic need that motivates the organisation to change	4.06	81%	4.25	85%
Organisational integration	32	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across bounderies at all levels of the organisation	3.94	79%	4.25	85%
Timing and planning	33	Organistional stability at each stage before advancing implementation	4.38	88%	4.19	84%
Key resource	34	Experienced and full time programme facilitator	4.25	85%	4.19	84%
Leadership commitment	35	Top management presence and availability on the shop floor, engaging with employees	3.81	76%	4.19	84%
Organisational integration	36	Employees have a shared set of values that influence the way new concepts are incorporated into everyday work	4.13	83%	4.13	83%
Bottom-up approach	37	Resources freed up by productivity gains are reinvested into the search for still greater improvements	4.00	80%	4.13	83%
Organisational integration	38	Integrating external suppliers and customers into the transformation	3.75	75%	4.13	83%
Employee engagement	39	Employees are engaged proactively on the project throughout the company	3.56	71%	4.13	83%

Employee engagement	40	Involving operators through empowered task teams to analyse specific issues and make improvements	4.31	86%	4.06	81%
Leadership commitment	41	Managerial push (mandatory participation of employees in workshops and training)	4.06	81%	4.06	81%
Organisational integration	42	Company systems, policies and procedures are regularly assessed to ensure the programme is supported	3.88	78%	4.00	80%
Bottom-up approach	43	Employees are free to allocate time to improvement (empowerment)	3.81	76%	3.88	78%
Recognition and reward	44	Employee recognition or reward system linked to the programme	3.81	76%	3.88	78%
Key resource	45	Finding a good change agent or champions to remove negativity or obstacles in the organisation	3.44	69%	3.88	78%
Employee engagement	46	Establish stakeholder commitment, i.e. workers' council	3.19	64%	3.56	71%
Organisational integration	47	HR and Production management partner to address issues and concerns of people on the shop floor	2.69	54%	3.38	68%

Appendix D: Spread of CSF rankings

Table 30: Standard deviation per SF for each question

#	Success-factors	Q1 SD	Q2 SD
1	Integrating external suppliers and customers into the transformation	1.12	1.16
2	Employee 'pull' the new ways of working as they understand the benefits of the programme for themselves	0.56	0.82
3	Standardised management system	0.78	0.62
4	Executive or senior manager appointed to oversee the project	0.68	0.68
5	Discipline in adhering to standardised work	0.69	0.73
6	Top management presence and availability on the shop floor, engaging with employees	0.96	0.96
7	Employee recognition or reward system linked to the programme	1.18	1.20
8	Finding a good change agent or champions to remove negativity or obstacles in the organisation	1.17	0.96
9	Leaders and supervisors motivate, coach, train and facilitate the work of those adding value (operators and technicians) rather than giving instructions	0.80	0.93
10	Employees understand company objectives through clearly communicated vision	0.76	0.68
11	Targeting areas of rapid success first	0.49	0.47
12	Employees are free to allocate time to improvement (empowerment)	1.14	0.87
13	Establish stakeholder commitment, i.e. workers' council	1.11	1.01
14	Individual and group learning is captured and deployed systematically	0.80	0.80
15	Resources freed up by productivity gains are reinvested into the search for still greater improvements	0.92	0.89
16	Getting shop floor commitment and employee trust	0.82	0.76
17	Involving operators through empowered task teams to analyse specific issues and make improvements	0.89	0.77
18	Company systems, policies and procedures are regularly assessed to ensure the programme is supported	0.98	0.83
19	Experienced and full time programme facilitator	0.72	0.67
20	Managerial push (mandatory participation of employees in workshops and training)	1.05	0.94
21	Organisational structure should enable the programme to succeed	0.87	0.57
22	Comprehensive training such that everyone has necessary skills and understands the philosophy	0.61	0.67
23	Employees are engaged proactively on the project throughout the company	0.89	0.80
24	Managers actively demonstrate commitment to the programme at all levels	0.77	0.81
25	Clearly defined measures for key performance areas, with regular monitoring	0.73	0.73
26	Standard work with visual management	0.93	0.68
27	Organisational stability at each stage before advancing implementation	0.83	0.97
28	Financial investment to support programme success	0.63	0.56
29	Management demonstration of trust in employees' abilities	0.95	0.68
30	Clearly defined measures for critical processes, with regular monitoring	0.73	0.63

31	Building internal customer-supplier relationships (by integrating support functions) such that employees work effectively across boundaries at all levels of the organisation	0.75	0.71
32	Management identification of which tools will work best in their organisation	0.77	0.62
33	Employees have a shared set of values that influence the way new concepts are incorporated into everyday work	0.86	1.04
34	Reliable data enabling regular detailed analyses	0.85	0.93
35	Conducting an important and visible activity of the programme as soon as possible (e.g. leadership deep clean)	0.98	0.73
36	Linking successes experienced to the project (celebrating successes)	1.00	0.80
37	Employee input for measuring performance to stimulate understanding and accountability	0.84	0.78
38	Standardisation of work for operators and non-management employees	1.18	0.73
39	Availability of a crisis or strategic need that motivates the organisation to change	0.93	0.84
40	HR and Production management partner to address issues and concerns of people on the shop floor	1.15	1.05
41	Standardisation of part of a manager's work day	0.85	0.75
42	Top management joins improvement events/meetings on a regular basis	0.89	0.61
43	Employees learn from personal and colleagues' positive and negative experiences	1.01	0.77
44	Setting and communicating an improvement agenda and roll-out plan	0.73	0.91
45	Top management actively driving and supporting change (with buy-in established before implementation)	1.01	0.70
46	Converting from top-down leadership to bottom-up initiatives	0.86	0.77
47	Addition of leading KPIs that operators understand (stops, MTBF)	0.56	0.63

Appendix E: Participant information sheet

August 2015

Dear participant,

Re: Participation in Research at Wits University

Thank you for your participation in the survey.

I am a part-time MSc student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand, under the supervision of Dr Bruno Emwanu. My MSc research title is:

Critical success factors for implementing a labour productivity improvement initiative in a competitive South African manufacturing plant for greater international competitiveness

My belief is that by understanding the critical success factors of the programme implemented in this company, the study should eventually provide support to local manufacturing managers or practitioners in improving labour productivity without having to substitute labour for capital investment – the shedding of labour to meet business needs should then reduce, assisting South Africa's unemployment rate and at the same time improving the country's manufacturing international competitiveness.

The study will be conducted between February 2015 and March 2016. Involvement in the study is to complete the questionnaire provided based on your experience and knowledge of manufacturing improvement programme implemented.

Participation in the study is voluntary, and you may withdraw at any time. Anonymity (regarding company name and any owner/manager/employee names) and confidentiality of information provided will be assured and respected.

The results of the study will form part of my MSc research report, and may also be reported in academic papers and at conferences. A summary of the results of the research will be made available to you on request.

Please contact me if you have any questions regarding the research and participation in the study.

I look forward to hearing from you.

Yours faithfully

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