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Advanced manufacturing technology implementation: An examination of organisational factors

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

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ABSTRACT

Amid increased competition associated with globalisation, the South African manufacturing sector has come under increased pressure in recent times, with an associated decline in competitiveness. There has been a strong drive by organisations to invest in innovations in the form of Advanced Manufacturing Technologies (AMTs) in an effort to improve their technological status and performance. While investment in AMTs often has a positive impact on performance, numerous accounts of the AMT not meeting expected benefits have been reported. Inability to effectively extract intended benefits from the AMT is often a result of the complex nature of the process, which requires technological considerations and a strategic approach. The objective of this research was to identify the critical organisational factors that impact AMT implementation and establish the relative importance of the factors to provide a guide to managers implementing AMTs to prepare their organisations for the new technology and extract the intended benefits.

The research took the form of a quantitative study guided by a self-developed survey and was carried out on manufacturing organisations operating in South Africa. The survey put forward a set of four critical factors that impact AMT implementation, each defined by a proposed set of sub-factors that were validated as accurate definitions in the research.

The research established the importance of the proposed factors in contributing to effective AMT implementation, with top management ability and training and education ranked highest, followed by organisational ability a level below and incentives and rewards occupying the lowest level of importance. The importance of these factors was validated through a correlation established between AMT implementation success and the degree to which the organisational factors are evident within an organisation. Organisational readiness of manufacturing companies in South Africa to effectively implement AMTs was also assessed. AMT Considerations related to the size of the organisation and the type of AMT being implemented are also presented along with a summary of key benefits targeted from AMT implementations. Findings were used to develop a model that presents a guide to highlight areas that need attention within an organisation to assist in the allocation of resources during AMT implementations.

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KEYWORDS

Advanced manufacturing technology, manufacturing, implementation, organisational factors, innovation diffusion

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DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Jason Knock

Signature: _____

Date: _____

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CHAPTER 1: INTRODUCTION

1.1 Research problem

Globalisation, coupled with increased competition, has led to rapid changes to manufacturing over the past two decades, and even more so recently (Singh & Khamba, 2010). While presenting growth opportunities, such dynamics have also raised questions about the competitiveness of South Africa's manufacturing sector evidenced by a gradual decline in the sectors ability to compete in the highly competitive global arena (Rodrik, 2008).

This decline in competitiveness, attributed to factors both within and outside the locus of control of stakeholders, has led to numerous job losses in the generally labour-intensive industry and undoubtedly impacted the standard of living in the country (Tregenna, 2009; Rodrik, 2008). Innovation is a key driver of productivity, which stimulates competitiveness and economic growth (Jiménez-Jiménez & Sanz-Valle, 2011; Porter, Ketels, & Delgado, 2007), and can provide a gateway to socioeconomic prosperity (Porter et al., 2007).

Investment in innovation in the form of Advanced Manufacturing Technologies (AMTs) is emerging as a strategic weapon for manufacturing organisations in an increasingly competitive global market (Singh, Gar, Deshmukh, & Kumar, 2007). In an effort to improve their technological status, and hence performance, there has been a strong drive by manufacturers to adopt innovations in the form of AMTs (Singh & Khamba, 2010; Millen & Sohal, 1998). Narula (2004) described how the establishment of an technological leader in the industry can threaten the very existence of the lagging competition. Increasingly, organisations are turning to AMTs to cope with fragmented mass markets, shorter product life cycles and increased consumer demand for customisation (Raymond & Croteau, 2006).

Youssef (1992) describes AMTs as a group of integrated hardware- and software-based technologies, which can improve the productivity and effectiveness of a company if properly implemented, monitored and evaluated.

Although positive relationships between AMT implementation and company performance have been widely reported in a variety of contexts (Taj & Morosan, 2011;

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Svobodová, 2011; Thomas, Barton, & John, 2008; Kotha & Swamidass, 2000), accounts of AMT implementation not meeting expectations have also been presented (Svobodová, 2011; Hynek & Janeček, 2010; Koc & Bozdag, 2009; Percival, 2009; Baldwin & Lin, 2002). AMTs and organisational performance were found to have a complex relationship (Koc & Bozdag, 2009), which was attributed to factors internally and as a result of external factors (Koellinger, 2008). The complexity of this relationship, coupled with the mixed results attained from AMT introduction into manufacturing organisations, posits the need to understand the underlying factors that influence this dynamic.

AMT failure is often a result of an inadequate implementation and diffusion of the new innovation through the organisation (Saberi, Yusuff, Zulkifli, & Megat Ahmad, 2010). Dewett, Whittier, & Williams (2007) further provided a good account of how the inability to effectively implement and diffuse innovations through targeted areas results in failure to reap true value from efforts directed at innovation. Waldeck & Leffakis (2007) argued that the success of AMT is not only dependent on the technology, but also on how well it is implemented. A number of past studies have also revealed how AMT implementation has often been a lot more complicated than expected and a continuing trend in firms struggling to implement these technologies and extract intended benefits (Gouvea Da Costa, Platts, & Fleury, 2006; Gupta, Chen, & Chiang, 1997).

1.2 Context: Manufacturing in South Africa

While still significant, the South African manufacturing sector's contribution to GDP has fallen over the years. The sector currently contributes R350 billion to the national GDP (Statistics South Africa, 2014). That equates to a 12% contribution, down from 17% in 2004 at current prices. The comparatively low annual growth rate realised by the manufacturing sector (Figure 1.1) further highlights the decline of manufacturing and the need for an intervention.

Figure 1.2 provides a breakdown of manufacturing industries in South Africa by size according to share of manufacturing sector total sales, based on 2013. The sector is dominated by the petroleum, chemical, rubber and plastic products that account for 26% of sales. The food and beverages and basic iron and steel, non-ferrous metal products, metal products and machinery industries also contribute a significant 22% of total sales.

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Figure 1.1: Sector contribution to the GDP of South Africa (2004 – 2013) and annual growth rate from 2004 at current prices (Data extracted from Statistics South Africa, 2014).

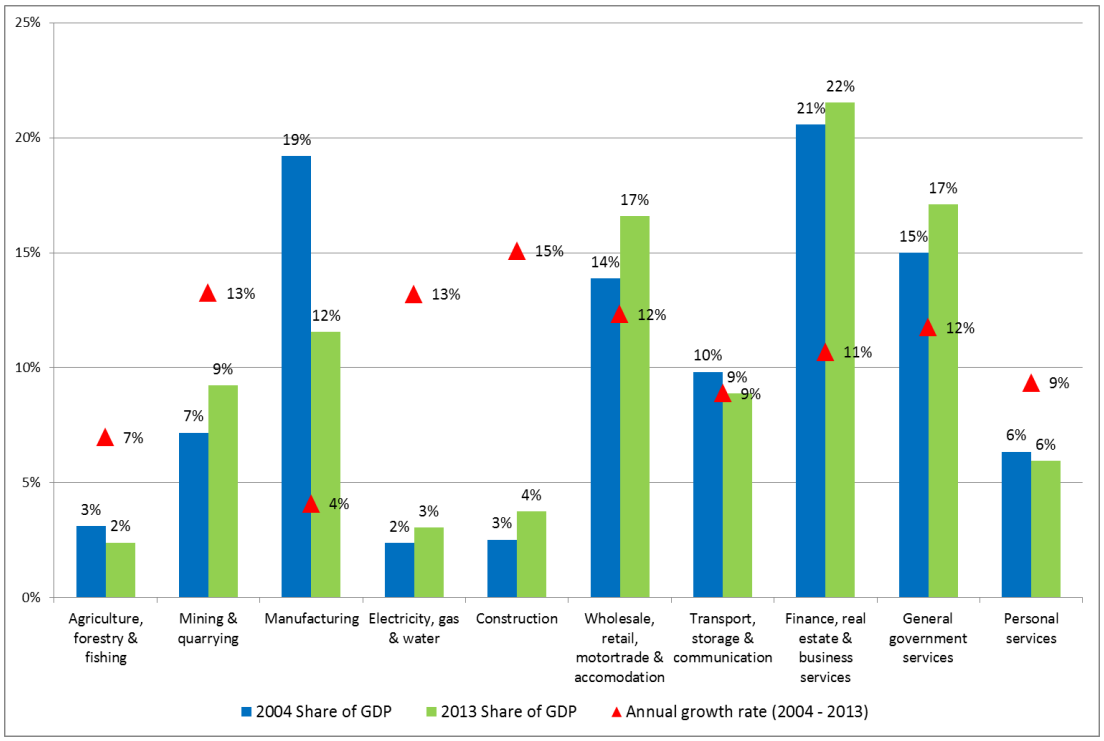
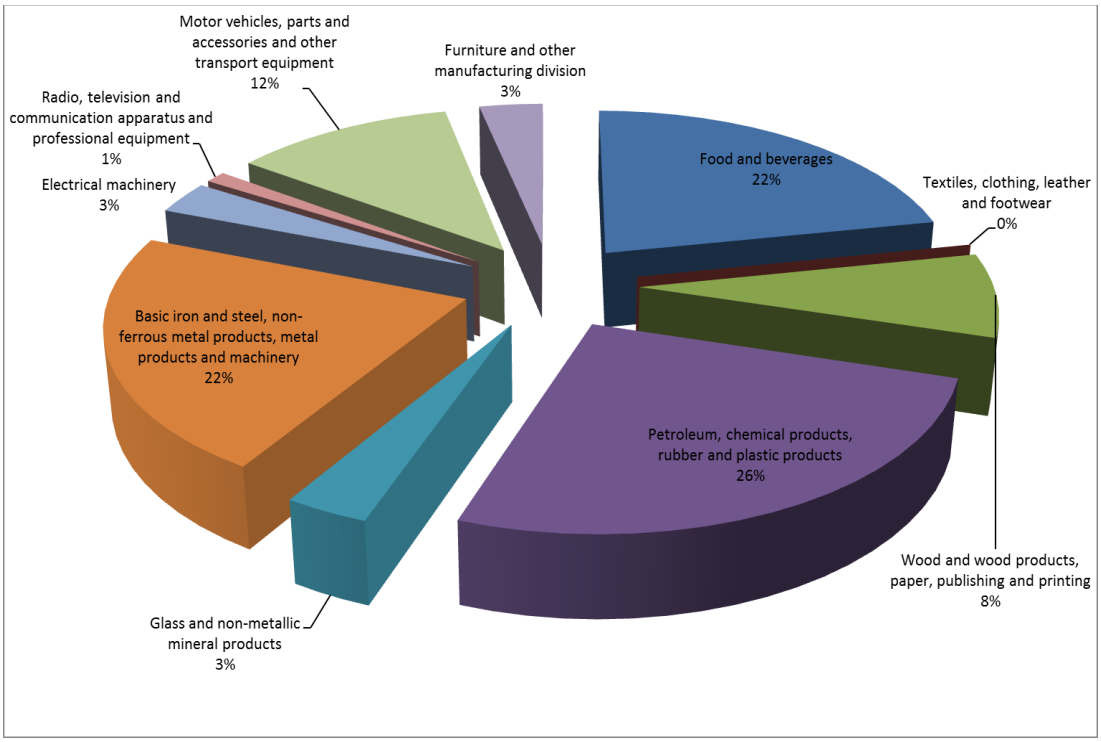


Figure 1.2: Breakdown of manufacturing industries by size according to share of manufacturing sector total sales, based on 2013 figures (Data extracted from Statistics South Africa, 2014).



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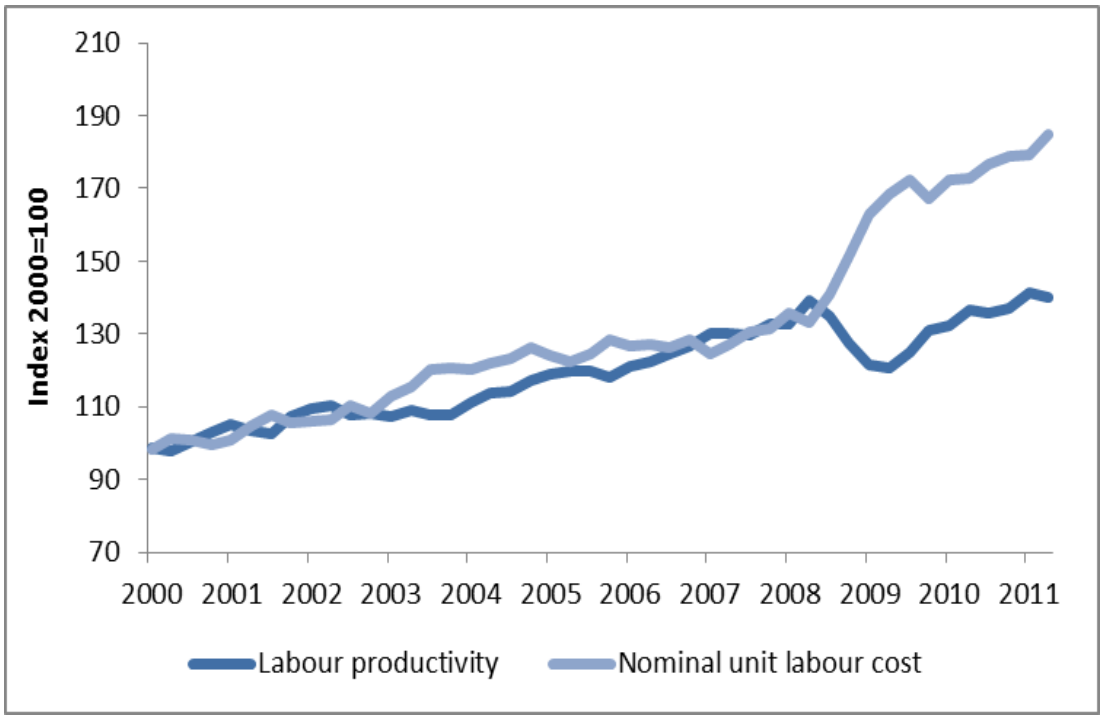
Although economic evolution does support the transition from primary and secondary (manufacturing) to the tertiary sector (Rostow, 1990), the manufacturing sector is still a significant and labour-intensive industry that has an important role to play in the South African economy. Manufacturing needs to form an integral part of economic and industry growth strategies.

This decline in manufacturing is exacerbated by increased competition in the sector as a result of globalisation. Productivity, coupled with labour costs, provides insight into the competitiveness of an industry. South Africa has seen a large divergence between labour productivity and nominal unit labour costs in the manufacturing sector in recent years (Figure 1.3) that points to reduced output at increased cost. Between 2000 and 2011, nominal unit labour costs increased by a staggering 85%, nominal labour productivity saw an increase of just 40%.

This worrying trend can only be detrimental to the global competitiveness and profitability of the South African manufacturing sector. To effect a recovery, labour costs will need to grow at a lower rate, which is unlikely, or productivity will need to increase at a greater rate. Innovation, in the form of technology, drives productivity, while suppressing labour costs.

Figure 1.3: Labour productivity and nominal unit labour cost from 2000 to 2011 in the South African manufacturing sector (Data extracted from Lehohla (2012)).



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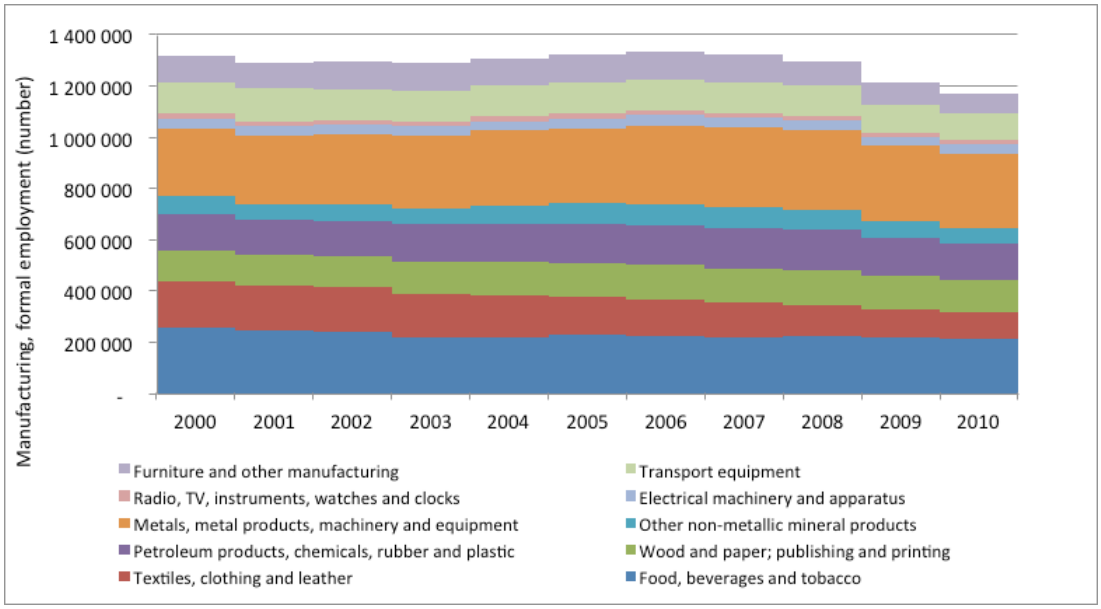
Under intense pressure, the manufacturing sector has experienced a decline of around 150,000 (11.3%) in formal employment numbers between 2000 and 2010 (Figure 1.4), with total formal employment jobs at about 1.17 million in 2010. The downward trend in employment numbers has been evident since 2006, when a small recovery was noted after the dot-com bubble burst in the United States in 2000 that lead to an economic downturn. This trend is worrying, particularly in South Africa, where unemployment levels are considered relatively high. Recovery will require a step-wise change in the competitiveness of this labour-intensive sector to spark job creation and economic growth.

Figure 1.4: Formal manufacturing employment figures for major manufacturing sub-sectors from 2000 to 2010 (Lehohla, 2012).



1.3 Motivation for research

AMTs, if implemented successfully, can contribute to achieving productivity gains within manufacturing organisations. The considerable challenges presented with the implementation of AMTs, however, lends itself to the need to gain a deeper understanding of the dynamics to identify the broader concerns that should be addressed when introducing AMTs.

In order to enhance the gains from AMTs, management needs to identify, understand and address the critical issues that impact on implementation effectiveness and absorption. It is imperative that critical factors that impact AMT implementation are prioritised to guide decision-making and use resources efficiently. A number of authors

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have put forward a strong case towards understanding the organisational and strategic factors that make a company more adept in taking on and using AMTs to enhance company performance (Saberi et al., 2010; Darbanhosseiniamirkhiz & Wan Ismail, 2012).

Organisational factors have been accepted in literature to have a considerable influence on the effectiveness of AMT implementation, often resulting in an inability to extract the intended benefits should ideal conditions not be evident within the organisation (Saberi et al., 2010; Marri, Gunasekaran, & Sohal, 2007). In their work on identifying the organisational factors that impact AMT implementation, Cardoso, Pinheiro de Lima, & Gouvea da Costa (2012) emphasised that most problems identified after implementation originated from a lack of analysis and identification of the organisational characteristics necessary for success.

Although studies related to the implementation of AMTs have been put forward in literature (Darbanhosseiniamirkhiz & Wan Ismail, 2012; Lima & Gouvea da Costa, 2012; Marri et al., 2007), these have largely been theoretical or confined to certain contexts, AMT types and industries, thus limiting the general applicability of the findings. A need therefore exists to build on the current body of research with a more empirical approach. Darbanhosseiniamirkhiz & Wan Ismail (2012) stated that there exists a need for further research around the organisational factors that impact AMT implementation within a specific context and environment to assist in gathering more relevant and applicable findings.

1.4 Research objective

The aim of this work will be to firstly identify and define a set of key organisational factors that impact AMT implementation. After confirming validity of these factors and definitions applied, a ranking of the importance of the critical organisational factors that impact AMT implementation within an organisation in the South African context will be established, through a quantitative assessment guided by current and recent AMT implementations. An assessment of the difference in the importance rankings based on organizational size and type of AMT will also be assessed. Thereafter, the actual dynamics of the organisational factors in play within the companies will be diagnosed to assess organisational readiness for the introduction of AMTs and as a means of supporting the validity of the proposed factors.

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The outcome of the work will present the current situation in South African manufacturing organisations coupled with a model to provide a guideline to managers intending on implementing AMT within their organisations, enabling them to prepare their organisations to adopt an AMT more effectively and extract the intended benefits. Insights around the primary benefits targeted from AMT implementations and the degree of AMT implementation success will also be briefly touched upon.

The investigation will be carried out on medium- and low-tech manufacturing organisations of all sizes within South Africa and thus will be applicable to this context. The study will also allow a comparison between large organisations and small and medium-sized enterprises (SMEs), as well as elucidate how the type of AMT impacts critical organisational factors required for effective implementation.

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CHAPTER 2: LITERATURE REVIEW

The literature review sets out to critically evaluate the broad areas of interest related to this study and identify gaps in literature around the subject. A large number of theories and models have been put forward to assist in explaining the implementation, acceptance and use of innovations or new technologies, such as AMT, in a range of organisational settings. Following an introduction to AMT and the benefits that can be derived from its implementation, the AMT implementation process is discussed. Some of the issues encountered during implementation are examined to further support the research problem put forward for this study.

Fundamental aspects around the spread of innovation within a community are explained through the theory of innovation diffusion (Rodgers, 2003) that forms a cornerstone in this field of study. The work has been further developed by numerous authors who have introduced theories to explain the organisational factors behind the effectiveness of the absorption of new innovations within an organisation. Diffusion theory is used as a basis to introduce the rationale behind how AMT is absorbed within an organisation.

While studies have been conducted on AMT, exploring theories around the impact of organisational factors in the implementation of AMT within an organisation, much of the focus has been on theoretical models with limited empirical studies. Frameworks around the organisational factors impacting AMT implementation are presented to assist in the development of the research questions and hypothesis this study will set out to address.

2.1 Advanced Manufacturing Technology (AMT)

Mora-Monge, González, Quesada, & Rao (2008) and Sohal, Schroder, Uliana, & Maguire (2001) described AMT as a variety of modern technologies designed to accomplish or support manufacturing tasks. AMTs can include computer software, such as computer-aided-design (CAD), computer-aided-manufacturing CAM, materials requirements planning (MRP), manufacturing-resource-planning (MRPII) and expert systems; computer hardware, such as mainframes, local-area-network (LAN) and shop floor capture data; and plant and equipment; such as flexible manufacturing cells, flexible manufacturing systems and automatic assembly (Gunawardana, 2006; Mora-

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Monge et al., 2008; Sohal et al., 2001).

Table 2.1: Classification of AMTs

AMT Type	Technology
Computer Hardware	• Local Area Networks (LAN) • Micros (PC Computers) • Graphics hardware • Mainframe • Online process instrumentation • Shop floor data capture • Wide area networks (WAN) • Automated Vision-based systems used for inspection/testing of inputs or final products • Other automated sensor-based systems used for inspection/testing of inputs
Computer Software	• Computer-Aided Design (CAD) • Computer-Aided Process Planning (CAPP) • Computer-Aided Manufacturing (CAM) • Database Management Systems (DBM) • Material Requirements Planning (MRP) • Manufacturing Resource Planning (MRP II) • Just-in-time (JIT) • Supervisory Control & Data Acquisition (SCADA)
Plant and Equipment	• Programmable logic control machines or processes (CNC and NC) • Materials working laser (MWL) • Robots with sensing capabilities • Robots without sensing capabilities • Other Robots • Rapid Prototyping systems • High speed machining • Flexible manufacturing cells • Automatic assembly • Flexible assembly systems • Automated warehousing/order picking

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A number of classifications have been applied to AMTs (Gunawardana, 2006). Table 1 presents a high-level classification of AMTs into three broad categories: computer hardware, computer software and plant and equipment, including the various technologies that fall into each of the categories. A further and interesting classification of AMTs is the degree of integration with current systems (Mora-Monge et al., 2008; Gunawardana, 2006). The technology can form a stand-alone, intermediate or integrated system and is largely dependent on the technology adopted and the technologies currently in operation within the organisation (Abdul Ghani, Jayabalan, & Sugumar, 2002; Gunawardana, 2006; Small, 2007).

2.2 Benefits of AMT

The promise of improved performance motivates organisations to adopt AMTs, while increased global competitiveness continues to drive the implementation of AMT within all manufacturing sectors (Hynek & Janeček, 2010; Hynek & Janeček, 2013; Saberi & Yusuff, 2012;). These studies, among others, have shown AMTs to provide both tangible and intangible benefits that are largely related to the type of technology and the intended application.

Technology is said to affect competitiveness in two ways (Viñas, Bessant, Pérez, & González, 2001). Firstly, the development of efficient and flexible processes drives a leaner cost structure, and secondly, through enabling the development of products of greater quality, better design and shorter delivery periods (Viñas et al., 2001). Efstathiades,Tassou, & Antoniou (2002) highlight how AMTs enable both economies of scale and of scope without the need to change hardware, while allowing the blending of small-batch and custom-order operations with the low-cost efficiency of standardised mass production. The strategic benefits of increased flexibility and responsiveness and the competitive gains that are achieved as a result of AMT implementation is further supported by Efstathiades, Tassou, Antoniou, & Oxinos (1998), Goyal & Grover (2012) and Millen, & Sohal (1998).

Some of the more common benefits sought through the implementation of AMT can include: increased productivity or throughput, better management control, overcoming lack of production skills, reduced set-up times, improved accuracy in materials planning, cost reduction, increased product or process flexibility, decreased lead-times; reduced product development cycle times, better working relationships, improved utilisation of equipment and improved product quality and productivity (Dangayach &

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Deshmukh, 2005; Hofmann & Orr, 2005; Koc & Bozdag, 2009; Percival, 2009; Sohal et al., 2001).

Studies aimed at ranking the main benefits targeted from AMT implementation according to importance have been conducted. Hynek & Janeček (2013) conducted a study of managers in the Czech Republic manufacturing industry to understand the importance of the benefits of AMT implementation. In a study conducted by Sohal et al. (2001) of the South African manufacturing industry, a similar evaluation was conducted to identify the main benefits targeted from AMT implementation. Table 2.2 displays the top six items for each study. With the exception of increased sales and flexibility, all other benefits were common to both studies, with improved quality and increased throughput making an appearance in the top three of both rankings.

Table 2.2: Comparison of the rankings of the importance of targeted AMT benefits from past studies

Rank	Study by Hynek & Janeček (2013) on Czech manufacturers	Study by Sohal et al. (2001) on South African manufacturers
1	Reduced costs	Obtaining competitive advantage
2	Improved quality	Increased throughput
3	Increased throughput	Improved quality
4	Obtaining competitive advantage	Reduced costs
5	Increased sales	Better management control
6	Better management control	Increased flexibility

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2.3 Innovation diffusion

Creation forms one aspect of the innovation process. However, in order to extract value following a decision to adopt the innovation, effective implementation and diffusion through the society for which the innovation is intended to benefit is critical, as is the case for AMT within manufacturing organisations (Pham, Thomas & Pham, 2010; Salaheldin, 2007). Rogers (2003), one of the pioneers of diffusion theory, defined innovation diffusion as a process through which innovation moves through and is taken up in a social system through a certain time and specific channels. In the context of this study, the social system can be defined as the stakeholders involved in the implementation and adoption of the AMT innovations within medium- and low-tech manufacturing organisations.

Rodgers (2003) proposed that the diffusion process was composed of innovation, communication channels, time and a social system. This work has been more recently examined and built on by MacVaugh & Schiavone (2010), who focused largely on the limitations of innovation adoption and diffusion, while Dewett et al. (2007) focused more on the concepts around innovation diffusion within an organisation.

The two broad conclusions drawn from the work of MacVaugh & Schiavone (2010) aimed at explaining the factors affecting whether a new innovation is adopted or not include the extent to which new technology meets technological, social or learning conditions encouraging its adoption and the extent to which new technology is considered useful in the individual, community or industry domains. These valid, yet relatively simplistic views of innovation adoption and diffusion put forward by MacVaugh & Schiavone (2010) fail to explore some of the more intricate factors of the process presented in the work of Dewett et al. (2007).

Figure 2.1 presents a general framework that can be used to conceptualise the internal diffusion process (Dewett et al., 2007). The process begins with the decision to adopt the innovation, as illustrated in the framework, before moving into the three categories of factors that impact the degree of implementation quality: organisation, innovation and human factors. Also illustrated in the model is the degree to which management can exercise control over the factors, with the human category most amenable to influence. This model illustrates the complex dynamics of the internal innovation diffusion process as played out through the array of influencing factors. This is further complicated when more than one technology is implemented at a time, as is the case

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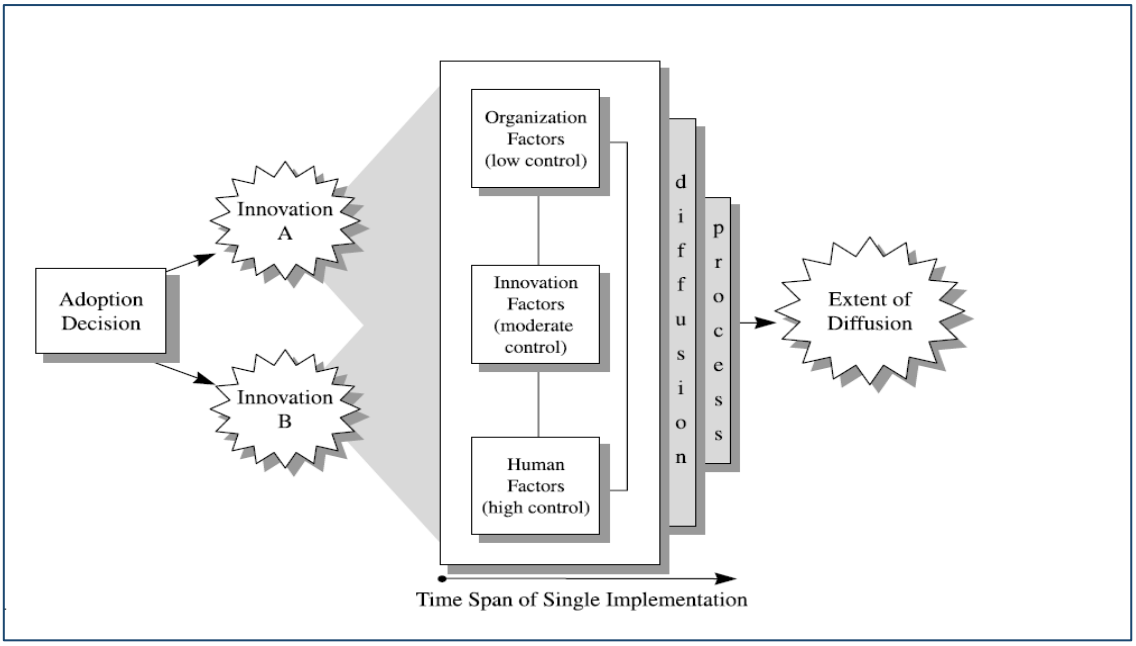
in most organisations.

Figure 2.1: The internal diffusion environment (Dewett et al., 2007).



A breakdown of the various factors from the three categories that influence innovation diffusion was extracted from the work of Dewett et al. (2007) and displayed in Table 2.3. This further illustrates the complex dynamics around innovation diffusion and how various factors need to be aligned and in play to effect internal innovation diffusion through an organisation. The various factors impacting the innovation are very context and innovation specific, therefore gaining deeper understanding around this subject will require research to be conducted within the context where the findings are to be applied, in this case, various types of AMTs in manufacturing organisations of all sizes. Focused research within a particular context is needed to explain the dynamics related to the different factors (Dewett et al., 2007).

Table 2.3: Breakdown of factors influencing internal innovation diffusion (Dewett et al. 2007).

Organisation factors	Innovation factors	Human factors
•Organisational structure •Functional differentiation •Professionalism •Organisational size •Economics •Organisational slack	•Type •Relationship of multiple innovations •Visibility •Utility •Cost	•Top management support •Power •Innovation roles •Communication

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2.4 AMT implementation process

The impact of an AMT investment on business performance is not immediate and requires a long period of planning (Rahardjo, & bin Yahya, 2010). Success or failure is directly linked to the complex implementation process, which can pose problems more serious than the ones the AMT was meant to resolve (Rahardjo & bin Yahya, 2010).

Rahardjo, & bin Yahya, (2010) describe the AMT implementation process as a strategic issue. Therefore, this calls for strategic planning at a business and manufacturing levels. AMT presents not only technical challenges during implementation, but as a strategic issue, planning at business and manufacturing levels is required when the decision is made to adopt such innovations (Rahardjo & bin Yahya, 2010).

To guide the implementation process, traditional roles and responsibilities, organisation structure, work content, reward systems and education and training should be redefined within an organisation (Cardoso et al., 2012; Darbanhosseiniamirkhiz & Wan Ismail, 2012; Rahardjo, & bin Yahya, 2010). The complex nature of implementation often drives failure of AMT as a result of organisations focusing on the technical challenges, while ignoring the managerial aspects and organisational planning required (Cardoso et al., 2012; Park, 2000).

In a study on the management of uncertainty in AMT implementation, Lindberg (1992) highlighted the extent of uncertainties introduced during an AMT implementation, which can lead to reactive, unplanned and disruptive adaption cycles. The disruptions caused by uncertainty can result in increased costs, restricted flexibility, delays and can often lead to the strategic aims of the implementation changing (Lindberg, 1992). These factors call for a well-organised and structured implementation process with strong management guidance and mentoring throughout the process with a focus on future potentialities (Ford, 2002).

Chan, Chan, Lau, & Ip, (2001) put forward the recognition of a need or opportunity as the initial stage in an AMT investment. Beatty (1991) argued that the implementation phase starts from the initiation phase of the project and is all encompassing, hence careful management is required from the outset of the decision to invest. Yusuff, Yee & Hashmi (2001) presented six considerations that form part of the implementation process. These include a committed sponsor, operating sponsor, alignment of

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organisation and business, integration with existing systems, natural organisational interfaces to the new system and commitment of users and stakeholders. Other considerations in the implementation process put forward by Rahardjo & bin Yahya (2010) include vision, top management commitment, employee participation, size of the organisation, type of ownership, and research and development (R&D) expenditure. Additionally, access to resources, customer requirements, increased technological availability, degree of AMT adoption by competition and labour cost are put forward as areas that need to be assessed during the AMT implementation process.

Voss, (1988) proposed a three phase “life-cycle” AMT implementation process. The pre-installation phase was characterised by planning and justification, the second phase, or installation phase, included the acquisition, installation and start-up of the AMT and the final phase, the post-commissioning phase, consisted of operating the new equipment and monitoring and performance evaluation. All phases, including the ability to integrate advanced and conventional technologies, have been considered critical in extracting benefits from the AMT and preventing a suboptimal manufacturing performance (Voss, 1988; Hayes & Jaikumar, 1991; Chen & Small, 1994).

2.4 AMT implementation issues

The implementation of AMTs is an extremely complex and involved process. As a result, the process can be met with many issues that can hamper the extraction of the intended benefits from the technology. Issues can emanate from all angles, pertaining to organisational culture, structure and size, type of ownership, manufacturing strategy and experience and education levels prevalent within the business (Hynek, & Janeček, 2010; Alvarado, 2013; Hynek, & Janeček, 2013). External factors, such as government intervention, suppliers, customers and technology trends, also contribute to issues that can arise during AMT implementation. The type of the technology and the complexities and justification associated with it also play a role (Saberi et al. 2010).

Beatty & Gordon (1990) presented three classifications related to the barriers of AMT implementation: structural, that talks to organisational infrastructures and justification difficulties; human, which centres on uncertainty and worker resistance; and technical, which relate to incompatibility of systems. In work conducted on the implementation of manufacturing technologies directed at flexibility, Adler (1989) argues that, in the majority of cases, human resource management issues are the major stumbling block.

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Insufficient organisational planning for the introduction of the new AMT, alignment to the organisation's strategic plan, lack of knowledge around the company requirements for effective operation of the AMT, lack of support from workforce, poor cross-functional integration, inadequate production management skills, poor management support and obsolete technology have been identified as potential barriers a company may face when trying to implement a new AMT and can often result in failure (Chan et al., 2001 and Small & Yasin, 2003). Da Costa & De Lima (2008) argue that planning mistakes, integration problems and infrastructural issues add to the challenges experienced when implementing AMTs.

Salaheldin (2007) posit that a lack of organisational ability, workforce skill deficiencies and production management skill deficiencies is perhaps one of the biggest drivers of AMT failure within organisations. Waldeck & Leffakis (2007) emphasise that if the support and commitment of the workforce is not garnered towards the AMT, this can lead to major problems during the implementation phase. A lack of communication of the benefits often results in a workforce with poor commitment towards and little interest in ensuring the success of the AMT (Thomas et al. 2008) – disengaged employees do not act to facilitate a smoother crossover to the new technology.

Sohal et al. (2001) and Yusuff et al. (2001), put forward a number of areas that need to be taken into consideration during AMT implementation. These include senior management commitment and ability, employee participation, size of the organisation, type of AMT, type of ownership, experience and skill availability, R&D expenditure, labour costs and resources within the organisation.

The size of the organisation and the type of AMT will form an independent variable used in this study when trying to understand how these variables may impact the critical organisational factors required for effective AMT implementation. Thomas et al., (2008) indicated how smaller organisations are often reluctant to adapt to new technologies, not only due to the financial investment required, but also on account of low confidence in their ability to develop or acquire the knowledge required to successfully utilise the AMT. Thomas et al., (2008) posit that failure of AMTs within SMEs is often a result of the inability to gain a proper understanding of the technical aspects of the AMT as a result of inadequate skills and resources.
Ultimately, these issues that impact the implementation can lead to non-utilisation,

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underutilisation, or incorrect utilisation of the newly implemented technology, resulting in an inability to extract the intended benefits of the investment. With large sums of money often committed to such projects, it is critical that management gains a better understanding of the dynamics that impact the effective adoption and absorption of the AMT in order to manage the implementation more effectively and realise the intended performance gains.

2.5 Organisational factors impact on AMT implementation

The organisational factors impacting AMT implementation have been discussed in a number of studies that have attempted to develop frameworks to assist in addressing issues when implementing an AMT. Empirical studies in different contexts, particularly in SMEs, and focusing on AMTs belonging to a specific family, have also been conducted using some of these frameworks. Frameworks illustrating some of the organisational factors that can have an impact on AMT implementation will be introduced, followed by a more detailed analysis of the factors selected as areas of interest. In addition, the question of why they form an area that calls for more research in the context of this study will be interrogated to assist in providing solutions to the AMT implementation issues put forward.

In a comprehensive literature review conducted by Darbanhosseiniamirkhiz & Wan Ismail (2012) and aimed at assessing the critical factors that influence AMT adoption and identifying the challenges faced by SMEs when implementing AMTs, a framework (Figure 2.2) was developed that presented three broad contexts – environmental, organisational and technological – that can influence AMT implementation. The framework was also put forward in the earlier work of Saberi et al. (2010) to stimulate future empirical and practical research directed at examining AMT implementation. When examining the organisational factors that form the interest of this study, organisational structure and culture, manufacturing strategy, HR practices and top management were presented as the key focus areas. Based on the framework and the comprehensive study, Darbanhosseiniamirkhiz & Wan Ismail (2012) put forward the following questions for management to address when making a decision to adopt and when implementing a new AMT to assist in preparing the organisation to successfully absorb the new technology:

- Are the internal characteristics of the organisation such that a new AMT will be supported?

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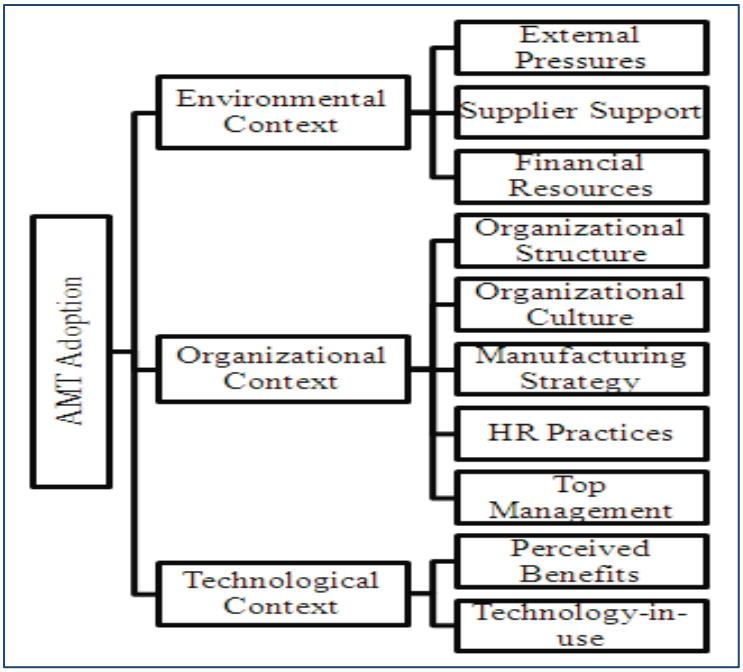
- Is the company culture one that would support new innovations?
- In what ways will the human resource policies and manufacturing strategies assist the AMT adoption process?
- Is there commitment from top management to support and guide the AMT adoption and assist in risk minimisation?
- Are the employees prepared to take on a new innovation and change their ways of completing manufacturing tasks?
- Is the human resource department equipped to guide the training processes required during the introduction of the new technology?

Figure 2.2: Factors impacting AMT adoption (Darbanhosseiniamirkhiz, & Wan Ismail, 2012)



While presenting these questions as a guide to managers, Darbanhosseiniamirkhiz, & Wan Ismail (2012) put forward the need for further research within a specific context and environment to assist in gathering specific answers that can provide a more focused guide for managers.

Marri et al. (2007) conducted an empirical study on the implementation of AMT in Pakistani SMEs. A framework was developed in this study to outline the organisational factors that indicate top management support and company alignment to the AMT that can lead to successful implementation. The framework that builds on other work

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around AMT implementation provides a set of factors that can be used to guide empirical research in a selected context. Four key constructs building on the work of Marrie et al (2007), and other authors that have examined AMT implementations have been extracted and are put forward to guide the study around the organisational factors that influence the effectiveness of AMT implementation in manufacturing organisations. The constructs include the following:

- Top management ability;
- Organisational ability;
- Training and education; and
- Incentives and rewards.

2.5.1 Top management ability

Top management's ability refers to the ability of top management to align the company's manufacturing strategy to the new AMT, their interest in the new technology, the extent to which the AMT supports long-term vision, technological know-how, and the receptiveness of the company culture to the introduction of AMT (Marri et al., 2007).

Ramdani, Kawalek & Lorenzo (2009), Al-Qirim (2008) and Jeyaraj, Rottman & Lacity (2006) argued that top management motivation, enthusiasm, support and commitment towards the implementation of an AMT play a critical role in determining the success that can be achieved from the introduction of new technology. Sun & Gertsen (1995) highlighted that the importance of management's personal traits, experiences and backgrounds in making decisions calls for any changes within an organisation to start with top management and then cascaded down to the shop floor through the different levels. Support of top management for the AMT is therefore critical if the rest of the organisation is to follow suit.

Marri et al. (2007) and Jeyaraj et al. (2006) highlighted that by gaining an understanding of the AMT and the human factors involved in the dynamic, top management can encourage other employees to be more receptive to the new AMT. This will encourage employees to be more efficient in the use of the AMT and result in successful implementation. This dynamic is achieved by ultimately ensuring that the capabilities, goals and benefits of the AMT are well communicated within the organisation. Management's ability to build trust and co-operation among employees further serves to facilitate the psychological, physical and cultural changes that

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accompany AMT implementation (Cook, & Cook, 1994; Li & Xie, 2012). Marri et al. (2007), Al-Qirim, (2008) and Ramdani et al. (2009) emphasised the importance of managerial training on the AMT, as well as commitment shown through the allocation of finances and resources to focus on the implementation that acts to build trust.

Darbanhosseiniamirkhiz & Wan Ismail (2012) and Marri et al. (2007) call for a manufacturing strategy that emphasises quality, responsiveness and flexibility to support the AMT. Flexibility refers to the ability of an organisation to respond to market demands by switching from one product to another (Saberi et al., 2010). Boyer & Pagell (2000), Gonzalez-Benito & Lannelonguem (2014), Ramdani et al., (2009) and Stock & McDermott (2001) posit that the effectiveness of a company's manufacturing strategy is dependent on a consistent alignment to the strategy of the organisation, as this assists in dictating priorities around resource allocation, capability requirements, management behaviour and responses to competitive forces. It is therefore critical that manufacturing strategy be adapted long before the AMT is introduced, such that, when introduced, the AMT is aligned to the manufacturing strategy, which is in turn aligned to the organisation's overall strategy. Because the AMT will have a direct impact on organisational performance, top management will have a vested interest in its success and act to enhance the gains derived from it.

While ensuring company strategy is aligned, it is also critical that the organisational culture be such that it encourages appropriate behaviours. A key behaviour is the receptiveness of the organisational culture to new technologies, cascaded through the organisation from a high level. Rosnah, Saberi & Zulkifli (2008) and Darbanhosseiniamirkhiz & Wan Ismail (2012) state that companies that experienced success with a new AMT implementation generally have a culture that drives innovation and is receptive to new technologies. This creates an environment receptive to change and hence eases the introduction of the new technology.

2.5.2 Organisational ability

Marri et al. (2007) includes in-house expertise, organisational responsibility, organisational teamwork and operational environment as the key elements that need to be addressed when assessing the organisational abilities that impact AMT implementation. Waldeck & Leffakis (2007) and Barua & Islam (2008) highlight the need for highly skilled workers with competencies that match the manufacturing environment and AMT requirements, who should be empowered to manage the AMT

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with regards to planning and troubleshooting. This approach acts to empower the employees, who will assume more responsibility and ownership over the technology, thereby providing a highly proficient workforce equipped with the knowledge and attitude required for the AMT success (Barua & Islam, 2008).

Involvement of all individuals who will be involved in the activities related to the planning and implementation is as an effective means of preparing the workforce for the AMT and can enhance the positive benefits derived from the technology through the positive inputs that emanate from an engaged workforce (Small, 2007). To enhance the positive influence of workers on the AMT success, Chung (1996), Bayo-Moriones & de Cerio (2004) and Waldeck (2007) further argue that employee-involvement practices provides inherent job satisfaction and motivation and can provide an effective means of aligning the goals of employees to that of the AMT.

Monge, Rao, Gonzalez, & Sohal (2006) and Maffei & Meredith (1994) highlight how, together with a well skilled workforce, problem solving using a teamwork approach by the users of the AMT assists in achieving the desired benefits. Maffei & Meredith (1994) also put forward the importance of having adequate channels of communication and participation to enhance the success of AMT implementation and absorption AMT within the organisation. This enhances preparedness of individuals for the AMT and an increased understanding of its purpose that can assist in producing a more receptive attitude.

Mora-Monge, et al. (2008), describe a set of activities that need to be addressed when planning and carrying out an AMT implementation. These activities are divided into external planning activities that may include the use of consultants and experts and benchmarking; internal planning activities that include linking business and manufacturing strategies, financial planning and analysis and training- and team-based activities that include multidisciplinary teams, open communication channels and teamwork. Millen & Sohal (1998) advocate the use of a dedicated AMT implementation team and a champion to provide the momentum required for a successful implementation. The importance of cross-functional teams is discussed by Doolen, Hacker & Van Aken (2003), whose work on the study of the dynamics in production teams, displays the importance of having as diverse a perspective as possible when tackling workplace challenges, including technical issues, like those experienced during AMT implementation. This is why a motivator is needed to employ a multi-

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disciplinary team to take on the task of implementation.

To further enhance organisational ability and effective absorption of the AMT within the organisation, Marri et al. (2007) proposed the need to develop in-house R&D expertise. This enhances the skills available to assist in the AMT implementation and the performance gains and benefits that can be obtained, thus encouraging the workforce to be more receptive to the introduction of new techology.

Frohlich, (1998) and Rosnah, Megat Ahmad, & Osman, (2004) indicate how the successful implementation of AMT requires an adaption of the technology to the organisation and vice versa, and how this acts to reduce management problems associated with the new AMT and improve the chances of success. Millen & Sohal (1998) state that major difficulties are encountered in organisations that fail to redesign organisational structures and processes before the implementation. To support this, Belassi & Fadlalla (1998), Abdul Ghani, et al. (2002) and Xiao-lin, Ye-zhuang, & Guo-gang (2007, August) argue that the organisational structure is a key factor in AMT implementation and that a structure that suits the technology will increase the chances of success.

The organisation should have a high level of responsiveness and flexibility to extract maximum benefit from the AMT. The organisational culture, in terms of the ability to operate flexibly, is critical. In a study on the impact of culture and organisation design in extracting the benefits of AMT, Zammuto & O'Connor (1992) developed two dimensions of culture, flexibility and control. A flexibility-oriented culture can be described as one that promotes human resource development and values member involvement in decision making, with individuals gaining encouragement from the significance or ideological appeal of the task being undertaken. On the contrary, a control-oriented culture is characterised by a more centralised formal, authoritative approach with assumptions of stability as the foundation, emanating with the individual's respect for the organisational mandate, largely driven by formal definition and enforcement of roles through rules and regulations (Zammuto & O'Connor, 1992).

Zammuto & O'Conner (1992) found that, although a control-oriented culture can lead to improved productivity, it can act to hinder AMT implementation, as the centralisation of responsibilities reduces opportunity for organisational learning and hampers the ability to fast-track the AMT into operation. The study findings of the work concluded that a

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flexibility-oriented culture will enhance AMT productivity and the flexibility benefits associated with AMTs as a natural match exists that enhances the alignment. Identification and adaption of culture to suit that of the AMT is therefore a key area that requires attention from top management.

2.5.3 Training and education

When examining the training and education aspects put forward by Marri et al. (2007) in their AMT implementation framework, employee skills, presence of an in-house training facility and access to an external facility are put forward as the areas that need to be addressed to assist in AMT implementation. Marri et al. (2007) posit that carrying out effective education and training of the relevant workforce on the new AMT can improve the receptiveness of workers to it. Training and education requirements are dependent on the type of AMT being introduced and the skills level prevalent in the organisation and can include computer- and film-based training, workshops and classroom instruction.

Boothby, Dufour & Tang (2010) stress the importance of AMT training during implementation and how costs associated with this can consume up to 40% of the total resources allocated to an AMT project. They have documented the strong positive relationship between improved productivity and investment into education and training for the new AMT. Types of training that were highlighted in the study include efforts directed at computer literacy and technical skills. Small & Yasin (2003) and Sohal et al. (2001) both propose the need to design education and training programmes specific to the AMT. Mora-Monge et al. (2008) explain how it is critical that training programmes implemented are specific to the type of AMT to ensure a workforce with the specific understanding of and skills required to properly utilise the AMT. This becomes more critical as the complexity of the system increases, such as in the case of integrated systems (Spanos & Voudouris 2009).

It is a key responsibility of human resources managers to ensure the relevant people are trained in a timeous manner to prepare them for the AMT and ensure successful diffusion within the organisation (Darbanhosseiniamirkhiz & Wan Ismail, 2012). The AMT generally comes with a step-wise change to work practices and activities. Workforce development activities, such as socialisation to the new systems and involvement of managers in R&D projects help to improve the skills level and relational requirements required to complement the new technology and should form a key

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requirement at the implementation stage (Liu & Tsai, 2008 and Chen, Liu & Tsai, 2008).

2.5.4 Incentives and rewards

General company benefits instilled in the organisation, such as medical care, leave and employee empowerment, are critical in ensuring a motivated workforce required for the AMT implementation. Bonus incentives and rewards can act to further enhance employee support and, in turn, the gains that can be achieved from an AMT installation (Marri et al., 2007). Marri et al. (2007) states that, as the workforce form the backbone of the organisation, it is critical that they are motivated to support the AMT. Waldeck & Leffakis (2007) further support the need to motivate employees through incentives and rewards to improve job satisfaction and the much-needed support.

To support these incentive and reward schemes, monitoring of the AMT performance and the benefits derived allows adequate performance measures to be put in place to inculcate correct behaviour and drive positive usage, which aids in extracting the intended benefits (Wall, Corbett, Martin, Clegg & Jackson, 1990; Kotha & Swamidass, 2000 and Hynek, & Janeček 2010). The performance measures directed at the AMT and aligned incentives can encourage the users to be more receptive and minimise the resistance that often accompanies such implementations (Wall et al. 1990).

2.6 Conclusion

Research has shown AMT implementation to be a complex process that if not carried out effectively can be wrought with problems that limit the effectiveness of the implementation and hence reduce the ability to extract the intended benefits. While technical challenges related to the AMT should form a focus area, AMT implementation is also a strategic issue that requires planning at business and manufacturing levels (Rahardjo & bin Yahya, 2010). This therefore calls for a focus on an array of organisational factors that act on AMT implementations.

Literature lays out a number of conceptual frameworks around the organisational factors that influence the effective implementation and diffusion of AMT that have been put forward to guide future studies (Marri et al., 2007; Saberi et al., 2010; Darbanhosseiniamirkhiz, & Wan Ismail, 2012). These frameworks presented are largely theoretically based and leave a gap, in that a well defined set of organisational factors that impact AMT implementation have not been packaged and presented in

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current literature. This calls for the development of a concise model with well-defined factors in the subject of interest. Tables 2.4 to 2.7 provide a summary of the proposed sub-factors that will be used to define the key factors identified to affect AMT implementation; top management ability, organisational ability, training and education and incentives and rewards, and the associated literature used to identify and develop these key factors.

Table 2.4: Proposed top management ability sub-factors and associated literature

Top management ability	
Alignment of the AMT to support the long-term vision of the organisation	Boyer & Pagell (2000), Gonzalez-Benito & Lannelonguem (2014), Ramdani et al., (2009) and Stock & McDermott (2001)
Communication of the motivation behind the AMT implementation and expected benefits	Marri et al. (2007), Ramdani, Kawalek & Lorenzo (2009), Al-Qirim (2008) and Jeyaraj et al. (2006)
Alignment of the AMT to the manufacturing strategy of the organisation	Boyer & Pagell (2000), Gonzalez-Benito & Lannelonguem (2014), Ramdani et al., (2009) and Stock & McDermott (2001)
High level of general technical expertise of top management and know-how around the technical aspects of the AMT	Marri et al. (2007), Al-Qirim, (2008) and Ramdani et al. (2009)
Communication of the company strategy within the organisation	Boyer & Pagell (2000), Gonzalez-Benito & Lannelonguem (2014), Ramdani et al., (2009) and Stock & McDermott (2001)
Investment in resources directed at the new technology	Cook & Cook (1994), Li & Xie (2012), Marri et al. (2007), Al-Qirim, (2008) and Ramdani et al. (2009
Receptiveness of the organisational culture to new technologies	Rosnah et al. (2008) and Darbanhosseiniamirkhiz & Wan Ismail (2012)
Promotion of new technologies and support and commitment towards the AMT by top management	Ramdani, Kawalek & Lorenzo (2009), Al-Qirim (2008) and Jeyaraj et al. (2006)

Table 2.5: Proposed organisational ability sub-factors and associated literature

Organisational ability	
Handing over planning and troubleshooting responsibilities related to the AMT to in-house employees rather than contractors	Chung (1996), Bayo-Moriones & de Cerio (2004) and Waldeck (2007)
Possessing a more flexibility-oriented culture	Zammuto & O'Conner (1992)
Changes to the organisational structure to support the new AMT	Belassi & Fadlalla (1998), Abdul Ghani, et al. (2002) and Xiao-lin et al. (2007, August)
Adequate channels of communication and widespread participation from organisational members in the implementation	Maffei & Meredith (1994)
Highly skilled workers with competencies that match the manufacturing and AMT environment	Barua & Islam (2008), Waldeck & Leffakis (2007) and Barua & Islam (2008)
Use of in-house Research and Development to enhance the effectiveness of an AMT implementation	Marri et al. (2007)
In-house expertise to manage the AMT implementation	Marri et al. (2007), Al-Qirim (2008) and Ramdani et al. (2009)
Organisation of the workforce into multidisciplinary teams to manage the AMT implementation	Monge, Rao, Gonzalez, & Sohal (2006) and Maffei & Meredith (1994) and Mora-Monge et al. (2008),

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Table 2.6: Proposed training and education sub-factors and associated literature

Training and education	
Training of managers on the AMT before implementation	(Cook, & Cook, 1994; Li & Xie, 2012).,Marri et al. (2007), Al-Qirim (2008) and Ramdani et al. (2009)
Possessing highly skilled and qualified operators	Barua & Islam (2008), Waldeck & Leffakis (2007) and Barua & Islam (2008)
Development of best practices to manage the AMT	None
Creation of specific training programmes tailored to the AMT	Small & Yasin (2003) and Sohal et al. (2001)
In-house training capability to support training requirements for the AMT	Marri et al. (2007)
Investment in education and training directed at the AMT	Boothby, Dufour & Tang (2010)

Table 2.7: Proposed incentives and rewards sub-factors and associated literature

Incentives and rewards	
Directing incentives and rewards schemes at the successful use of the AMT	Marri et al. (2007) and Waldeck & Leffakis (2007)
Implementation of performance measures directed at the AMT	Wall et al. (1990), Kotha & Swamidass, (2000) and Hynek, & Janeček (2010).

When presenting these frameworks, emphasis was placed on the need to take factors around the context of this study into consideration, as this has an influence on the outcomes. Although empirical studies examining these frameworks are evident in literature, a large focus of the studies is on SMEs in specific contexts, as it is believed that the problems around AMT implementation are more prevalent in SMEs, where resources are scarcer than in larger organisations (Scannell, Calantone, & Melnyk, 2012; Marri et al., 2007; Salaheldin, 2007). Further to this no quantitative studies highlighting the relative importance of organisational factors that impact AMT implementation could be uncovered in literature and therefore presents a further gap that supports research in this subject.

The reduced competitiveness of the South African manufacturing sector at all levels, as presented earlier, and the potential for effective AMT implementations to contribute to a recovery in this sector, highlights the need to explore the dynamics around AMT in more detail in the South African context, with a focus not only on SMEs, but also larger manufacturers. No records of research examining the organisational factors that impact AMT implementation in the South African context were found in the literature study, hence motivating the need to pursue this research in the South African context, where a gap in the existing body of knowledge around AMT implementation exists.

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CHAPTER 3: RESEARCH QUESTIONS AND HYPOTHESES

The study sets out to diagnose the current dynamics of the organisational factors that impact AMT implementation in South African manufacturers and to gauge this against what are perceived to be the critical factors that impact implementation. The study attempts to establish a set of well-defined critical factors that impact AMT implementation effectiveness, and build on this by developing a ranking of the importance of the identified factors. Ultimately the research questions and hypothesis laid out contribute to the development of a practically applicable model that can be used to guide effective AMT implementation.

The study, extended to manufacturing organisations of all sizes within the South African context implementing a variety of AMTs and identifying the critical organisational factors required for implementation, allowed for a comparison of the perceived critical organisational factors between large manufacturing organisations and SMEs and the various AMT types. The study also entails a diagnosis of the current readiness of South African organisations to effectively implement AMTs in terms of the prevalence of the critical organisational success factors and test whether this organisational readiness impacts the achievement of the intended benefits.

3.1 Research questions

The following research questions were put forward by the researcher:

3.1.1 Research question one

What are the predominant benefits targeted through AMT implementations?

3.1.2 Research question two

What is the extent to which the intended benefits are being fully derived from AMT implementations?

3.1.3 Research question three

What is the perceived relative importance of the various defined organisational factors towards impacting the effectiveness of an AMT implementation?

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3.1.4 Research question four

Does the size of the organisation impact the degree of importance of the critical organisational factors required to guide effective implementation of AMTs within an organisation?

Company size will be divided into two categories: SMEs that have less than 500 employees and large organisations with 500 or more employees. These will form the two groups that will be used to test the research question.

3.1.5 Research question five

Does the type of AMT being implemented impact the degree of importance of the critical organisational factors required to guide effective implementation within an organisation?

Types of AMT will be divided into three groups as described in the literature survey: computer software, computer hardware and plant and equipment. The research question will attempt to analyse differences between these groups of interest.

3.1.6 Research question six

Do manufacturing organisations within the South African context exhibit a high degree of organisational readiness for AMT implementation with regard to the defined organisational factors?

3.1.7 Research question seven

Do larger organisations exhibit a higher degree of organisational readiness for AMT implementations than SMEs?

3.2 Research hypotheses

The following hypotheses are put forward to guide the study:

3.2.1 Hypothesis one

Hypothesis 1 H_1: Large organisations experience more success in extracting the intended benefits from AMT implementations than SMEs.

***Null hypothesis 1 $H0_1$*:** Large organisations do not experience more success in extracting the intended benefits from AMT implementations than SMEs.

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3.2.2 Hypothesis two

Hypothesis 2 H_2: Internally managed AMT implementations experience more success in extracting the intended benefits than those externally managed.

Null hypothesis 2 $H0_2$: Internally managed AMT implementations do not experience more success in extracting the intended benefits than those externally managed.

3.2.3 Hypothesis three

Hypothesis 3 (H_3): Organisations that achieve the intended benefits of the AMT implementation exhibit a higher degree of organisational readiness with regard to defined organisational factors than organisations that achieve partial success.

Null hypothesis 3 ($H0_3$): Organisations that achieve the intended benefits of the AMT implementation do not exhibit a higher degree of organisational readiness with regard to the defined organisational factors than organisations that achieve partial success.

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CHAPTER 4: RESEARCH METHODOLOGY

A quantitative approach was adopted in this study to address the research questions and hypotheses put forward. The literature survey set out to extract some in-depth insights on the dynamics of the organisational factors that impact AMT implementation within companies operating in the manufacturing sector. This set a foundation for the development of a survey questionnaire with a defined set of constructs around the organisational factors that impact AMT implementation, that aimed to build on insight and quantitatively test theories related to the subject of this study.

The research firstly sets out to assess the primary benefits targeted from AMT implementations and the extent to which the benefits of AMT implementations are being derived. A research instrument in the form of a survey was developed putting forward four constructs as the key organisational factors that impact AMT implementations. The validity of the sub-factors that make up each of the key constructs was thereafter examined before the rankings of the importance factors were applied.

After assessing and ranking the importance of the various organisational factors put forward as constructs, the research assesses the extent to which the relevant organisational factors are in force during AMT implementations in manufacturing organisations within South Africa. Essentially, this is an assessment of the organisational readiness of manufacturing organisations for the implementation of AMTs within the South African context. The assessment also compares the importance of the critical factors and organisational readiness, using the organisation size and the AMT type as variables. Finally, the validity of the factors identified as critical for the implementation of AMT are tested by examining the organisational readiness of organisations that extract maximum benefit from the AMT, versus organisations who partially achieve the intended benefits.

This section will introduce the research methods chosen for the study and the rationale behind the decision to employ the selected methods. The population or universe of relevance to the study will thereafter be discussed, together with the sampling method. The research process is also described, together with the data collection method and a

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breakdown of the analysis carried on the collected data to answer the research questions and hypothesis put forward.

4.1 Quantitative research

A quantitative study using descriptive statistical analysis methods to answer the research questions and hypotheses will form the basis of the study. The main aim of the descriptive research will be to describe the characteristics of the population under investigation (Zikmund, 2003). In this case, these are the organisational characteristics required for AMT implementation by South African manufacturers and the benefits targeted from AMT implementations.

Saunders & Lewis (2012) and Leedy & Ormrod (2001) advocate a quantitative study when a deductive approach is adopted to answer questions around known phenomena within a certain context. Zikmund (2003) states that descriptive research sets out to answer the "who", "what", "where" and "how" questions related to the subject. In this case, "who" refers to manufacturing organisations of all sizes, the "what" refers to the critical organisation factors that impact AMT implementation, the "where" is within South African manufacturing organisations and the "how" refers to the way in which independent variables impact the critical organisational factors required for effective AMT implementation. The "how" also refers to the way in which these factors are playing out within the South African context. A quantitative research approach is therefore a valid method of achieving the research objectives.

4.2 Research process

The research process was divided into two main phases. The initial phase, presented in Section 2 of this document, entailed a detailed literature review of the existing body of knowledge, aimed at gaining deeper insight into organisational factors impacting AMT implementation within manufacturing organisations. Insight gained through this guided the development and refinement of the survey questionnaire that was used to gather research data.

The nature of the study required that many members of a wide variety of manufacturing organisations be reached to ensure wider applicability of findings. Zikmund (2003) advocates the use of a survey when attempting to reach a large audience of respondents. A survey was therefore developed as the research instrument used to collect data from the population of interest.

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4.3 Population and unit of analysis

A population is defined by Zikmund (2003) as any complete group of people, companies, hospitals, stores, college students or similar that have a set of characteristics in common. The population of interest for this study consisted of individuals working for or who had recently worked for manufacturing companies that have been involved in AMT implementations.

Any company involved in the conversion of raw materials into a finished product was considered to be a manufacturer. There were no limitations on the size of the company and manufacturing companies across industries using a range of AMTs were considered part of the targeted population. The study focused on manufacturing companies in South Africa for applicability to the given context and contexts with similar characteristics to that of the South African manufacturing sector.

Individuals defined as part of the population of interest included the following professional individuals within manufacturing organisations:

- Individuals responsible for developing, identifying and promoting the AMTs within the organisation. This included researchers and technical personnel responsible for identifying and transferring new AMTs that may have been developed by an external party.
- Individuals responsible for the decisions to adopt new AMTs. This included operation, production and general managers.
- Intended users or adopters of the new innovations. This included engineers and plant managers responsible for the implementation and roll-out of the new AMT in their manufacturing plants.

The individuals selected for inclusion in the population will allow for a multi-perspective view on the subject of interest and a more comprehensive assessment of the AMT implementation story within manufacturing organisations. Blumberg, Cooper & Schindler (2008) describe the unit of analysis as the level at which the research is performed and which objects are researched. The unit of analysis was selected as the survey responses of individuals on the levels at which they perceive the degree to which various defined organisational dynamics impact the AMT implementation effectiveness and were in play within their organisation while implementing new AMTs. The outcome will be sets of ratings applied to defined organisational factors that

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describe the ideal situation and to the current situation.

4.4 Sampling

Specific job functions are characteristics sought in the subjects to be surveyed in the research process in order to qualify as relevant to the population of interest and contribute to the research objectives. Saunders & Lewis (2012) describe the process of selecting a sample using judgment based on the subject's ability to answer the research questions as purposive sampling, a non-probability technique. Zikmund (2003) states that the benefits of such a technique allows a large number of completed surveys to be obtained quickly and economically. Negatives can include the inability to measure, control variability and bias of estimates and project data beyond the sample (Zikmund, 2003). The access to a larger sample size and higher response rate justified this selection.

The population of interest can be considered heterogeneous as evidenced through the individuals described as part of the population. To ensure representation from all groups of interest, samples were targeted across manufacturing organisations of all sizes that could be accessed.

Samples will be drawn from individuals working in the manufacturing sector in South Africa who form part of the defined population of the study. Individuals from a range of companies in the manufacturing sector were surveyed to ensure a range of industries is accessed in the study to allow broader applicability of the findings. The sample included individuals within the organisations who are currently involved in AMT implementation or who have been in the past.

4.5 Data collection instrument

A detailed questionnaire was developed and employed as the data collection instrument in this study. The questionnaire focused on gathering ratings on perceptions towards importance of the four key constructs related to the organisational factors impacting the effectiveness of AMT implementation and diffusion within an organisation. These include top management ability, organisational ability, education and training and incentives and rewards. The survey also set out to assess the degree to which these factors were in play within manufacturing organisations in South Africa during AMT implementations.

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After gathering general demographic data around the respondent, the company and the AMT, rating questions were introduced to test importance of the factors and the extent to which the various factors were in play during an AMT implementation. The rating questions made use of a 7-point Likert scale. In the case of the questions aimed to gather data to determine how critical the various factors were which can be referred to as the ideal situation, the following importance rating scale was used: (Extremely important – 7, Very important – 6, Moderately important – 5, Neutral– 4, Slightly important – 3, Low importance – 2, Not important at all – 1).

Questions aimed at assessing the extent to which the various factors were in play within the organisation or the current situation made use of the agree rating scale: (Strongly Agree – 7, Agree – 6, Somewhat Agree – 5, Neither Disagree/Agree – 4, Somewhat Disagree – 3, Disagree – 2, Strongly Disagree – 1). Blumberg et al. (2008) describe the Likert scale as the most widely used variation of the summated rating scale. A summated rating scale is composed of unfavourable and favourable statements towards an object of interest that the respondent rates according to their independent view (Saunders & Lewis, 2012).

The questionnaire was divided into three main sections and included a qualifier question. This question eliminated respondents who had not experienced AMT implementation and were therefore not relevant to the study. Respondents who had not experienced AMT implementations were immediately taken to the end of the survey, with no additional questions posed to them. Following an introduction to the topic and the purpose of the research, the qualifier question was presented. The three sections discussed below formed the broad areas explored in the survey instrument that was electronically administered via SurveyMonkey, an online portal used for the development of surveys and data collection (Appendix A).

The questionnaires were pre-tested with a pilot audience for ambiguity and reliability; this forms a critical element in the development of a quality questionnaire (Saunders & Lewis, 2012). The pilot audience was drawn from a subset of the population that the researcher has easy access to. This enabled feedback to be obtained on the time needed to complete the questionnaire; any ambiguities in the wording of the questions and whether the questions put forward were relevant to this field of study. The surveys were thereafter refined accordingly, before being distributed to the population of interest via an email introducing the subject and providing a link to the online survey.

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Saunders & Lewis (2012) prescribe the following information to be included in the communication with potential respondents: a brief description of the questionnaire, estimation of the time required to compete it, confidentiality of the information provided and an expression of gratitude. These elements all formed part of the questionnaire introduction.

4.5.1 General demographics of respondent, organisation and AMT

This section aimed to gather general demographic information related to the respondent, the organisation and the AMT. Critical areas explored in this section included the size of the organisation and the type of industry in which AMT implementation was conducted, as well as the type of implementation. Information on the individual's role during the AMT implementation and related data, such as primary intended benefits was also sought. Furthermore, an assessment of whether the AMT achieved the intended benefits is conducted in this section.

This section defines the critical independent variables, company size and AMT type, which will guide the analysis and hypothesis testing to follow. The success of the AMT in achieving the intended benefits of the AMT is also assessed here and this forms a question that assists in validation of the critical success factors that impact AMT implementation put forward in this study.

4.5.2 Ranking of importance of factors to establish ideal situation

The 7-Point Likert scale was introduced in this section. This section of the questionnaire set out to gauge the perceptions of the respondent towards the importance of organisational factors that can impact the effective implementation of AMT in an organisation. The main themes explored in this section were around the four constructs related to top management ability, organisational ability, education and training and incentives and rewards. Four sets of sub-factors related to each of the four constructs were developed and put forward.

Respondents were called upon to draw responses based on experience from past or current AMT implementations to rate the different sub-factors according to the ability to impact the success of an AMT implementation. Based on what worked and what should have or could have been done better, or may not have been that critical, ratings received from the various respondents will allow the identification of the critical organisational factors that are required to guide an effective AMT implementation. Essentially, the ratings established present the importance of the factors put forward

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that can be used to represent the ideal situation in terms of the extent to which the organisational factors should be in force during AMT implementations.

4.5.3 Ranking of factors to establish current situation

This part of the questionnaire will follow a similar format as the section used to establish the ideal situation. The main aim of this section will be to assess the degree to which the factors impact AMT implementations are prevalent in the respondent's organisation during implementations. The ratings established in this part of the survey can be used to describe the current situation with regards to the extent to which the critical factors are in force in South African manufacturing companies during AMT implementations. This enabled an assessment of the identified critical organisational factors to gauge the extent to which organisations address the critical factors that assist in the successful implementation of AMT. Further to this, the current situation of organisations that achieve the intended benefits of AMT implementation is compared with organisations with lower levels of success to assist in validation of these critical factors.

4.5.4 Response rate

A total of 14 033 emails were distributed to potential respondents. Although emails were directed at individuals who were thought to meet the criteria, only 346 responses were received. This equates to a response rate of 2.5%, which is extremely low and points to the likelihood of the email being sent to a large number of respondents who did not have any interest in or knowledge of the subject.

Of those responses, 114 (33%) of the respondents had not had any experience with an AMT and therefore did not meet the qualifying criteria required for the remainder of the survey. The high percentage of respondents not meeting the qualifying criteria can be attributed to the survey not being sent to the well-defined target population in certain instances and cannot be used to imply to a low prevalence of AMT implementation within manufacturing organisations in South Africa. Ninety (26%) of the respondents who met the qualifying criteria did not fully complete the survey and their responses were duly discarded. The remaining 142 (41%) were used for the quantitative analysis carried out for this research. This represents around 1% of the total respondents who were invited to participate.

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4.6 Data analysis

The statistical data analysis conducted in the study to answer the research questions and test the hypotheses put forward is discussed in this section. To establish trends in the data and the general characteristics of the respondents, their organisations and the AMTs, descriptive statistics will first be run on all data (Saunders & Lewis 2012).

To identify any new factors or themes in the data, factor analysis is thereafter conducted. The factors put forward as constructs and the sub-factors used to measure these are checked for reliability. The factors used for further data analysis to answer research questions and test hypotheses were therefore established through this process.

To assist in the selection of the appropriate statistical analysis, normality checks were thereafter conducted on the data sets required to answer the research questions and test the hypotheses. The appropriate statistical analysis selected for each of the research questions and hypotheses is thereafter presented.

4.6.1 Establishment of factors and reliability

Factor analysis conducted on the data entailed two approaches. The first was an exploratory factor analysis that aimed to reveal any new themes or constructs around the organisational factors impacting AMT implementation that had not been defined through the literature study. Reliability of the factors established through the exploratory analysis was thereafter checked for internal consistency using Cronbach's alpha coefficient, one of the most commonly used indicators of internal consistency (DeVellis, 2011).

Confirmatory factor analysis was thereafter conducted on the factors of the four defined constructs – top management ability, organisational ability, training and education and incentives and rewards – to determine if the factors defined under each of these constructs grouped together to form an internally consistent factor. Internal consistency of the defined constructs was thereafter checked using Cronbach's alpha coefficient to determine if internal consistency supported the grouping of the variables for further analysis and hypothesis testing in this study. Responses related to the agreement of the degree to which the various factors were in play during the AMT implementation were used in the exploratory factor analysis, as well as in the testing of the reliability of the defined factors.

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4.6.2 Tests of normality

Most statistical tests generally assume a normal distribution for most data (Pallant, 2010). This assumption can lead to errors in statistical analysis if it does not hold true (Pallant, 2010). A check for normality is therefore conducted on all data corresponding to the Likert Scale responses for the different groups of interest before analysis. This enabled selection of the appropriate statistical test suited to the data. On groups of less than 50, the Shapiro-Wilk test of normality was used. The Kolmogorov-Smirnov test of normality was used on groups greater than or equal to 50 individuals.

For normally distributed data, parametric tests are selected for the data analysis (Pallant, 2010). When non-normality is noted in the data, additional variables are evaluated to determine feasibility of a parametric test. This includes a check on the size of the group and the similarities of the group sizes for which the comparisons will be conducted (Pallant, 2010). For large enough groups and groups of similar sizes, a parametric test can be considered, depending on the robustness of the test (Pallant, 2010).

4.6.3 Research questions one and two

Research questions one and two are answered using a basic descriptive statistical analysis conducted on all respondents with valid returned questionnaires.

4.6.4 Research question three

This research question sets out to rank the organisational factors, defined as the constructs, according to their importance ratings across the entire population. The means for the constructs were computed, followed by a comparison between the means of the factors to determine if any significant differences can be noted. This allowed determination of the relative importance of the variables and a ranking of the factors identified according to importance.

Tests for normality revealed non-normality for all the variables of interest for this analysis (Appendix C1). Despite this, the groups were deemed to be large enough at 140 respondents and equal enough in size (all the same), to still select a robust, parametric test. The paired samples t-test was selected for the analysis as the comparison was conducted on constructs based on responses from the same group of people – the entire set of respondents with usable responses.

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4.6.5 Research question four

This research question sets out to assess if there were any differences in the relative importance of critical organisational factor ratings between organisations of different sizes. In this case, SMEs, or organisations with less than 500 employees, was compared with large organisations with 500 or more employees.

Tests of normality (Appendix C2) indicated non-normality on all groups with the exception of the responses related to organisational ability importance for organisations with greater than 500 employees. A p-value of 2.00 was obtained here, indicating normality of the data. Despite the non-normality of the majority of the data, the large group size and similarity of the sizes between the groups justified the use of a parametric test. The independent samples t-test was selected for the comparison as it was deemed robust enough to deal with the non-normality.

4.6.6 Research question five

Research question five sought to establish if the type of AMT being implemented impacts the degree of importance of the various organisational factors. Due to non-normality of the majority of the data linked to the factors for each AMT type (Appendix C3) and the small size of the groups involved in the comparison, a non-parametric test, the Kruskall-Wallis, was selected for the analysis. The Kruskall-Wallis test compares groups on mean rank with the Chi-Square test statistic used to determine the level of significance of the differences.

4.6.7 Research question six

The aim of this research question was to assess the organisational readiness of organisations in South Africa, based on the differences in the current ratings of the critical organisational factors, versus the ideal situation, which is based on organisational readiness. The analysis is accomplished through a comparison of the means of the responses of the entire group for the importance and agree questions of the four constructs. Comparisons were done on each construct for the agree and importance rating questions. Despite non-normality of all the variables (Appendix C1), the paired samples t-test was selected for this analysis due to its robustness.

4.6.8 Research question seven

An assessment of the organisational readiness, or degree to which the four organisational factors that impact AMT implementation, was conducted to assess whether larger organisations exhibit a higher level of readiness than SMEs. The

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responses of individuals in each group to the agree, or current situation, questions were therefore analysed. Despite non-normality of the data, the robustness of the independent samples t-test was considered suitable for the analysis.

4.6.9 Research hypothesis one

This hypothesis assesses whether larger organisations achieve a higher degree of full AMT success than SMEs. The assessment is based on responses to whether the AMT implementation achieved the intended benefits. The group indicating "no" was too small, hence it was excluded from the analysis. The comparison was therefore based on respondents answering "yes" (full success) or "partially" (partial success). The two-by-two Fisher's exact test was used to conduct the comparison and test the hypothesis.

4.6.10 Research hypothesis two

Hypothesis two tests whether the success in extracting the intended benefits from an AMT implementation is dependent on whether the AMT implementation was managed internally or externally. The two-by-two Fisher's exact test was used to conduct the comparison and test the hypothesis.

4.6.11 Research hypothesis three

Hypothesis three set out to assess whether organisations that achieve the intended benefits of the AMT have a higher degree of organisational readiness with regards to the extent to which organisational factors are in play during AMT implementations than organisations that partially achieve the intended benefits of the AMT.

Most of the data for the groups related to this hypothesis and the degree of agreement (current situation) questions were not normally distributed (Appendix C4). Based on this and the unequal sizes of the groups being compared (93 versus 39), a non-parametric test, the Mann-Whitney *U* test, was selected for the analysis to compare the two groups with regard to the differences in the extent to which the organisational factors were in play during AMT implementation. The Mann-Whitney *U* test involves the summation of ranks.

4.6.12 Summary of data analysis

Table 4.1 displays a summary of the statistical analysis conducted to answer each of the research questions and hypotheses put forward for this study.

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Table 4.1: Data analysis used to answer research questions and test hypotheses

Research question / Hypothesis	**Statistical analysis**
Research question one	Descriptive
Research question two	Descriptive
Research question three	Paired-samples t-test; Descriptive for mean rankings
Research question four	Independent-samples t-test; Descriptive for mean rankings
Research question five	Kruskall-Wallis test; Descriptive for mean rankings
Research question six	Paired-samples t-test
Research question seven	Independent-samples t-test
Hypothesis one	Two-by-two Fisher's exact test
Hypothesis two	Two-by-two Fisher's exact test
Hypothesis three	Mann-Whitney *U* test

4.7 Limitations of this research

The following limitations have been identified when setting out on this study:

- The research was conducted within manufacturing companies situated in South Africa. Numerous authors have noted that studies around AMT implementation, particularly the organisational factors, are very context specific, therefore findings may only be applicable to manufacturing organisations operating within South Africa, or in other developing countries that have a similar manufacturing structure.
- AMT implementation requires high capital investment. Implementations are therefore not a regular occurrence in organisations, as once implemented, the investment can suffice for a long period. This introduced some difficulties in accessing a larger sample size of respondents relevant to the study. An acceptable sample size was, however, still accessed.
- The nature of the research in the form of a survey with well defined responses

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around the critical organisational factors that impact AMT implementation limited the ability to gain further insights around the dynamics related to the organisational factors that impact AMT implementation, that may be prevalent within organisations in the South African context.

- The nature of the convenience sampling selected for this study limits the ability to control variability and bias of estimates. This may therefore limit reliability of the projection of the data to the entire population.

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CHAPTER 5: RESULTS

Results gathered from the quantitative research, conducted together with the selected statistical analysis carried out on the data, are presented in the following chapter. Statistics to describe the profile of the respondents who participated in the survey with regards to their organisation and other factors related to the AMT implementation is first presented. This is followed by another set of descriptive statistics, graphically illustrating the mean scores of the whole population of respondents on questions related to the importance of the organisational factors that impact AMT implementations and the degree to which the various organisational factors were in play during implementations they were involved in.

Factor analysis, coupled with an assessment of reliability, was thereafter conducted to reveal any common unspecified themes. This analysis was also conducted on the high-level organisational factors identified in the literature review to assess whether the questions related to test these factors could be reliably grouped together to define the proposed factors and hence be used to answer the research questions and test hypotheses put forward.

5.1 Descriptive statistics of respondents

5.1.1 Company size

Figure 5.1: Respondent by company size

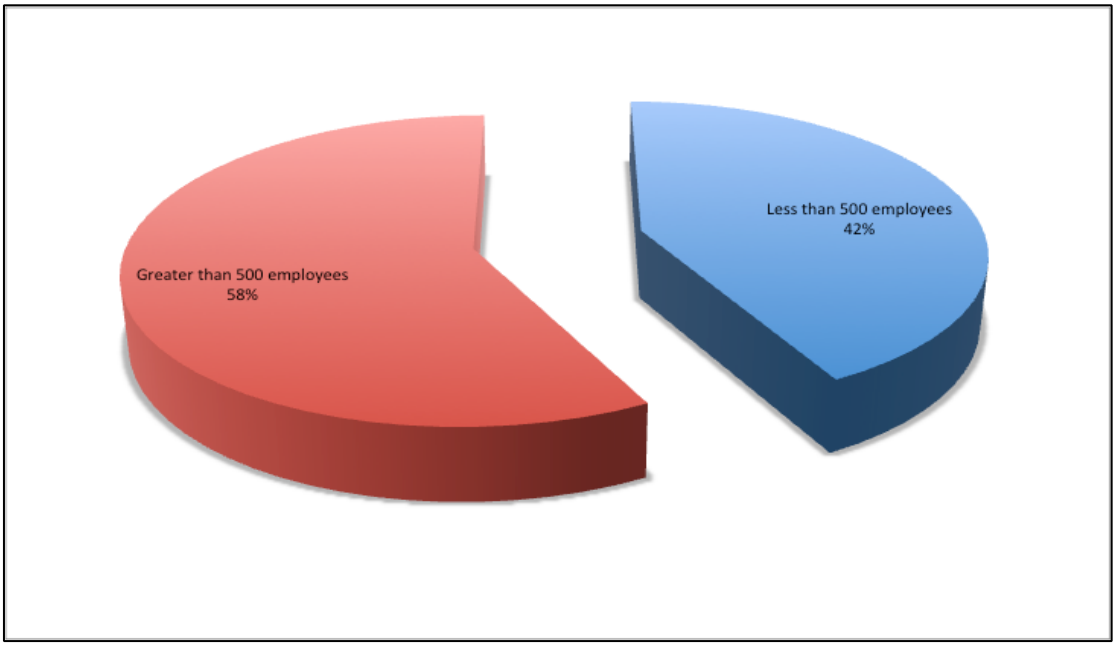

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Figure 5.1 displays the respondents by company size. A higher percentage of the respondents (58%) belonged to large organisations with greater than 500 employees, while the remaining 42% belonged to SMEs with less than 500 employees.

5.1.2 Manufacturing sector

The manufacturing sector represented by the respondents is illustrated in Figure 5.2. The information and communications technology (ICT) and electronics (22%) and the pulp and paper (21%) sectors dominate. The high prevalence of respondents in the pulp and paper industry can be attributed to the author working in this industry, hence having easier access to such respondents. Respondents that fell into the sectors not defined in the questionnaire accounted for 29% of the respondents, with the mining sector dominating this group with 13% of total respondents (Table 5.1). Of the defined groups, the textile, clothing and footwear (1%), agriculture and agri-processing (1%) and the automotive (3%) sectors were poorly represented.

Figure 5.2: Respondent by manufacturing sector

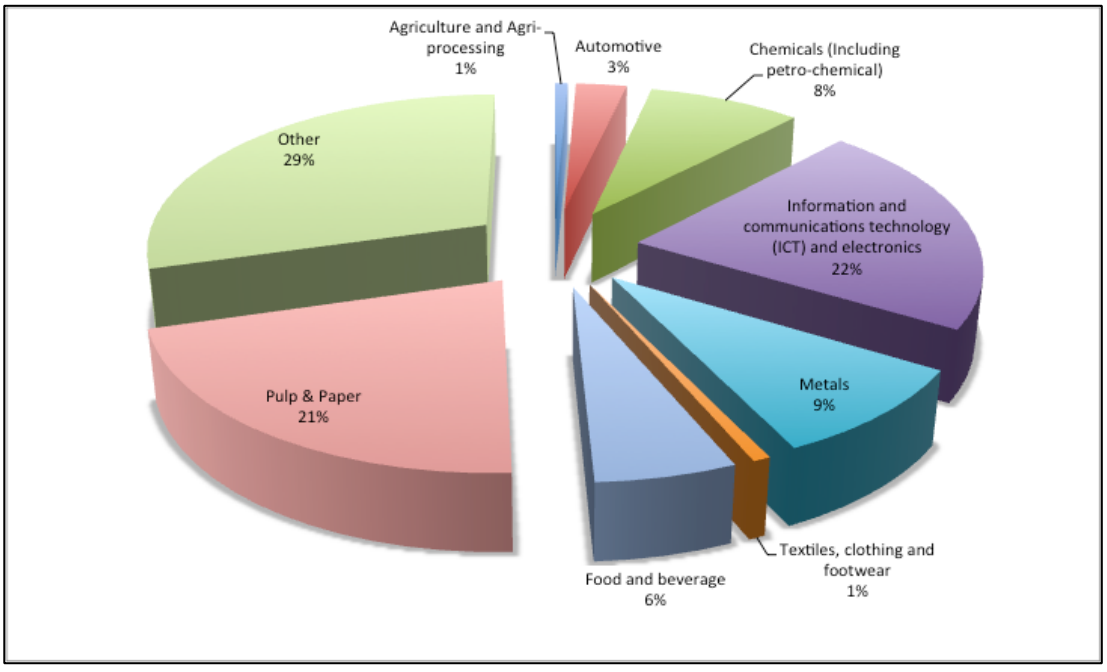

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Table 5.1: Manufacturing sectors represented by respondents falling outside defined groups

Manufacturing sector	Respondents
Mining	13.4%
Electricity	4.9%
Defence	2.1%
Electronics	2.1%
Materials handling	0.7%
Explosives	0.7%
Security printing	0.7%
Vehicle tracking	0.7%
Fuel supply	0.7%
Cable manufacturing	0.7%
Fleet	0.7%
Vehicle tracking	0.7%
Machine design	0.7%
Not specified	2.1%

5.1.3 Organisation footprint

Figure 5.3: Respondents working for a multinational company (Yes) or not (No)

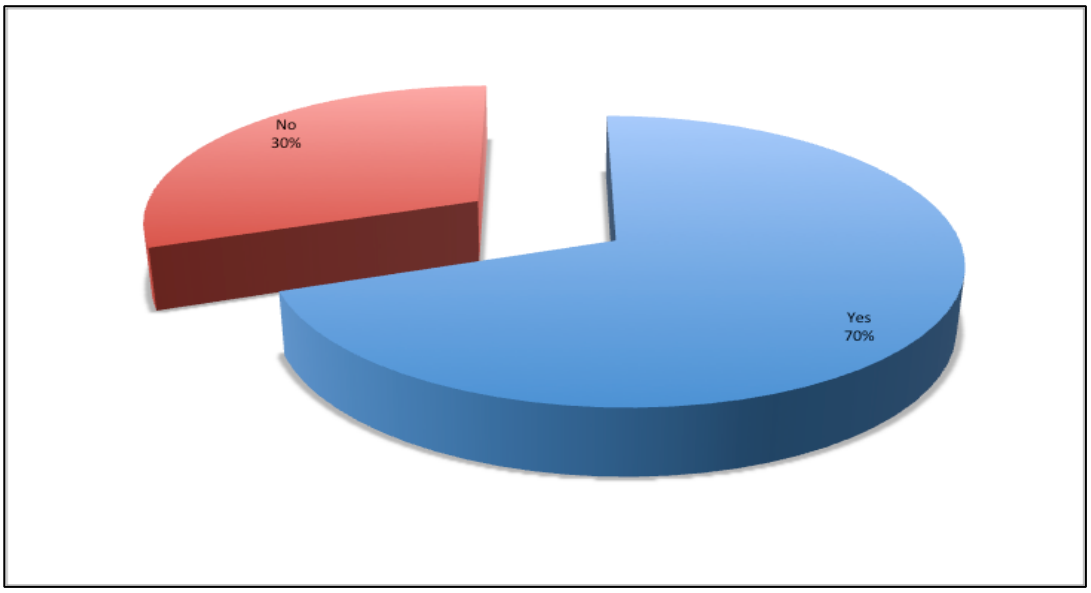

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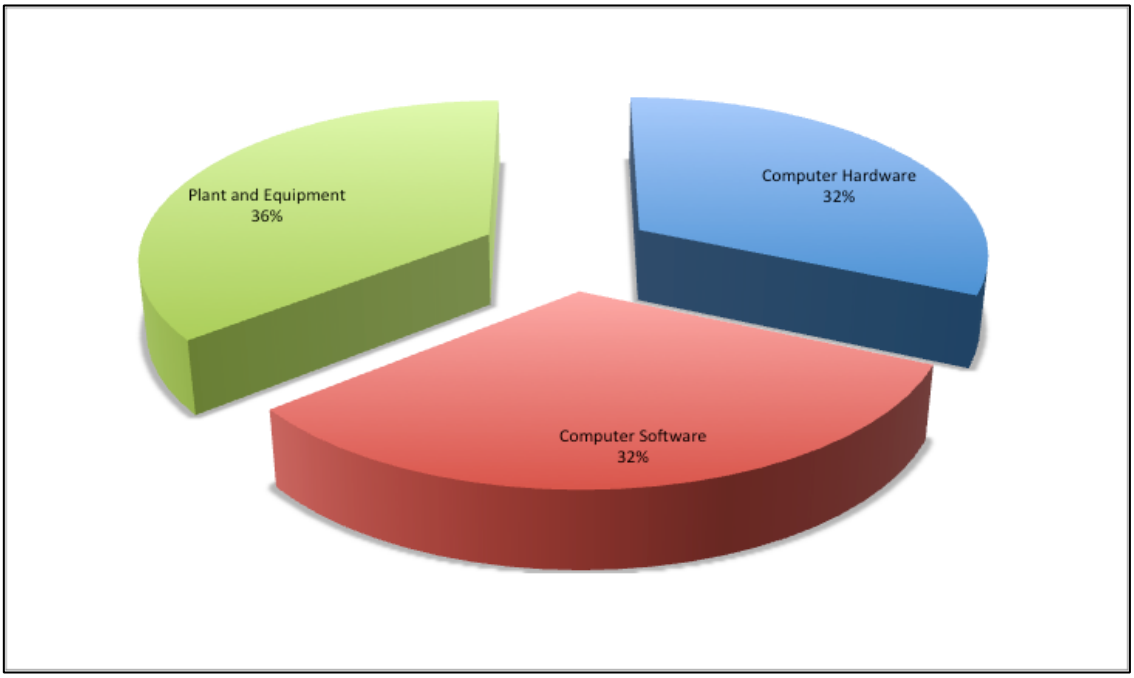
Figure 5.3 shows a higher percentage of respondents belonging to multinational organisations (70%) than local companies (30%).

5.1.4 AMT type

A relatively even spread over the AMT type the respondent was most recently involved in implementing was achieved (Figure 5.4). Plant and equipment had the highest number of respondents (36%), while both computer hardware and software had 32%.

Figure 5.4: AMT type respondent most recently experienced an implementation of



5.1.5 Manufacturing system

Manufacturing systems represented by the respondents is displayed in Figure 5.5. A continuous/flow line manufacturing system was represented by the bulk of the respondents (53%), followed by batch production systems at 31%. The least represented of defined manufacturing systems was jobbing production at 16%.

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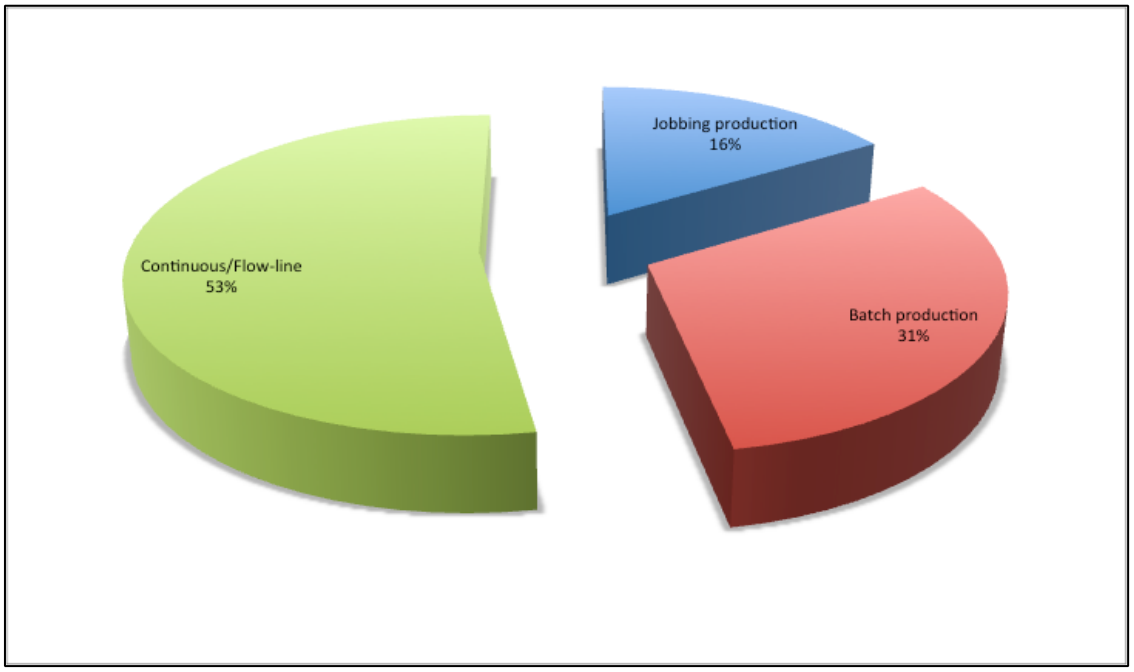
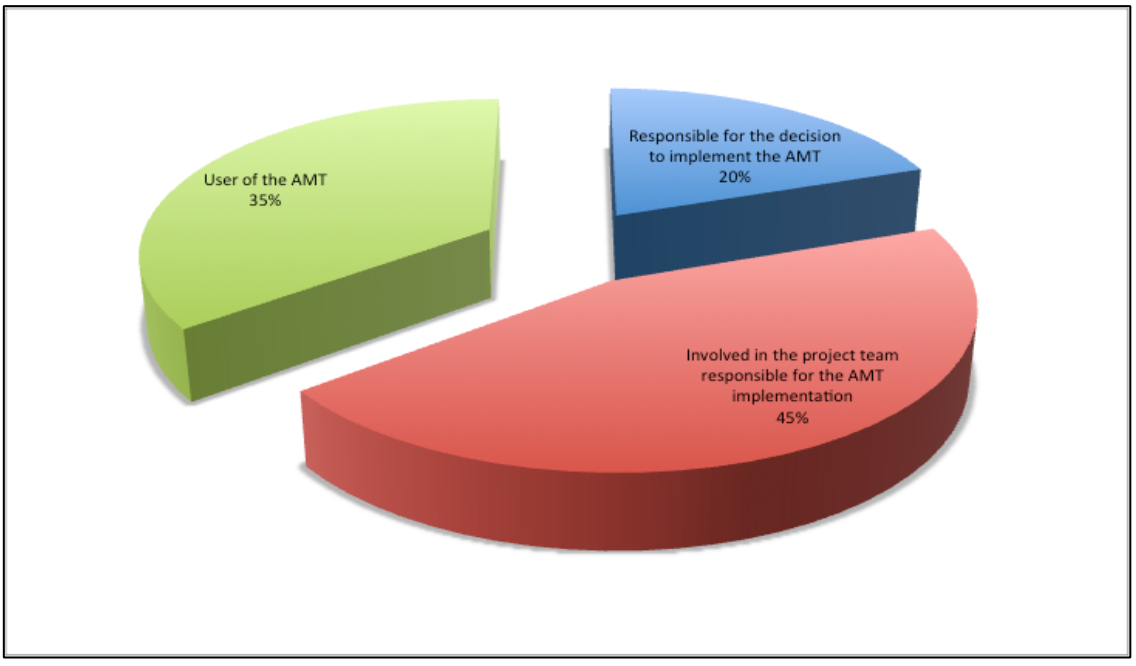
Figure 5.5: Respondent by manufacturing system



5.1.6 Role in AMT implementation

The role of the respondents in the AMT implementation is represented in Figure 5.6. Some 45% of the respondents were involved in the project team responsible for the AMT implementation. Another 35% of the respondents were users of the AMT, while the 20% of respondents were responsible for the decision to implement the AMT.

Figure 5.6: Respondents role in the AMT implementation



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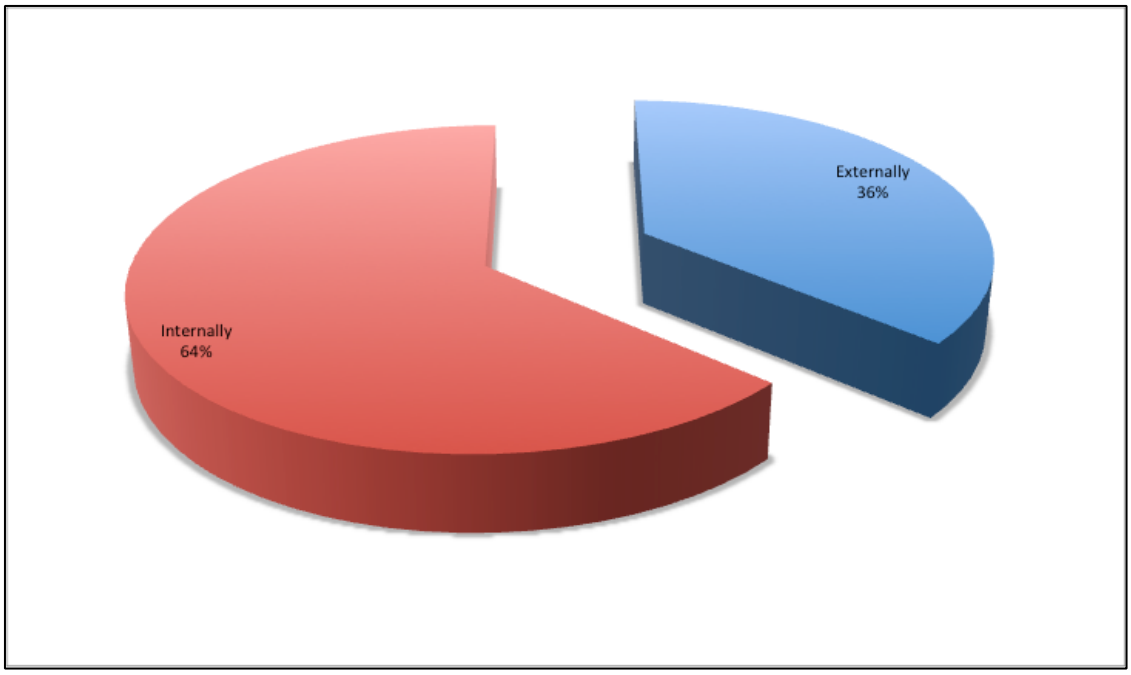
5.1.7 Location of AMT implementation management

The majority of the AMT implementations were managed internally (64%), while the remaining 36% were managed externally as illustrated in Figure 5.7.

Figure 5.7: Location of AMT implementation management



5.1.8 AMT investment value

Figure 5.8: Respondent by AMT investment value

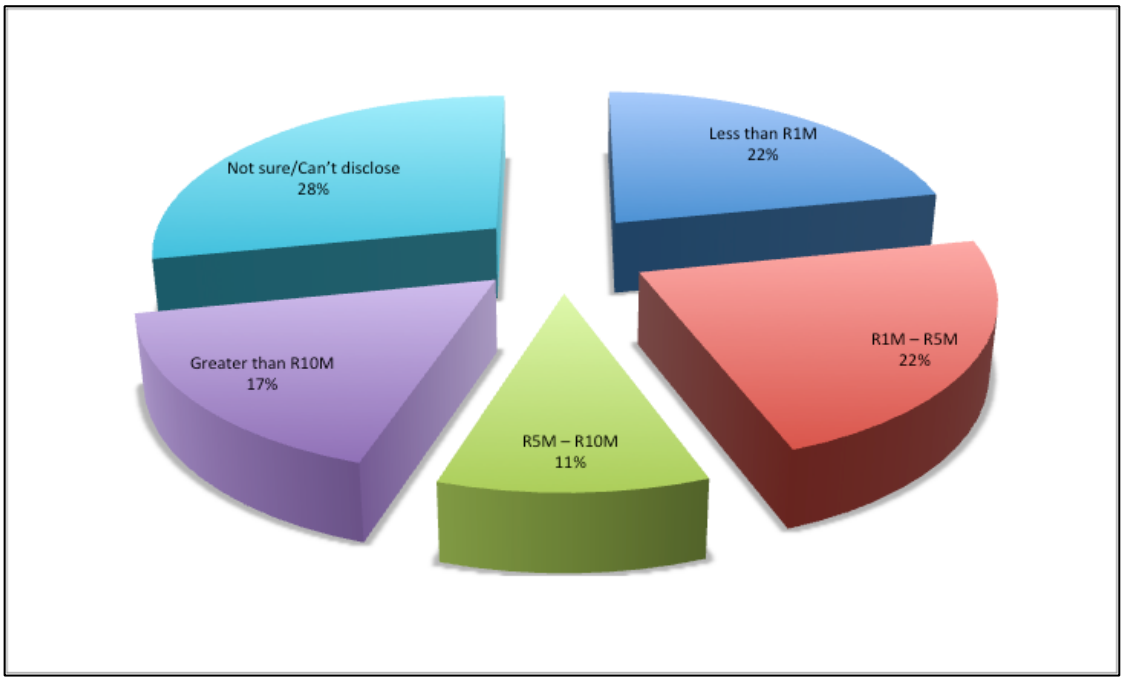


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Figure 5.8 displays the AMT investment value. Respondents who were not sure of, or could not disclose the AMT investment amount, made up 28% of the total. Of the values indicated in the display, investments less than R1m and R1m – R5m were each accounted for by 22% of the respondents. The remainder was split between investments greater than R10m (17%) and investments ranging from R5m – R10m (11%).

5.2 Factor analysis and reliability

Factor analysis conducted on the data entailed two approaches. The first took the form of an exploratory factor analysis that aimed to analyse the data to reveal any new themes or constructs around the organisational factors impacting AMT implementation that had not been defined through the literature study. Reliability of the factors established through the exploratory analysis was thereafter checked for internal consistency using Cronbach's alpha coefficient, one of the most commonly used indicators of internal consistency (DeVellis, 2011). Factors generated through the exploratory analysis were not considered relevant to the remainder of the data analysis conducted. The analysis was therefore removed from the body of the document and can be accessed in Appendix B.

Confirmatory factor analysis was thereafter conducted on the factors of the four defined constructs – top management ability, organisational ability, training and education and incentives and rewards – to determine if the factors defined under each of these constructs grouped together to form an internally consistent factor. Internal consistency of the defined constructs was thereafter checked using Cronbach's alpha coefficient to determine if internal consistency supported the grouping of the variables for further analysis and hypothesis testing in this study. Responses related to the agreement of the degree to which the various factors were in play during the AMT implementation were used in the exploratory factor analysis, as well as in the testing of the reliability of the defined factors.

5.2.1 Confirmatory factor analysis

Confirmatory factor analysis was conducted on each of the constructs identified through the literature review of this study. These constructs included top management ability, organisational ability, training and education and incentives and rewards. Extraction was carried out on each of the sets of variables using principle axis factoring. Responses to the agreement of the degree to which various factors were in

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play during the AMT implementation, consisting of 24 items, were run through a principle axis factoring extraction technique. Principle axis factoring, also known as common factor analysis, attempts to determine the smallest number of factors that can be used to best represent the interrelations between variables (Pallant, 2010).

To check the suitability of the data for factors analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value and the Bartlett's test of sphericity values were checked. KMO requires a value of 0.6 or above for data suitability. Bartlett's test of sphericity requires that the Sig. value be below 0.05.

Table 5.2 displays the KMO values and Bartlett's test of sphericity Sig. values derived from the analysis. All constructs were found to meet the criteria set out by KMO and Bartlett's test of sphericity, indicating suitability for factor analysis. Tables 5.3 to 5.5 display the correlation matrices generated for the different constructs. The presence of correlation coefficients above 0.3 further supports the suitability of the data for factor analysis.

Kaiser's criterion was applied to the various constructs to determine how many factors to retain. Tables 5.6 to 5.8 display the total variance explained tables for the constructs. Each of the constructs had only one variable with an eigenvalue above one, indicating that only one factor could be extracted for each of the constructs examined. This is in line with expectations as the variables linked to each construct were designed to test the defined construct. The prevalence of one extracted factor supports this.

Table 5.2: KMO values and Bartlett's test of sphericity values for constructs

	Top management ability ('TM)	**Organisational ability (OA)**	**Training and education (TE)**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)	0.890	0.907	0.873
Bartlett's test of sphericity (Sig.)	0.000	0.000	0.000

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Table 5.3: Correlation matrix for top management ability

Correlation matrix for top management ability								
	TM1	**TM2**	**TM3**	**TM4**	**TM5**	**TM6**	**TM7**	**TM8**
TM1	1.000	.520	.654	.425	.529	.494	.466	.634
TM2	.520	1.000	.523	.505	.641	.675	.502	.582
TM3	.654	.523	1.000	.505	.574	.495	.491	.577
TM4	.425	.505	.505	1.000	.452	.561	.583	.598
TM5	.529	.641	.574	.452	1.000	.481	.555	.512
TM6	.494	.675	.495	.561	.481	1.000	.452	.548
TM7	.466	.502	.491	.583	.555	.452	1.000	.511
TM8	.634	.582	.577	.598	.512	.548	.511	1.000

Table 5.4: Correlation matrix for organisational ability

Correlation matrix for organisational ability								
	OA1	**OA2**	**OA3**	**OA4**	**OA5**	**OA6**	**OA7**	**OA8**
OA1	1.000	.542	.489	.490	.391	.369	.585	.565
OA2	.542	1.000	.538	.564	.541	.456	.517	.583
OA3	.489	.538	1.000	.502	.455	.465	.465	.600
OA4	.490	.564	.502	1.000	.546	.440	.448	.634
OA5	.391	.541	.455	.546	1.000	.411	.510	.482
OA6	.369	.456	.465	.440	.411	1.000	.390	.449
OA7	.585	.517	.465	.448	.510	.390	1.000	.445
OA8	.565	.583	.600	.634	.482	.449	.445	1.000

Table 5.5: Correlation matrix for training and education

Correlation matrix for training and education						
	TE1	**TE2**	**TE3**	**TE4**	**TE5**	**TE6**
TE1	1.000	.583	.582	.677	.543	.587
TE2	.583	1.000	.576	.543	.554	.552
TE3	.582	.576	1.000	.498	.479	.513
TE4	.677	.543	.498	1.000	.633	.758
TE5	.543	.554	.479	.633	1.000	.690
TE6	.587	.552	.513	.758	.690	1.000

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Table 5.6: Total variance explained for top management ability

Total variance explained for top management ability							
Factor	Initial Eigenvalues				Extraction Sums of Squared Loadings		
	Total		% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.766		59.571	59.571	4.307	53.841	53.841
2	.697		8.716	68.287			
3	.628		7.855	76.142			
4	.594		7.421	83.563			
5	.401		5.013	88.576			
6	.375		4.684	93.260			
7	.284		3.548	96.808			
8	.255		3.192	100.000			

Table 5.7: Total variance explained for organisational ability

Total variance explained for organisational ability							
Factor	Initial Eigenvalues				Extraction Sums of Squared Loadings		
	Total		% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.483		56.032	56.032	3.992	49.902	49.902
2	.704		8.799	64.831			
3	.631		7.883	72.714			
4	.613		7.666	80.380			
5	.481		6.013	86.393			
6	.423		5.293	91.686			
7	.350		4.380	96.066			
8	.315		3.934	100.000			

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Table 5.8: Total variance explained for training and education

Total variance explained for training and education							
Factor	Initial Eigenvalues				Extraction Sums of Squared Loadings		
	Total		% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.930		65.501	65.501	3.528	58.803	58.803
2	.653		10.888	76.389			
3	.465		7.745	84.134			
4	.409		6.823	90.957			
5	.328		5.472	96.428			
6	.214		3.572	100.000			

As there was only one factor present for each of the constructs, no oblimin rotation was necessary. Tables 5.9 to 5.11 display the factor loadings on the various constructs, as well as the internal consistency measured through the Cronbach's alpha coefficient. The coefficient was measured at above 0.884 for all of the constructs evaluated, indicating acceptable internal consistency reliability for the scales used with the samples (Pallant, 2010). Definitions applied to these factors through the sub-factors can therefore be considered reliable and valid.

Table 5.9: Factor loading for top management ability construct and Cronbach's alpha

Factor items for top management ability		Factor loading	Cronbach's alpha
TM1	Alignment of the AMT to support the long-term vision of the organisation	.726	0.901
TM2	Communication of the motivation behind the AMT implementation and expected benefits	.775	
TM3	Alignment of the AMT to the manufacturing strategy of the organisation	.746	
TM4	High level of general technical expertise of top management and know-how around the technical aspects of the AMT	.702	
TM5	Communication of the company strategy within the organisation	.729	
TM6	Investment in resources directed at the new technology	.722	
TM7	Receptiveness of the organisational culture to new technologies	.686	
TM8	Promotion of new technologies and support and commitment towards the AMT by top management	.779	

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Table 5.10: Factor loading for organisational ability construct and Cronbach's alpha

Factor items for organisational ability		Factor loading	Cronbach's alpha
OA1	Handing over planning and troubleshooting responsibilities related to the AMT to in-house employees rather than contractors	.696	0.884
OA2	Possessing a more flexibility-oriented culture	.768	
OA3	Changes to the organisational structure to support the new AMT	.714	
OA4	Adequate channels of communication and widespread participation from organisational members in the implementation	.742	
OA5	Highly skilled workers with competencies that match the manufacturing and AMT environment	.672	
OA6	Use of in-house Research and Development to enhance the effectiveness of an AMT implementation	.591	
OA7	In-house expertise to manage the AMT implementation	.675	
OA8	Organisation of the workforce into multidisciplinary teams to manage the AMT implementation	.775	

Table 5.11: Factor loading for training and education construct and Cronbach's alpha

Factor items for training and education		Factor loading	Cronbach's alpha
TE1	Training of managers on the AMT before implementation	.777	0.894
TE2	Possessing highly skilled and qualified operators	.721	
TE3	Development of best practices to manage the AMT	.673	
TE4	Creation of specific training programmes tailored to the AMT	.832	
TE5	In-house training capability to support training requirements for the AMT	.759	
TE6	Investment in education and training directed at the AMT	.827	

As incentives and rewards were only made up of two sub-factors to test the construct, it was deemed not necessary to conduct a factor analysis on them to check the reliability. Table 5.12 illustrates the factor items used to test the incentives and rewards construct for the analysis that follows.

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Table 5.12: Factor items for incentives and rewards

Factor items for incentives and rewards	
IR1	Directing incentives and rewards schemes at the successful use of the AMT
IR2	Implementation of performance measures directed at the AMT

5.3 Descriptive statistics of organisational factors

In the sections that follow, descriptive statistics conducted on the factors used to define the various defined organisational constructs that impact AMT implementation are presented. The analysis is carried out on the responses related to the degree of importance of the individual factors as well as the degree of agreement as to whether the factor was prevalent within the respondent's organisation during an AMT implementation. Responses were averaged out, based on the established Likert Scale ratings used. The means are calculated for each of the factors using data from all respondents. Error bars are used to illustrate the standard deviations from the mean calculated for each of the factors.

5.3.1 Descriptive statistics of top management ability construct

Table 5.13 displays the sub-factors that were used to measure top management ability. A comparison of the averages achieved for the mean importance (ideal) rating versus each of each of the sub-factors versus the degree of agreement (current situation) ratings is displayed in Figure 5.9. The results display a relatively high rating achieved for most factors with most of them close to an average rating of six indicating a strong level of importance for all factors. The exception was the rating related to a high level of general technical expertise of top management and know-how around the technical aspects of the AMT, which rated the lowest at 5.04. The ideal situation was also found to rank higher than the current situation for all factors related to the top management ability construct.

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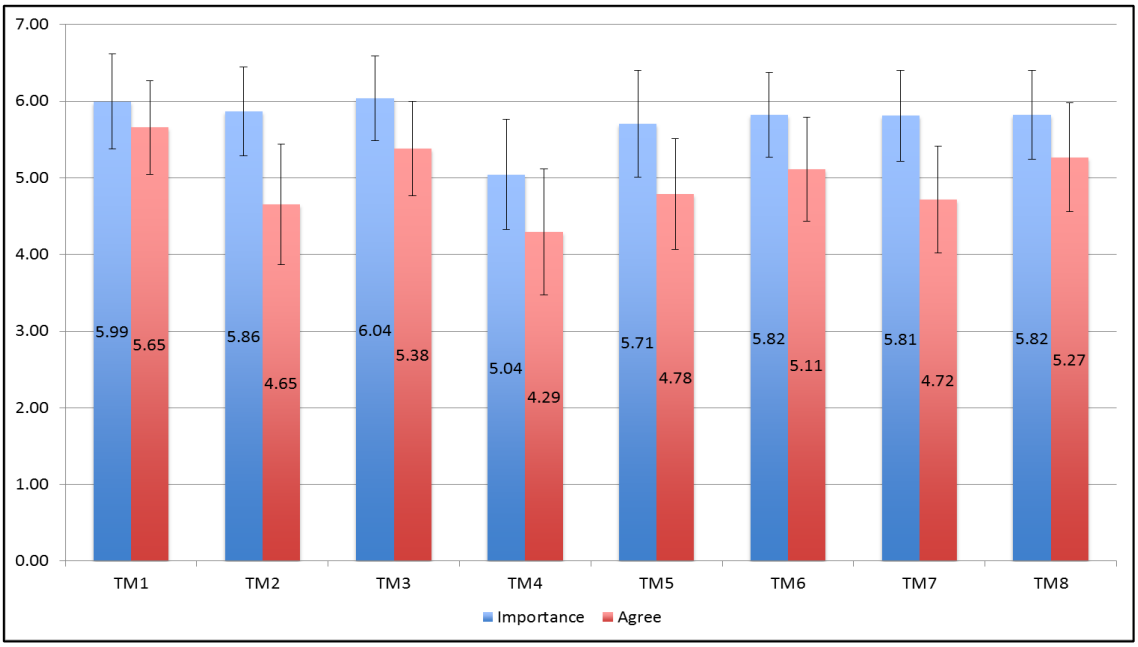
Table 5.13: Top management ability construct

Factors related to top management ability construct	
TM1	Alignment of the AMT to support the long-term vision of the organisation
TM2	Communication of the motivation behind the AMT implementation and expected benefits
TM3	Alignment of the AMT to the manufacturing strategy of the organisation
TM4	High level of general technical expertise of top management and know-how around the technical aspects of the AMT
TM5	Communication of the company strategy within the organisation
TM6	Investment in resources directed at the new technology
TM7	Receptiveness of the organisational culture to new technologies
TM8	Promotion of new technologies and support and commitment towards the AMT by top management

Figure 5.9: Mean importance rating of factors related to top management ability construct and degree of agreement around factors prevalent during AMT implementation



5.3.2 Descriptive statistics of organisational ability constructs

The sub-factors used to measure organisational ability are displayed in Table 5.14. A comparison of the averages achieved for the mean importance (ideal) rating, versus each of each of the sub-factors, versus the degree of agreement (current situation) ratings is displayed in Figure 5.10. Ratings of importance were found to mostly fall around halfway between five and six, indicating a level of importance for all of the sub-factors. The exception was the rating related to use of in-house research and

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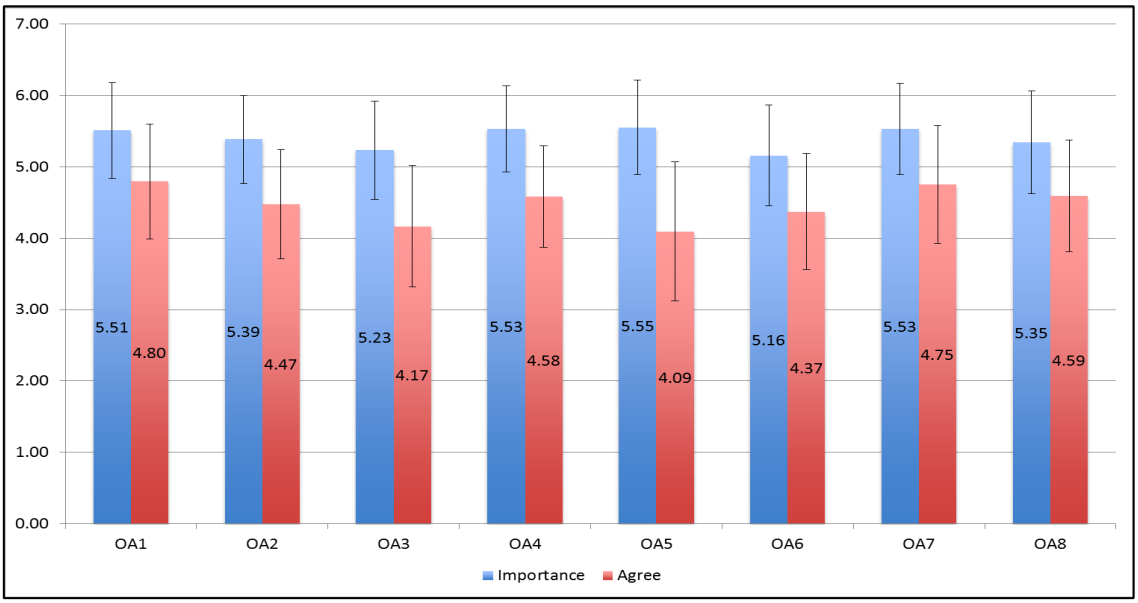
development, which was the lowest at 5.16. Highly skilled workers with competencies that match the AMT and manufacturing environment ranked the highest at 5.55. The ideal situation was also found to rank higher than the current situation for all factors related to the organisational ability construct.

Table 5.14: Organisational ability construct

Factors related to organisational ability construct	
OA1	Handing over planning and troubleshooting responsibilities related to the AMT to in-house employees rather than contractors
OA2	Possessing a more flexibility-oriented culture
OA3	Changes to the organisational structure to support the new AMT
OA4	Adequate channels of communication and widespread participation from organisational members in the implementation
OA5	Highly skilled workers with competencies that match the manufacturing and AMT environment
OA6	Use of in-house Research and Development to enhance the effectiveness of an AMT implementation
OA7	In-house expertise to manage the AMT implementation
OA8	Organisation of the workforce into multidisciplinary teams to manage the AMT implementation

Figure 5.10: Mean importance rating of factors related to organisational ability construct and degree of agreement around factors prevalent during AMT implementation



5.3.3 Descriptive statistics of training and education construct

Table 5.15 displays the sub-factors that were used to measure training and education. A comparison of the averages achieved for the mean importance (ideal) rating, versus

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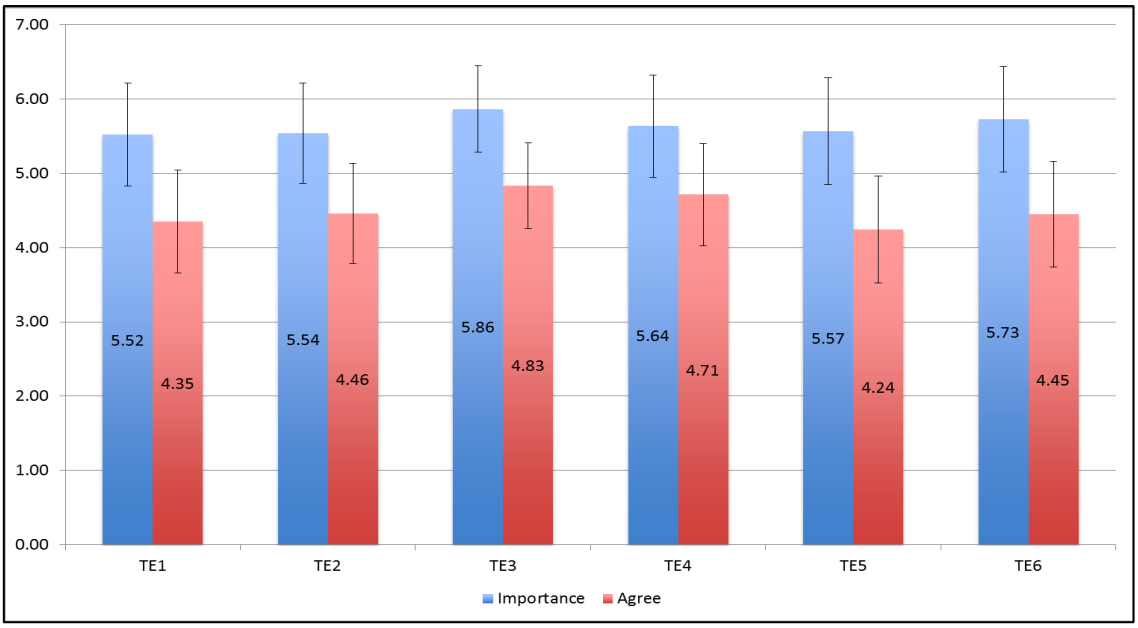
each of each of the sub-factors, versus the degree of agreement (current situation) ratings is displayed in Figure 5.11. Ratings of importance were found to mostly fall around halfway between five and six, indicating a level of importance for all of the sub-factors. Development of best practices to manage the AMT was found to have the highest mean rating at 5.86. The ideal situation was also found to rank higher than the current situation for all factors related to the training and education construct.

Table 5.15: Training and education construct

Factors related to training and education construct	
TE1	Training of managers related to the AMT before implementation
TE2	Possessing highly skilled and qualified operators
TE3	Development of best practices to manage the AMT
TE4	Creation of specific training programmes tailored to the AMT
TE5	In-house capability to support training requirements for the AMT
TE6	Investment in education and training directed at the AMT

Figure 5.11: Mean importance rating of factors related to training and education construct and degree of agreement around factors prevalent during AMT implementation



5.3.4 Descriptive statistics of incentives and rewards construct

The two sub-factors used to measure incentives and rewards are illustrated in Table 5.16. A comparison of the averages achieved for the mean importance (ideal) rating ,versus each of each of the sub-factors, versus the degree of agreement (current

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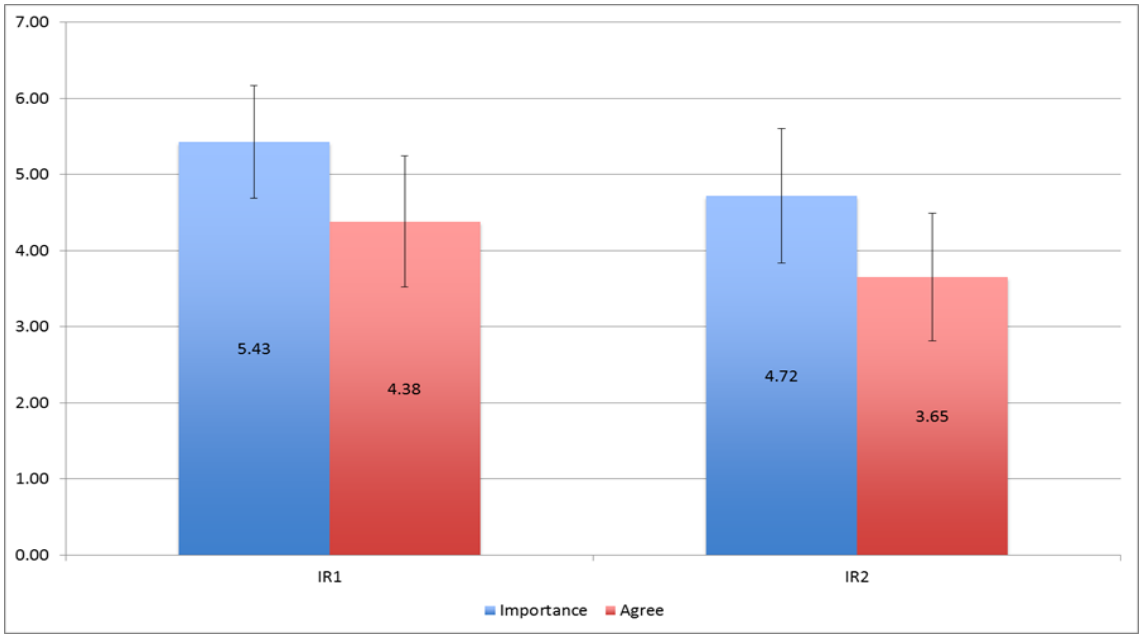
situation) ratings is displayed in Figure 5.12. Ratings of importance differed for the two sub-factors. Implementation of performance measures showed a higher level of importance at 5.43, while directing incentives and rewards schemes at the successful use of the AMT had the lowest rating at 4.72. The ideal situation was found to rank higher than the current situation for all factors related to the incentives and rewards construct.

Table 5.16: Incentives and rewards construct

Factors related to incentives and rewards construct	
IR1	Implementation of performance measures directed at the AMT
IR2	Directing incentives and rewards schemes at the successful use of the AMT

Figure 5.12: Mean importance rating of factors related to incentives and rewards construct and degree of agreement around the factors prevalent during AMT implementation



5.5 Results related to research questions and hypotheses

The following section will expand on the descriptive statistics and factor analysis conducted to address the research questions put forward and test the research hypotheses developed. Ultimately, the analysis aims to extract the constructs identified and rank them according to importance, test the organisational readiness of the organisations against the importance ratings, test factor applicability across contexts and assess whether the critical factors are reliable in predicting the degree of implementation success. The primary benefits targeted through AMT implementations

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and the degree of AMT success is also addressed as part of the research questions laid out.

Statistical tests generally assume a normal distribution for most data (Pallant, 2010). This assumption can lead to errors in statistical analysis if this does not hold true (Pallant, 2010). A check for normality is therefore conducted on all data corresponding to the Likert Scale responses for the different groups of interest before analysis was conducted. This enabled selection of the appropriate statistical test. For groups of less than 50, the Shapiro-Wilk test of normality was used. The Kolmogorov-Smirnov test of normality was used on groups greater than or equal to 50 individuals. Results of the normality tests conducted on the data used in the comparative analyses have been excluded from the body of the report and can be found in Appendix C.

For normally distributed data, parametric tests are selected for the data analysis (Pallant, 2010). When non-normality is noted in the data, additional variables are evaluated to determine feasibility of a parametric test. This includes a check on the size of the group and the similarities of the group sizes for which the comparisons will be conducted (Pallant, 2010). For large enough groups and groups of similar sizes, a parametric test can be considered, depending on the robustness of the test selected. If not, an appropriate non-parametric test needs to be selected (Pallant, 2010).

5.5.1 Research question one

What are the predominant benefits targeted from AMT implementations?

A breakdown of the percentage of the different primary intended benefits targeted from the AMT investment are displayed in Figure 5.13. Better management control (20%) and improved quality (19%) made up the largest groups of the defined intended benefits. These groups were followed by obtaining a competitive advantage and increased throughput, both at 13%. Of the defined intended benefits, material cost savings at 3% was the least represented. Table 5.17 displays the intended benefits that did not fit into the defined groups. This constituted 9% of the total respondents.

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Figure 5.13: Respondent by primary intended AMT benefit

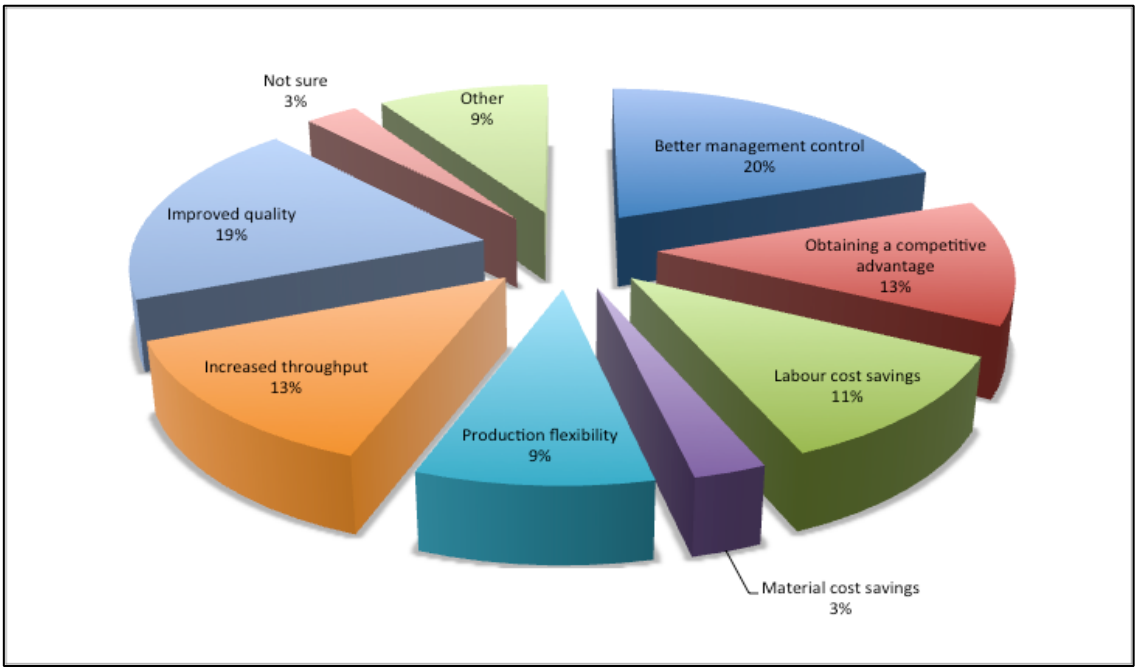

Table 5.17: Primary intended benefits falling out defined groups

Primary intended benefit	Respondents
All of the above	2.0%
Call centre setup	0.7%
Cheaper alternative	0.7%
Safety, productivity, time, quality and labour cost	0.7%
Efficiency improvements	0.7%
Energy saving	0.7%
Core function	0.7%
Maintain best practice standards	0.7%
Replacement of old technology	0.7%
Safety and efficiency	0.7%

5.5.2 Research question two

What is the extent to which the intended benefits are being fully derived from AMT implementations?

A large majority of the respondents indicated that the AMT provided the intended benefits (68%), with 27% of the respondents reporting that the AMT only partially

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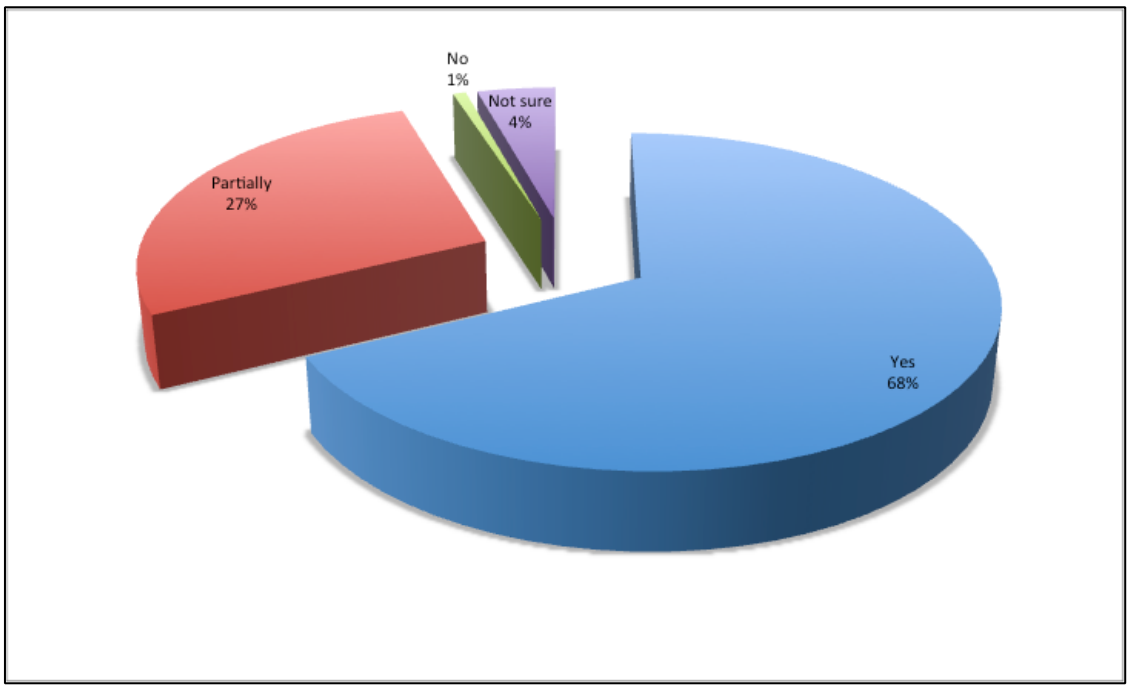
achieved the intended benefits (Figure 5.14). The remainder of the respondents (4%) indicated that they were not sure of the outcome with regards to meeting benefits and 1% indicated that the benefits were not achieved.

Figure 5.14: Respondent by AMT success in achieving intended benefits



5.5.3 Research question three

What is the perceived relative importance of the various defined organisational factors towards impacting the effectiveness of an AMT implementation?

This research question sets out to rank the organisational factors, defined as the constructs, according to their importance ratings across the entire population. The means for the constructs will be computed, followed by a comparison between the means of the factors to determine if any significant differences can be noted between them. This will determine the relative importance of the variables and allow for a ranking of the factors identified according to importance.

Tests revealed non-normality for all the variables of interest for this analysis (Appendix C1). Despite this, the groups were deemed to be large enough at 140 respondents and equal enough in size (all the same), to still select a robust, parametric test. The paired samples t-test was selected for the analysis as the comparison was conducted on constructs based on responses from the same group of people – the entire set of respondents with usable responses.

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The results of the paired samples t-test used for the comparisons on the importance (ideal) ratings of the constructs across the group are presented in Table 5.18. Differences were noted between all the sets of groups (Sig. 2-tailed or p-value < 0.05) with the exception of the comparison between top management and ability and training and education. These were found to lie on the same level of importance with no differences observed between the two variables (p value = 0.114). Based on means, these sit at the top level of importance, followed by organisational ability and incentives and rewards.

Table 5.18: Paired samples t-test statistics on importance (ideal) ratings across entire group

Paired samples t-test statistics on importance (ideal) ratings across entire group									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Lower	95% Confidence Upper			
Pair 1	TopManAbility_Imp - OrgAbility_Imp	.358	.583	.049	.260	.455	7.261	139	.000
Pair 2	TopManAbility_Imp - TrainingEdu_Imp	.117	.874	.074	-.029	.264	1.589	139	.114
Pair 3	TopManAbility_Imp - IncentRewards_Imp	.686	1.313	.111	.467	.906	6.186	139	.000
Pair 4	OrgAbility_Imp - TrainingEdu_Imp	-.240	.839	.071	-.381	-.100	-3.389	139	.001
Pair 5	OrgAbility_Imp - IncentRewards_Imp	.329	1.251	.106	.120	.538	3.110	139	.002
Pair 6	TrainingEdu_Imp - IncentRewards_Imp	.569	.973	.082	.406	.732	6.921	139	.000

Table 5.19 displays the group statistics conducted on the variables of interest. All variables had 140 respondents, with top management ability (TopManAbility_Imp) achieving the highest ranking in terms of importance across all groups. This was followed closely by training and education (TrainingEdu_Imp) with a lower rank, but on the same level of importance. The next level of importance was occupied by organisational ability (OrgAbility_Imp) and finally incentives and rewards (IncentRewards_Imp) with the lowest ranking of the four constructs in terms of importance. All constructs can however be considered to have a mean score that indicates a degree of importance to AMT implementation as they all fell above the “somewhat important” rank (five) on the Likert scale.

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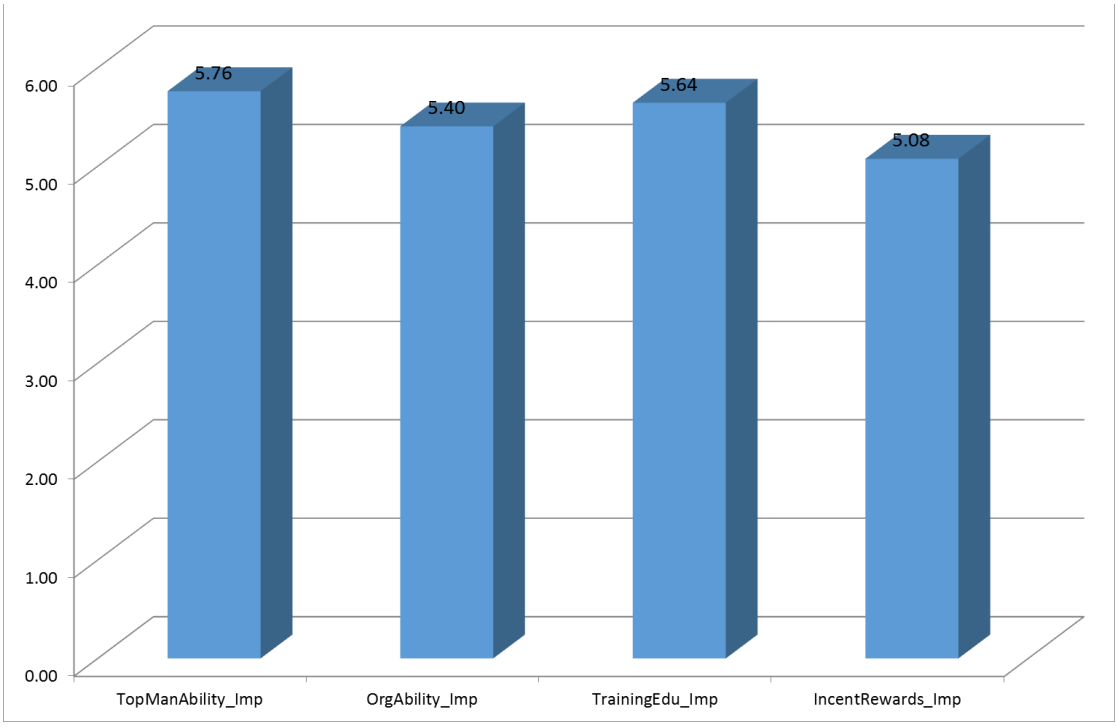
Table 5.19: Group statistics of importance (ideal) ratings across entire group

Group statistics of importance (ideal) rating across entire group			
	N	Mean	Std. Deviation
TopManAbility_Imp	140	5.76	.936
OrgAbility_Imp	140	5.40	.960
TrainingEdu_Imp	140	5.64	1.057
IncentRewards_Imp	140	5.08	1.453

Figure 5.15: Comparison of mean importance (ideal) ratings importance (ideal) rating for constructs across entire group



5.5.4 Research question four

Does the size of the organisation have an impact on the degree of importance of the critical organisational factors required to guide effective implementation of AMTs within an organisation?

This research question sets out to assess if there were any differences in the relative importance of critical organisational factor ratings between organisations of different size. In this case, SMEs, or organisations with less than 500 employees, were compared with large organisations with 500 or more employees.

Tests indicate non-normality on all groups with the exception of the responses related to organisational ability importance for organisations with 500 or more employees,

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where a p-value of 2.00 was obtained, indicating non-normality of the data (Appendix C2). Despite the non-normality of the majority of the data, the large group size and similarity of the sizes between the groups justified the use of a parametric test. The independent samples t-test was selected for the comparison as it was deemed robust enough to deal with the non-normality of the data.

Table 5.20 displays the results generated for the independent samples t-test for the comparison of the importance ratings of the four constructs between SMEs and large organisations. No differences were noted for top management ability, organisational ability and incentives and rewards (Sig. (2-tailed) or p-values > 0.05), indicating an equal rating of importance for these factors across the two groups. This indicates a lack of correlation between the importance of these factors and the size of the groups.

The only difference between the groups was noted on the training and education construct, where a p-value of 0.043 was generated on the independent samples t-test, indicating a difference between groups. This result indicates that the importance rating of training and education is related to the size of the organisation. An examination of the means indicates that larger organisations rate training and education at a higher level of importance for AMT implementations than SMEs (Table 5.21).

A graphical representation of the means of the ideal situation ratings of the constructs for SMEs (less than 500 employees) and large organisations (500 or more employees) identifies that despite the rating of training and education at a higher level for large organisations, the factors are rated in the same order of importance for both groups (Figure 5.16). Top management ability leads the rankings, followed by training and education, organisational ability and finally, incentives and rewards.

Table 5.20: Independent samples t-test statistics for comparison of importance (ideal) ratings of groups based on organisation size

Independent samples t-test statistics for comparison of importance (ideal) ratings of groups based on organisation size									
	Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Lower	95% Confidence Upper
TopManAbility_Imp	1.687	.196	-1.246	138	.215	-.199	.160	-.515	.117
OrgAbility_Imp	.196	.659	-1.623	138	.107	-.265	.163	-.588	.058
TrainingEdu_Imp	1.215	.272	-2.046	138	.043	-.366	.179	-.720	-.012
IncentRewards_Imp	1.469	.228	-1.711	138	.089	-.423	.247	-.911	.066

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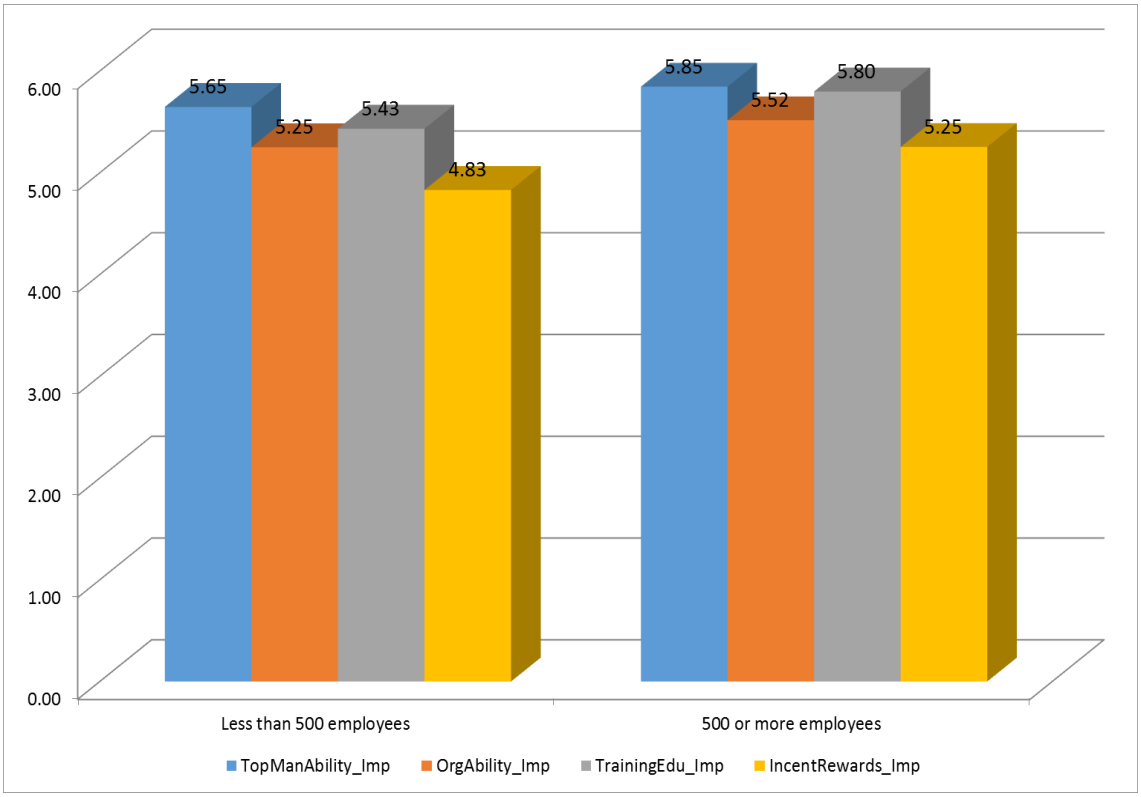
Table 5.21: Group statistics of importance (ideal) rating for groups based on organisation size

Group statistics of importance (ideal) rating for groups based on organisation size				
		N	Mean	Std. Deviation
TopManAbility_Imp	Less than 500 employees	59	5.65	1.100
	500 or more employees	81	5.85	.793
OrgAbility_Imp	Less than 500 employees	59	5.25	1.070
	500 or more employees	81	5.52	.861
TrainingEdu_Imp	Less than 500 employees	59	5.43	1.231
	500 or more employees	81	5.80	.887
IncentRewards_Imp	Less than 500 employees	59	4.83	1.577
	500 or more employees	81	5.25	1.337

Figure 5.16: Comparison of the means of the importance (ideal) rating of constructs for SMEs and large organisations



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5.5.5 Research question five

Does the type of AMT being implemented have an impact on the degree of importance of the critical organisational factors required to guide effective implementation of AMTs within an organisation?

Research question three seeks to establish if the type of AMT being implemented impacts the degree of importance of the various organisational factors. Due to non-normality of the majority of the data linked to the factors for each AMT type (Appendix C3), and the small size of the groups involved in the comparison, a non-parametric test, the Kruskall-Wallis, was selected for the analysis. The Kruskall-Wallis test is used to compare mean rank. The Chi-Square test statistic was used to determine the level of significance of the differences.

Table 5.22 illustrates the results of the Kruskall-Wallis non-parametric test to detect any differences in the ideal ratings between the different AMT types. Only one difference was noted on top management ability, with a p-value or Asymp. Sig. of 0.033 indicating a significant difference. As three groups were being compared, to identify the location of the difference, post-hoc tests, Mann-Whitney U, were conducted on the groups for the top management ability construct. The criteria for the level of significance was reduced to $p < 0.0167$ or 1.67% for the post-hoc tests. The tests revealed a significant difference in ratings between plant and equipment and computer software for top management abilities importance for AMT implementation with a p-value of 0.014 (Table 5.23).

Table 5.22: Chi-Square Test statistics a,b for importance (ideal) ratings based on AMT type

Chi-Square Test Statistics[a,b] for importance (ideal) ratings based on AMT type			
	Chi-Square	df	Asymp. Sig.
TopManAbility_Imp	6.835	2	.033
OrgAbility_Imp	4.463	2	.107
TrainingEdu_Imp	2.025	2	.363
IncentRewards_Imp	3.965	2	.138
a. Kruskal Wallis Test			
b. Grouping Variable: Q5			

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Table 5.23: Mann-Whitney Group Statistics for post-hoc tests on the comparison of top management ability importance (ideal) for computer hardware versus computer software

Mann-Whitney Group Statistics for post-hoc tests on the comparison of top management ability importance (ideal) for computer hardware versus computer software									
		N	Mean	Std. Deviation	Std. Error Mean	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
TopManAbility_Imp	Computer Hardware	44	5.81	.680	.102	48.31	2125.50	888.5000	0.317
	Computer Software	46	5.51	1.216	.179	42.82	1969.50		
TopManAbility_Imp	Computer Hardware	44	5.81	.680	.102	42.30	1861.00	871.000	.082
	Plant and Equipment	50	5.95	.790	.112	52.08	2604.00		
TopManAbility_Imp	Computer Software	46	5.51	1.216	.179	41.22	1896.00	815.000	.014
	Plant and Equipment	50	5.95	.790	.112	55.20	2760.00		

Evaluation of the mean importance ratings revealed that respondents involved in implementations of plant and equipment rated top management ability at a higher level than their counterparts involved in software implementations (Table 5.24). A comparison of the mean importance ratings of the four constructs under investigation for the three groups – computer hardware, computer software and plant and equipment – is contained in Figure 5.24. While the order of rankings of the importance of the factors or constructs followed that of the overall group for computer hardware and plant and equipment, it is noted that for computer software, training and education had a higher ranking than top management ability, based on the mean rating of importance.

Table 5.24: Group statistics of importance (ideal) ratings for groups based on AMT Type

Group statistics of importance (ideal) ratings for groups based on AMT Type					
		N	Mean	Std. Deviation	Mean Rank
TopManAbility_Imp	Computer Hardware	44	5.81	.680	68.10
	Computer Software	46	5.51	1.216	60.53
	Plant and Equipment	50	5.95	.790	81.78
OrgAbility_Imp	Computer Hardware	44	5.40	.805	67.83
	Computer Software	46	5.14	1.200	62.91
	Plant and Equipment	50	5.64	.776	79.83
TrainingEdu_Imp	Computer Hardware	44	5.63	.820	65.83
	Computer Software	46	5.55	1.185	67.99
	Plant and Equipment	50	5.74	1.128	76.92
IncentRewards_Imp	Computer Hardware	44	5.24	1.310	73.83
	Computer Software	46	4.82	1.507	61.01
	Plant and Equipment	50	5.17	1.517	76.30

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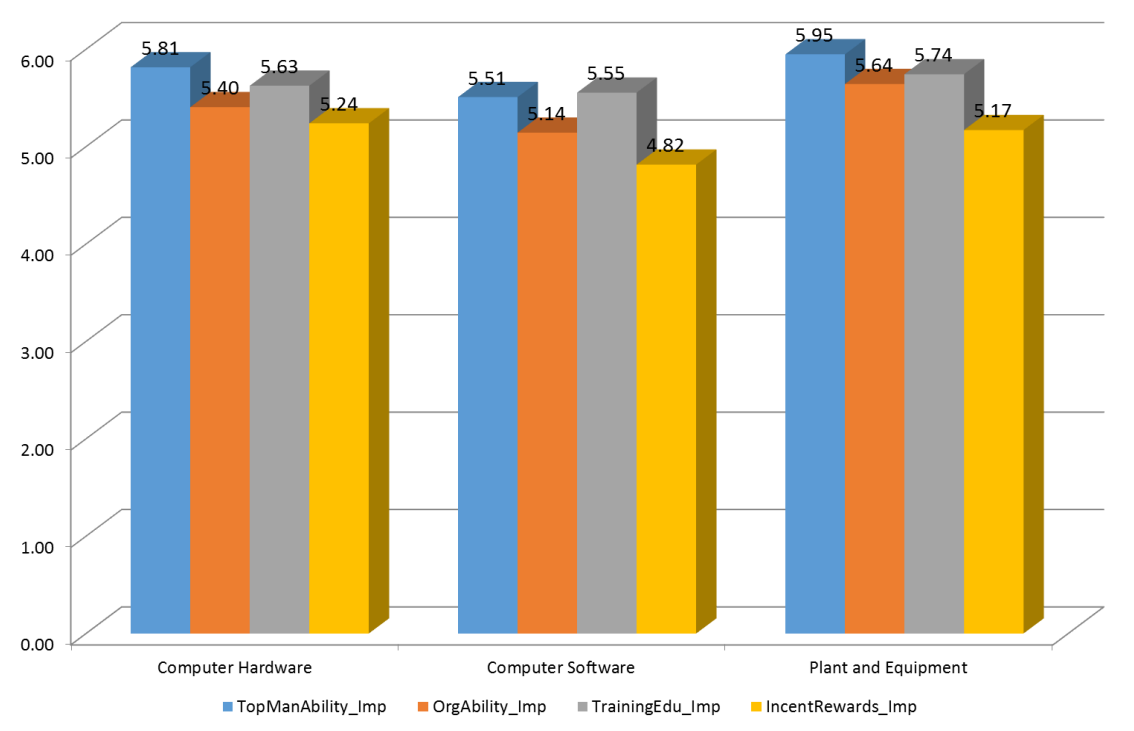
Figure 5.17: Comparison of the means importance (ideal) ratings of constructs for computer hardware, computer software and plant and equipment



5.5.6 Research question six

Do manufacturing organisations within the South African context exhibit a high degree of organisational readiness for AMT implementation with regards to the degree to which the defined organisational factors are in play during AMT implementations?

The aim of this research question was to assess the organisational readiness of organisations in South Africa, based on the differences in the current ratings of the critical organisational factors, versus the ideal situation, based on the organisational readiness. The analysis is accomplished through a comparison of the means of the responses of the entire group for the importance and agree questions of the four constructs. Comparisons were done on each construct for the agree and importance rating questions.

Despite non-normality of all the variables (Appendix C1), the paired samples t-test was selected due to its robustness. Differences were observed between the ideal and current situation for all constructs assessed with Sig. (2-tailed) or p-values values all less than 0.05 (Table 5.25). When assessing the statistical analysis together with the means of the ratings, presented in Table 5.26 and Figure 5.18, it can be seen that the

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current situation exhibits a lower rating than the ideal situation for all the constructs, indicating a low degree of organisational readiness for AMT implementations.

Table 5.25: Paired samples t-test on agree (current) versus importance (ideal) ratings across entire group

Paired samples t-test on agree (current) versus importance (ideal) ratings across entire group									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Lower	95% Confidence Upper			
Pair 1	TopManAbility_Imp - TopManAbility_Agr	.751	1.044	.089	.575	.928	8.422	136	.000
Pair 2	OrgAbility_Imp - OrgAbility_Agr	.908	1.153	.098	.713	1.103	9.222	136	.000
Pair 3	TrainingEdu_Imp - TrainingEdu_Agr	1.150	1.356	.116	.921	1.379	9.924	136	.000
Pair 4	IncentRewards_Imp - IncentRewards_Agr	1.051	1.642	.140	.774	1.329	7.493	136	.000

Table 5.26: Group statistics of importance (ideal) and agree (current) ratings for constructs across entire group

Group statistics of importance (ideal) and agree (current) ratings across entire group			
	N	Mean	Std. Deviation
TopManAbility_Imp	140	5.76	.936
OrgAbility_Imp	140	5.40	.960
TrainingEdu_Imp	140	5.64	1.057
IncentRewards_Imp	140	5.08	1.453
TopManAbility_Agr	139	4.99	1.082
OrgAbility_Agr	139	4.47	1.227
TrainingEdu_Agr	139	4.50	1.345
IncentRewards_Agr	139	4.02	1.567

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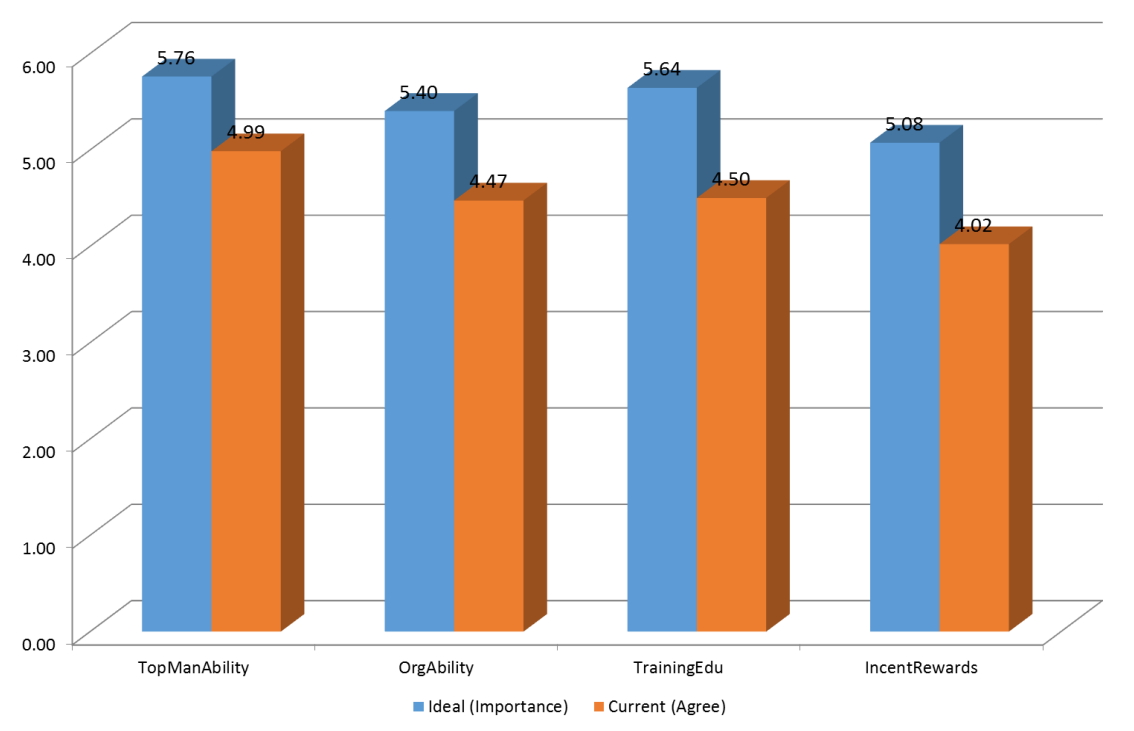
Figure 5.18: Comparison of means of importance (ideal) and agree (current) ratings for constructs across entire group



5.5.7 Research question seven

Do larger organisations exhibit a higher degree of organisational readiness for AMT implementations than SMEs?

An assessment of the organisational readiness or degree to which the four organisational factors that impact AMT implementation was conducted on SMEs and large organisations to assess whether larger organisations exhibit a higher level of readiness than SMEs. The responses of individuals in each group to the agree, or current situation, questions were therefore analysed.

Despite non-normality of the data, the robustness of the independent samples t-test was considered suitable for the analysis. The analysis revealed a difference in the mean agree or current ratings of training and education between the organisation's of different sizes, with the independent samples t-test generating a p-value of 0.042 for this variable (Table 5.27). No differences were noted for the other factors. When assessing the means, it is noted that the larger organisations had a higher level of training and education than SMEs (Table 5.28 and Figure 5.19).

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Table 5.27: Independent samples t-test statistics for comparison of agree (current) ratings of groups based on organisation size

Independent samples t-test statistics for comparison of agree (current) ratings of groups based on organisation size									
	Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Interval of the Lower	Interval of the Upper
TopManAbility_Agr	.000	.984	-.242	137	.809	-.045	.187	-.414	.324
OrgAbility_Agr	.229	.633	-.993	137	.322	-.210	.211	-.627	.208
TrainingEdu_Agr	2.238	.137	-1.797	137	.075	-.412	.230	-.866	.042
IncentRewards_Agr	2.745	.100	-1.237	137	.218	-.333	.269	-.865	.199

Table 5.28: Group statistics of agree (current) rating for groups based on organisation size

Group statistics of agree (current) rating for groups based on organisation size				
		N	Mean	Std. Deviation
TopManAbility_Agr	Less than 500 employees	58	4.96	1.169
	500 or more employees	81	5.00	1.022
OrgAbility_Agr	Less than 500 employees	58	4.35	1.272
	500 or more employees	81	4.56	1.194
TrainingEdu_Agr	Less than 500 employees	58	4.26	1.431
	500 or more employees	81	4.67	1.261
IncentRewards_Agr	Less than 500 employees	58	3.83	1.700
	500 or more employees	81	4.16	1.460

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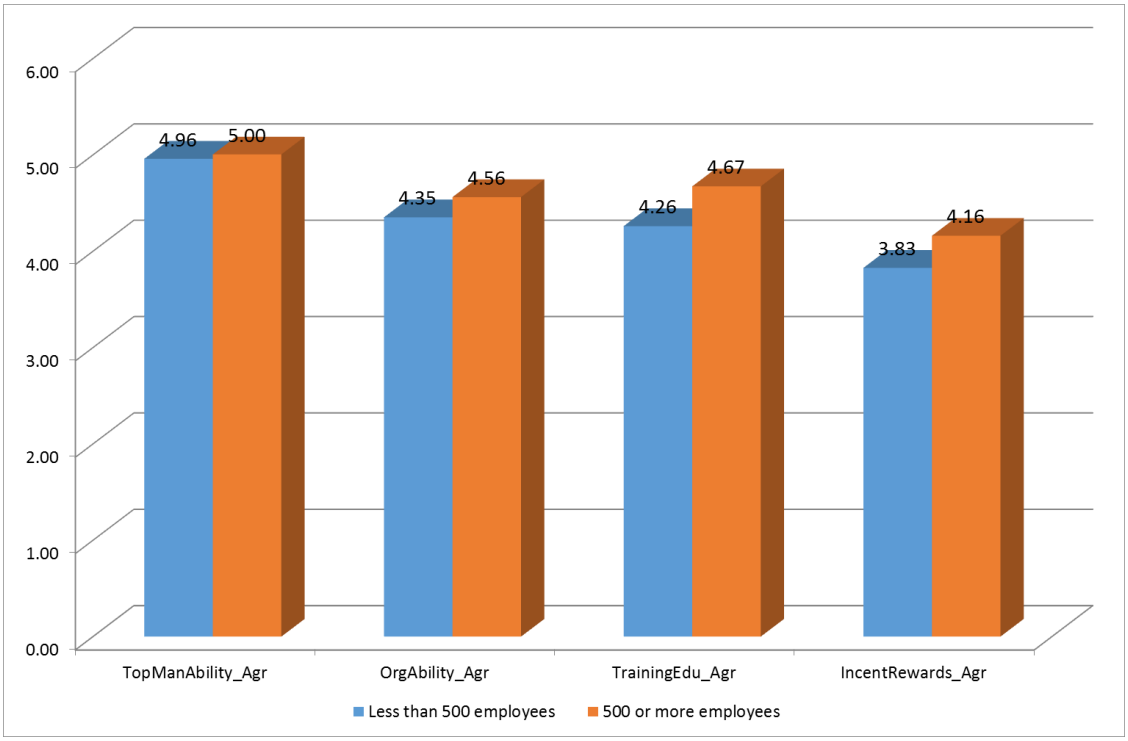
Figure 5.19: Comparisons of the mean agree (current) ratings of the constructs for SMEs versus large organisations



5.5.8 Hypothesis one

(H_1): Large organisations experience more success in extracting the intended benefits from AMT implementations than SMEs.

($H0_1$): Large organisations do not experience more success in extracting the intended benefits from AMT implementations than SMEs.

This hypothesis assesses whether larger organisations achieve a higher degree of AMT success than SMEs. The assessment is based on responses as to whether the AMT implementation achieved the intended benefits. The group indicating "no" was too small hence, it was excluded from the analysis. The comparison was therefore based on respondents answering "yes" (full success) or "partially" (partial success from AMT).

The crosstab for the comparison reveals 72.7% respondents from organisations of less than 500 employees (SMEs) answering yes to achieving the intended benefits of the AMT implementation (Table 5.29), while the remaining 27.3% only partially achieved the intended benefits of the AMT. Some 70% of respondents in organisations with 500 or more employees (large organisations) also answered yes to achieving the intended benefits, while 30% achieved partial success. A two-by-two Fisher's exact test was used for the comparison. A p-value of 0.847 was generated, therefore the null

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hypothesis is accepted. This indicates that large organisations do not extract more intended benefits from AMT implementations than SMEs, hence no correlation exists between achieving intended benefits and the size of the organisation.

Table 5.29: Crosstab organisation achieving intended benefits based on size

Crosstab organisation achieving intended benefits based on size					
			Yes	Partially	Total
	Less than 500 employees	Count	40	15	55
		% within Q3	72.7%	27.3%	100.0%
	500 or more employees	Count	56	24	80
		% within Q3	70.0%	30.0%	100.0%
Total		Count	96	39	135
		% within Q3	71.1%	28.9%	100.0%

5.5.9 Hypothesis two

(H_2): Internally managed AMT implementations experience more success in extracting the intended benefits from AMT implementations than those externally managed. AMT.

($H0_2$): Internally managed AMT implementations do not experience more success in extracting the intended benefits from AMT implementations than those externally managed.

Hypothesis two tests whether the success in extracting the intended benefits from an AMT implementation is dependent on whether the implementation was managed internally or externally. Regarding the externally managed implementations, 74% answered “yes” to achieving the intended benefits of the AMT, 68.7% answered “yes” to achieving the intended benefits. The two-by-two Fisher’s exact test used to conduct the comparison generated a p-value of 0.560, therefore the null hypothesis was accepted (Table 5.30). This indicates that internally managed AMT implementations do not experience more success in extracting the intended benefits than those externally managed. No correlation was found to exist between the location of management and achieving the intended benefits from AMT implementations.

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Table 5.30: Crosstab organisation achieving intended benefits based on internally or externally managed AMT

Crosstab orgnisation achieving intended benefits based internally or externally managed AMT					
			Yes	Partially	Total
	Externally	Count	37	13	50
		% within Q8	74.0%	26.0%	100.0%
	Internally	Count	57	26	83
		% within Q8	68.7%	31.3%	100.0%
Total		Count	94	39	133
		% within Q8	70.7%	29.3%	100.0%

5.5.10 Hypothesis three

(H_3): Organisations that achieve the intended benefits of the AMT implementation exhibit a higher degree of organisational readiness with regards to the degree to which the defined organisational factors are in play during AMT implementation than organisations that achieve partial success.

($H0_3$): Organisations that achieve the intended benefits of the AMT implementation do not exhibit a higher degree of organisational readiness with regards to the degree to which the defined organisational factors are in play during AMT implementation than organisations that achieve partial success.

Hypothesis three sets out to assess whether organisations that achieve the intended benefits of the AMT have a higher degree of organisational readiness with regards to the extent to which organisational factors are in play during AMT implementations than organisations that partially achieve the intended benefits of the AMT.

Most of the data for the groups related to this hypothesis and the degree of agreement (current situation) questions were not normally distributed (Appendix C4). Based on this and the unequal sizes of the groups being compared (93 versus 39), a non-parametric test, the Mann-Whitney test, was selected for the analysis to compare the two groups on the differences in the extent to which the organisational factors were in play during the AMT implementation. The Mann-Whitney test compares the groups on ranks.

Differences were noted between the two groups for all the constructs under examination. Asymp. Sig. (2-tailed) or p-values for all the constructs were less than 0.05 indicating a significant difference between the groups of interest (Table 5.31).

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When assessed together with the mean ratings of the two groups (Table 5.32 and Figure 5.20), hypothesis three is accepted, therefore, organisations that achieve the intended benefits of the AMT implementation exhibit a higher degree of organisational readiness with regards to the degree to which the defined organisational factors are in play during AMT implementation than organisations that achieve partial success.

Table 5.31: Mann-Whitney Test Statistics of agree (current) rating for groups based on achieving intended benefits

Mann-Whitney Test Statistics[a] of agree (current) rating for groups based on achieving intended benefits		
	Mann-Whitney U	Asymp. Sig. (2-tailed)
TopManAbility_Agr	1092.500	.000
OrgAbility_Agr	1028.000	.000
TrainingEdu_Agr	1111.500	.000
IncentRewards_Agr	1227.500	.003
a. Grouping Variable: Q11		

Table 5.32: Group statistics of agree (current) rating for groups based on achieving intended benefits

Group statistics of agree (current) rating for groups based on achieving intended benefits						
		N	Mean	Std. Deviation	Mean Rank	Sum of Ranks
TopManAbility_Agr	Yes	93	5.20	1.022	74.25	6905.50
	Partially	39	4.54	.979	48.01	1872.50
OrgAbility_Agr	Yes	93	4.75	1.111	74.95	6970.00
	Partially	39	3.84	1.206	46.36	1808.00
TrainingEdu_Agr	Yes	93	4.77	1.320	74.05	6886.50
	Partially	39	3.93	1.183	48.50	1891.50
IncentRewards_Agr	Yes	93	4.26	1.514	72.80	6770.50
	Partially	39	3.42	1.502	51.47	2007.50

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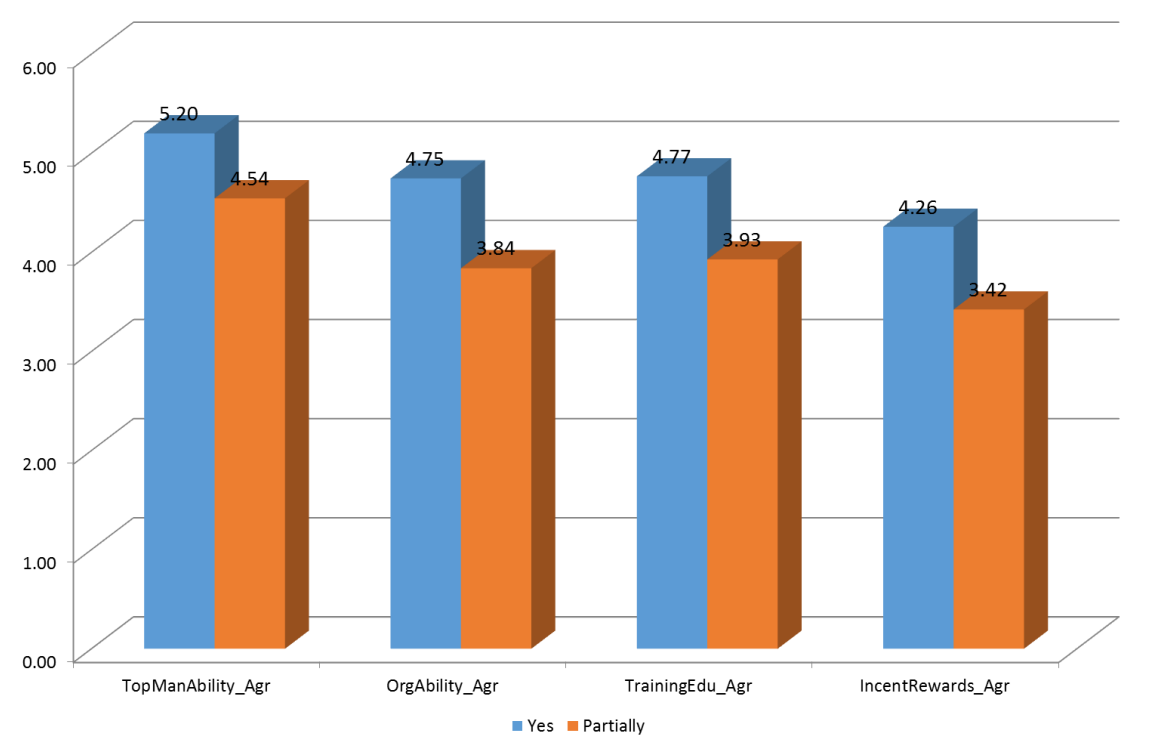
Figure 5.20: Comparisons of the mean agree (current) ratings of the constructs for intended benefits of the AMT implementation being fully achieved (yes), versus partial achievement of the AMT benefits



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CHAPTER 6: DISCUSSION OF RESULTS

Results generated through the analysis conducted on the data are discussed in more detail, drawing on literature that was used to develop the study. Findings related to the research questions and hypothesis are further developed with the aim of consolidating the findings to address the research objectives put forward in this study. Ultimately, while confirming current literature related to AMT and the organisational factors that impact AMT implementations, the discussion sets out to develop new insights related to the subject.

6.1 Research question one

What are the predominant benefits targeted from AMT implementations?

Better management control was found to be the number one primary benefit targeted in AMT implementations as indicated by respondents participating in this study. Improved quality was ranked second, followed by increased throughput. A comparison is conducted with rankings put forward in previous studies by Sohal et al. (2001) on South African manufacturers and Hynek, & Janeček (2013) on Czech manufacturers (Table 6.1). The order of the rankings achieved was found to be different to previous findings, illustrating different primary benefits targeted in the different contexts. Although the study of Sohal et al. (2001) was conducted on South African manufacturers, this was more than ten years ago, hence the context would have changed during that period with technology advancements and changes to the competitive envirinment. All three studies were however found to have improved quality and throughput ranked among the top three benefits targeted, illustrating a high prevalence of these intended benefits across a variety of contexts.

The findings therefore illustrate that primary benefits targeted from AMT implementations is context dependent. They can be added to the existing body of knowledge around benefits targeted from AMT implementations within the South African context.

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Table 6.1: Comparison of the rankings of the importance of targeted AMT benefits between current study versus past research

Rank	Study by Hynek, & Janeček (2013) on Czech manufacturers	Study by Sohal et al. (2001) on South African manufacturers	Current findings on South African manufacturers, (2014)
1	Reduced costs	Obtaining competitive advantage	**Better management control**
2	Improved quality	Increased throughput	**Improved quality**
3	Increased throughput	Improved quality	**Increased throughput**
4	Obtaining competitive advantage	Reduced costs	**Obtaining competitive advantage**
5	Increased sales	Better management control	**Labour cost savings**
6	Better management control	Increased flexibility	**Production flexibility**

6.2 Research question two

What is the extent to which the intended benefits are being fully derived from AMT implementations?

This analysis aimed to ascertain the extent of the AMT implementation problem within South African organisations. This was accomplished by determining the number of organisations achieving AMT the benefits of the AMT, partially achieving them and not achieving them at all. 68% of respondents reported achieving the benefits of the AMT while 27% reported only partially achieving the benefits. A small amount responded no to achieving the benefits, while 4% could not disclose or were not sure.

This response signifies a relatively high degree of AMT benefits being derived from implementations. However, more than a quarter of respondents reported only partially achieving the intended benefits, implying room for improvement. It must also be noted that a simplistic approach was adopted to determine AMT implementation success and could be improved by respondents rating the degree of success to allow for more variability in the results and a better representation of the degree of success. This can

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be explored in future studies.

This research was primarily put forward to assess the extent of the problem in South African manufacturing organisations. No literature was found to allow a comparison to be conducted. However, the scene was set for the analysis that follows around the organisational factors that impact AMT implementation and to develop a correlation between these and the success of implementations.

6.3 Development of definitions for high-level organisational factors that impact AMT implementations

Four high-level categories of organisational factors related to AMT implementation were developed and proposed to guide the research. Each factor or construct was defined through a series of statements of factors extracted from literature pertaining to the organisational factors that impact AMT implementations and married into categories that were best suited to their meanings. The four broad categories or factors proposed were top management ability, organisational ability, training and education and incentives and rewards.

Confirmatory factor analysis conducted on each of the four proposed factors confirmed internal consistency and validity, indicating that each of the four unique groups of sub-factors proposed as definitions of the four constructs, were reliably measuring the same thing as a group and could therefore each be used to define one key factor. Four constructs or high-level factors are therefore put forward as the key factors related to AMT implementation effectiveness. The factors are defined according to the variables that make up the constructs and were tested for reliability are illustrated in Table 6.2.

The four key factors were therefore put forward for further analysis in the study and will be used in the development of the proposed model. Definitions applied to each factor are therefore used to assist in tying back findings to literature as the overall consolidated definitions put forward are new.

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Table 6.2: Definitions of four key factors that impact AMT implementation effectiveness

Top management ability	Organisational ability	Training and education	Incentives and rewards
Alignment of the AMT to the manufacturing strategy of the organisation	Highly skilled workers with competencies that match the manufacturing and AMT environment	Development of best practices to manage the AMT	Implementation of performance measures directed at the AMT
Alignment of the AMT to support the long-term vision of the organisation	Adequate channels of communication and widespread participation from organizational members in the implementation	Investment in education and training directed at the AMT	Directing incentives and rewards schemes at the successful use of the AMT
Communication of the motivation behind the AMT implementation and expected benefits	In house expertise to manage the AMT implementation	Creation of specific training programmes tailored to the AMT	
Investment in resources directed at the new technology	Handing over planning and troubleshooting responsibilities related to the AMT to in-house employees rather than contractors	In-house training capability to support training requirements for the AMT	
Promotion of new technologies and support and commitment towards the AMT by top management	Possessing a more flexibility-oriented culture	Possessing highly skilled and qualified operators	
Receptiveness of the organisational culture to new technologies	Organisation of the workforce into multidisciplinary teams to manage the AMT implementation	Training of managers on the AMT before implementation	
Communication of the company strategy within the organisation	Changes to the organisational structure to support the new AMT		
High level of general technical expertise of top management and know-how around the technical aspects of the AMT	Use of in house Research and Development to enhance the effectiveness of an AMT implementation		

6.4 Research question three

What is the perceived relative importance of the various defined organisational factors towards impacting the effectiveness of an AMT implementation?

The assessment of the relative importance of the four organisational factors that were put forward for the study found that top management ability was the number one factor in terms of its importance in contributing to AMT implementation success. Rated on a similar level of importance, but with a lower mean importance rating, was training and education. Organisational ability was ranked third and was found to be significantly lower than both top management ability and training and education. The lowest ranked or least important factor was incentives and rewards.

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Despite differences in the relative importance and hence the ranking that could be applied to the factors, all factors were found to have some level of importance towards contributing to AMT implementations. Assessment of the mean ratings across the entire group of respondents and conversion back to the Likert scale ranking (rounded off to nearest whole number) employed shows that some degree of importance can be applied to each of the factors (Table 6.3). Top management ability and training and education were both considered very important in contributing to the successful implementation of AMTs. Organisational ability and incentives and rewards were found to be of moderate importance.

Table 6.3: Mean importance ratings of constructs and conversion to Likert scale ratings presented in ranking order

Ranking	Factor/Construct	Mean importance rating	Likert conversion
1	Top management ability	5.76	Very important
2	Training and education	5.64	Very important
3	Organisational ability	5.40	Moderately important
4	Incentives and rewards	5.08	Moderately important

No rankings of these specific factors in terms of their importance and order of importance are reported in literature, therefore these findings quantitatively support these factors put forward by Marri et al. (2007) *and* Darbanhosseiniamirkhiz & Wan Ismail (2012), in terms of their importance towards contributing to AMT implementation success. The factors proposed by these authors were, however, not properly defined as is the case for this study. No quantitative assessment of the importance was also put forward to support the models of these authors.

In order to gain deeper insight into the critical factors that impact AMT implementation and tie this into literature, the sub-factors that were used to develop each of the four constructs have also been assessed and ranked (Table 6.4). The rankings are discussed and married into each of the four high-level factors that have been developed to illustrate how the various sub-factors serve as suitable definitions for the critical factors identified. The findings also provide a guide in terms of prioritisation of the areas that need attention with regards to AMT implementations. This contributes to the current body of knowledge, where a ranking related to the importance of organisational factors that impact AMT implementation is not evident.

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Table 6.4: Ranking of sub-factors related to AMT implementation

Ranking	Sub-factors related to AMT implementation	Mean rating	Category
1	Alignment of the AMT to the manufacturing strategy of the organisation	6.04	TM
2	Alignment of the AMT to support the long-term vision of the organisation	5.99	TM
3	Communication of the motivation behind the AMT implementation and expected benefits	5.86	TM
4	Development of best practices to manage the AMT	5.86	TE
5	Investment in resources directed at the new technology	5.82	TM
5	Promotion of new technologies and support and commitment towards the AMT by top management	5.82	TM
7	Receptiveness of the organisational culture to new technologies	5.81	TM
8	Investment in education and training directed at the AMT	5.73	TE
9	Communication of the company strategy within the organisation	5.71	TM
10	Creation of specific training programmes tailored to the AMT	5.64	TE
11	In-house training capability to support training requirements for the AMT	5.57	TE
12	Highly skilled workers with competencies that match the manufacturing and AMT environment	5.55	OA
13	Possessing highly skilled and qualified operators	5.54	TE
14	In house expertise to manage the AMT implementation	5.53	OA
14	Adequate channels of communication and widespread participation from organizational members in the implementation	5.53	OA
16	Training of managers on the AMT before implementation	5.52	TE
17	Handing over planning and troubleshooting responsibilities related to the AMT to in-house employees rather than contractors	5.51	OA
18	Implementation of performance measures directed at the AMT	5.43	IR
19	Possessing a more flexibility-oriented culture	5.39	OA
20	Organisation of the workforce into multidisciplinary teams to manage the AMT implementation	5.35	OA
21	Changes to the organisational structure to support the new AMT	5.23	OA
22	Use of in house Research and Development to enhance the effectiveness of an AMT implementation	5.16	OA
23	High level of general technical expertise of top management and know-how around the technical aspects of the AMT	5.04	TM
24	Directing incentives and rewards schemes at the successful use of the AMT	4.72	IR

*(TM – Top Management; TE- Training and education; OA – Organisational ability; IR – Incentives and rewards

6.4.2 Top management ability

Alignment of the AMT to the manufacturing strategy of the organisation and alignment to support the long term vision of the organisation, can both be considered high in importance towards contributing to the successful implementation of AMT as they achieve the two highest ranks of the factors. These findings support the work of Boyer & Pagell (2000), Stock & McDermott (2001), Marri et al. (2007) and Ramdani et al., (2009) who all emphasised an importance in aligning the manufacturing strategy to the organisation strategy and, in turn, the AMT to the manufacturing strategy. Chan, Chan, Lau, & Ip, 2001 and Small & Yasin, 2003 also highlighted how a lack of alignment of the AMT to the manufacturing strategy of the organisation can lead to barriers during implementation, hence the critical need for alignment.

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Achieving alignment is key as it signifies the importance of the AMT in achieving the ultimate objectives of the organisation as the manufacturing strategy should be aligned to the organisation strategy in a well-run business. The investment in the AMT should be driven from the ultimate strategic objectives and vision of the organisation and filtered down through the manufacturing strategy to the AMT. In this way, the AMT will receive support from top management as they will have a vested interest in delivering the key benefits targeted and raising organisation performance. Through this alignment, the AMT will be prioritised and is likely to receive the much-needed resources and support required to assist in successful implementation.

This ties in with the fifth-ranked factor, investment in resources directed at the new technology. The importance of this factor supports the work of Al-Qirim (2008) and Ramdani et al. (2009), who expressed that gaining commitment from top management is key and is illustrated by a commitment of resources to the AMT implementation. AMT implementation is a highly involved process and requires a considerable investment of time and energy to accomplish. Through the support of management via commitment of resources, the AMT can receive the necessary attention and tools required for effective management.

Effective communication is also identified as an important theme. This relates to communication of the motivation and expected benefits of the AMT through the organisation and communication of the company strategy through the organisation that both ranked highly in terms of importance. This should again be driven from the top management. Waldeck & Leffakis (2007) and Thomas et al. (2008) both highlighted in their work that poor communication of the benefits behind the AMT can lead to a disengaged and uncommitted workforce that often leads to AMT failure.

By clearly articulating the organisation strategy and filtering it through the organisation, the alignment to the AMT is better understood by all. Additionally clear communication of the motivation behind the AMT, its capabilities and the intended benefits, increases the receptiveness and buy-in of workforce. This acts to encourage positive and efficient usage of the AMT and hence an improvement in the chances of achieving the intended benefits. These findings support the work of Jeyraj et al., (2006) and Marri et al., (2007) where it was put forward that effective communication of the intended benefits of the AMT acts to drive commitment of the workforce to the AMT.

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Another top management ability factor linked to gaining buy-in from the workforce was the importance of the receptiveness of the organisational culture to new technologies that ranked fifth overall. This talks to the inherent buy-in of the workforce to the new technology. An organisation where innovation is encouraged and there exists a strong drive to be a technology leader is less resistant to the introduction of new technologies. This aids the implementation process as a strong drive will exist to use the new technology to their benefit. In addition, studies conducted by Rosnah et al. (2008) and Darbanhosseiniamirkhiz & Wan Ismail (2012) highlighted the importance of organisational receptiveness to new technologies.

The lowest-ranked factor related to top management ability was the importance of the need for top management to exhibit a high level of general technical expertise. The low ranking of 23 illustrates that this factor, although still achieving a rating that indicates some degree of importance, may not be as critical as others. The need for top management to possess a high level of general technical expertise is therefore not very important. The work of Marri et al. (2007) alluded to this requirement for AMT implementation success, but no level of importance was stressed. It can therefore be concluded that a certain level of technical expertise of top management will assist in achieving AMT implementation success, however the results imply that this level need not be extremely high. The role of the manager will rather be to allocate the resources with a high-level of technical expertise and focus more on addressing the other overriding factors that drive AMT implementation success, such as aligning the organisation objectives to the AMT and harnessing the support of the workforce towards the implementation.

6.4.3 Training and education

Development of best practices to support the AMT achieves a high overall ranking of 4, stressing the high level of importance of this factor towards contributing to successful AMT implementation. Best practices provide an effective means of ensuring standardisation and consistent use of equipment and carrying out tasks. Development of best practices for the new AMT will therefore increase the rate of uptake of new users who are to deploy the AMT effectively. It can serve to accelerate the rate of learning of a new task. No literature was found concerning the importance of best practices and AMT. This therefore presents a new variable of relatively high importance that requires attention during implementations.

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Investment in training and education directed at the AMT also ranked highly in terms of importance. Although this can also be related to top management in terms of an indication of support for the AMT through allocation of resources, it still primarily measures the importance of training and education towards AMT implementation success and highlights it as a critical area towards which resources should be directed. Other highly ranked factors linked somewhat to investment in training and education include creation of specific training programmes for the AMT and in-house training capabilities to support these training requirements.

These factors all talk to the need to dedicate resources and time towards preparing workers for the AMT implementation through training tailored for the AMT. AMTs are very specific and often customised solutions for various production requirements, therefore a general training approach will not suffice. Specific training related to the AMT needs to be developed and rolled out to workers. This can be an involved and expensive process. However, its importance implies that it is a critical area that needs to be addressed when implementing a new AMT. Proper training will increase the rate at which the new AMT is absorbed by the organisation.

These findings around the importance of and investment in training and education supports the work of a number of authors. Boothby et al., (2010) highlighted the importance of investment in education and training in a study that found a strong positive relationship between improved productivity and investment in AMT training and education. Mora-Monge (2008) found a strong need to design training programmes specific to the AMT in order to accelerate the rate at which benefits can be extracted while Marri et al. (2007) advocated the need to have in-house training capabilities.

Possessing highly skilled and qualified operators talks to the general experience and training or education that workers already have. This factor ranked number 12, indicating a degree of importance. Having operators who have a general level of experience in the environment and some degree of general training assists their ability to take up and absorb new technologies easily. Basic skills such as literacy, computer literacy and communication skills, increases the ease with which the new technology can be learnt and effectively utilised. Monge et al. (2006) highlighted the benefits of a skilled workforce in effecting a more effective AMT implementation. AMTs can be extremely complicated and introducing these new technologies to operators with a basic skillset achieved through formal or informal training catalyses the implementation

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process.

6.4.4 Organisational ability

The highest-ranked of the organisational abilities factors was the need for a highly skilled workforce that matched the manufacturing and AMT environment ranked at 11. The skills of operators alluded to in the discussion of the training and education where a operator skills factor was introduced. This particular factor talks to the suitability of the entire workforce to support the AMT. Introduction of an AMT extends beyond the manufacturing shop-floor throughout the organisation. Maintenance skills requirements change, technical support requirements, order-flow management and planning will all need to be aligned to the AMT to support it and assist in extracting the benefits and hence successful implementation.

In house-expertise to manage the AMT also comes in at 13 and can be considered to be important to AMT implementations. Management of the AMT implementation can either be in-house or suppliers can be contracted. Regardless, the interface requires that individuals within the organisation have sufficient expertise to integrate the AMT into the current manufacturing process and deploy the AMT within the organisation such that the intended benefits are derived. Millen & Sohal (1998) call for the use of a dedicated AMT implementation team of individuals with the expertise to manage the implementation. The findings therefore support this.

Handing over planning and troubleshooting responsibilities ranks at 16 and still falls into the very important rating when converting them back to the Likert scale. By handing over ownership and responsibility to the users of the AMT, this acts to engage the employees and prepare them for the AMT implementation, which leads to more effective usage. Such employee involvement practices are an effective means of motivating employees and improving job satisfaction and hence aligning the goals of the employees to the AMT. This goes a long way towards achieving AMT success. The importance applied to this factor ties into the research through the positive inputs that emanate from an engaged workforce. Chung (1996), Bayo-Moriones & de Cerio (2004), Waldeck (2007) and Small (2007) found increased employee involvement in the AMT implementation was seen to enhance success.

Other factors related to organisational ability that ranked more towards the somewhat important rating of the Likert-Scale, included, possessing a more flexibility oriented

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culture, organisation of the workforce into multi-disciplinary teams, changes to the organisational structure and use of in-house R&D teams. These factors, although important, imply areas that require less focus during AMT implementations than some of the other areas identified.

A flexibility oriented culture is important as it implies an organisational ability that speaks to responsiveness through the ability to deal with the flexibility offered and mostly sought from AMTs. The AMT can offer agility. However, if the organisation is not receptive to operating under flexible principles or does not possess the capabilities to complement the AMT, such benefits are not fully extracted. A culture that drives flexibility is required to draw these benefits more readily. This is in alignment with the findings of Rosnah et al. (2008) and Darbanhosseiniamirkhiz & Wan Ismail (2012), whose research revealed that companies with a flexibility oriented culture are more likely to achieve more success from AMTs.

Organising the workforce into multi-disciplinary teams provides a diverse skills-set that provides greater ability to troubleshoot and address problems experienced during the AMT implementation. Problems can emanate from all avenues and can include technical and other workplace challenges. Therefore, technical skills alone may not be sufficient to provide solutions. The work of Mora-Monge et al. (2008) alludes to the need for multidisciplinary teams to manage and support the AMT and hence enhance the chances of an efficient implementation. The findings also support those of Doolen et al. (2003), who posit the need for multidisciplinary teams to address the vast array of problems related to AMT implementations.

The findings also rated changing the organisational structure to support the AMT implementations as an important factor, though not highly. This is corroborated in the work of Belassi & Fadlalla (1998), Abdul Ghani, et al. (2002) and Xiao-lin, et al. (2007, August) who all argue that the organisational structure is a key factor in AMT implementation and that the correct organisational structure to support the AMT needs to be in place.

6.4.5 Incentives and rewards

Incentives and rewards received the overall lowest rating of the factors identified. The construct was only made up of two factors. Of the two, implementation of performance measures ranked highest at a relatively low 18th, not one of the high focus areas during

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AMT implementation. Performance measures should, however, still be put in place to drive the positive behaviour towards and usage of the AMT and drive positive usage. Clegg & Jackson (1990), Kotha & Swamidass (2000) and Hynek, & Janeček (2010) support the need for performance and its relative importance towards affecting successful AMT implementations.

The lowest ranked factor of the 24 examined in this study was directing incentives and rewards at the AMT, which received a low moderately important rating. This factor will therefore require a very low level of focus during AMT and resources should rather be directed at other factors.

6.5 Research question four

Does the size of the organisation have an impact on the degree of importance of the critical organisational factors required to guide effective implementation of AMTs within an organisation?

An assessment of the differences in the critical organisational factors that impact AMT implementation effectiveness was conducted between SMEs and large organisations. The comparison was conducted to determine if the ranking of the four critical factors established could be consistently applied between organisations of different sizes, or if there are any additional considerations that need to be taken into account when applying the rankings to an organisation based on its size.

The rankings of the critical factors for both large and small organisations was found to follow the order established for the whole group, implying applicability across organisations of all sizes. Top management ability, organisational ability and incentives and rewards were all found to have the same level of importance for both large organisations and SMEs.

The exception was training and education, where a difference in the level of importance was noted. Large organisations with 500 or more employees were found to rate training and education at a higher level of importance than SMEs. This implies that large organisations focus more intensely on training and education than SMEs.

No current literature exists pertaining to a comparison of critical organisation factors for organisations of different sizes. Studies uncovered in literature have largely focused on

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either large organisations or SMEs in isolation. These findings can therefore be added to the body of knowledge on the impact of organisational factors on AMT implementation, through the correlations derived related to organizational size.

When examining literature, reference is made to SMEs often lacking the resources to commit to the AMT (Thomas et al., 2008). Training and education, as highlighted, require a high level of resource commitment. SMEs may therefore need to persist without the luxury of large investment in training and education that is afforded to larger organisations. This may therefore result in the SMEs adapting and driving AMT implementation success with fewer resources, resulting in a lower regard for this factor in supporting AMT implementation. This is merely an unsupported hypothesis and will require further research.

6.6 Research question five

Does the type of AMT have an impact on the degree of importance of the critical organisational factors required to guide effective implementation within an organisation?

Differences in the critical success factors related to the type of AMT implantation were assessed. This assessment was also conducted to determine applicability of the ranking, established through research question three.

Both computer hardware and plant and equipment had a ranking of the critical factors that matched the ones established, indicating applicability to these types of AMTs. Training and education was, however, found to have a slightly higher ranking than top management for computer software. The other factors followed suite as per the established rankings. This implies that training and education may need to be a higher priority than top management ability when implementing computer software AMTs, even though these factors had the same level of importance on per the original rankings. Both these factors remain critical to the success of AMT implementation.

One difference was also noted in the comparisons conducted – top management ability was rated on a higher level for plant and equipment than computer software

These findings have not been presented in current literature and therefore add to the body of academia on the subject. Plant software implementations are often integrated

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into current manufacturing systems, hence the complexity around these increases when compared to simple, stand-alone systems. Morra-Monge et al. (2008) highlighted the need for a higher focus on specific training programmes as system complexity increases, such as in the case of an integrated system. This may provide some clues to the reasons behind the higher emphasis placed on education and training for computer software AMTs. Further research should be conducted in this area, with a focus on training and education, to gain empirical evidence around the reasons for the differences in importance ratings of the critical factors identified for plant software.

6.7 Research question six

Do manufacturing organisations within the South African context exhibit a high degree of organisational readiness for AMT implementation with regards to the degree to which the defined organisational factors are in play during implementations?

This analysis aimed to assess the organisational readiness of manufacturing organisations within SA. This was accomplished by assessing data to determine if any differences could be noted between the ideal or importance rating and the current situation in manufacturing organisations using responses related to the agree questions. The comparisons were conducted on each of the four critical success factors across the entire set of respondents.

The analysis revealed differences between the current and ideal situation for all the critical factors examined. It was also found that the mean rating of the importance or ideal situation questions were all higher than the current situation mean ratings. This implied that the ideal situation was at a higher level than the current situation, indicating a gap in the organisational readiness of manufacturing organisations in SA with regards to the degree to which the critical success factors are in play.

This specific research question will have limited applicability to the body of knowledge around AMT implementation. The main aim was to assist in the development of recommendations' for organisations in SA, with regards to areas that may need focus to improve. In this case, a lag was found in all critical success factors related to AMT implementation success and therefore presents a potential knowledge and management gap in South African organisations.

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6.8 Research question seven

Do larger organisations exhibit a higher degree of organisational readiness for AMT implementations than SMEs?

The degree of organisational readiness of SMEs in comparison with large organisations was assessed. The findings revealed one difference with regards to training and education, where large organisations were found to have a higher level during AMT implementations than SMEs. All other factors were found to have the same level of importance, indicating a similar level regardless of organisation size.

Research question two revealed large organisations placed a higher level of importance on training and education than did SMEs. This may be why this factor is in play at a higher degree within large organisations. This may also indicate that the lower level of training and education in SMEs may not be a major problem, as it was found to have a lower level of importance when compared with large organisations. Thomas et al. (2008) found that smaller organisations often lack the resources to commit to AMT implementation. Training and education can be resource-intensive, hence this may be a driver of the reduced resources committed to the AMT in the form of training and education. Lack of resources, however, will also impact other critical success factors that also absorb resources. Therefore, the finding that these factors are on a similar level to that of large organisations contradicts the conclusions of Thomas et al. (2008).

This finding contributes to the body of knowledge around AMT implementation and deepens insight around SMEs with regard to the levels of training and education. It was, however, interesting to note that SMEs do not lag behind larger organisations with regard to the other critical success factors.

6.9 Research hypothesis one

Hypothesis 1 H1: Large organisations experience more success in extracting the intended benefits from AMT implementations than SMEs

Null hypothesis 1 H01: Large organisations do not experience more success in extracting the intended benefits from AMT implementations than SMEs

The impact of organisational size on the success of achieving the intended benefits of AMT implementations was assessed. As very few respondents indicated a total failure

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to achieve the intended benefits of the AMT, the comparison was based on respondents achieving the intended benefits and those that partially achieved the intended benefits. The null hypothesis was accepted, indicating no correlation between organisation size and success in achieving the intended benefits of the AMT implementation. There was therefore no difference in the success achieved from AMTs by SMEs and large organisations.

No existing literature related to this comparison was uncovered in the review conducted. Therefore, this study represents a new addition to the body of work related to the success of AMT implementations with regard to benefits derived. It is often thought that the general resource limitations faced by SMEs when compared to large organisations can negatively impact success in technology implementations. This findings illustrate that the size of an organisation is not a contributing factor towards AMT implementation success or failure.

The findings are, however, in-line with the assessment around organisational readiness with regard to the degree to which the critical success factors were evident within the organisations where no differences were observed between large organisations and SMEs with the exception of training and education – this was found to be at a lower level in SMEs. However, it was noted that this factor was also at a lower level of importance in SMEs than in large organisations, indicating a lower level in the current situation, could still imply a similar level of readiness relative to the importance ratings.

6.10 Research hypothesis two

Hypothesis 2 H2: Internally managed AMT implementations experience more success in extracting the intended benefits than those externally managed

Null hypothesis 2 H02: Internally managed AMT implementations do not experience more success in extracting intended benefits than those externally managed

The impact of the location of the management of the AMT implementation, internally or externally, on its success is assessed. Achievement of the intended benefits of the AMT was used as a criterion for success. No differences were noted between the degree of success between AMT implementations that were managed internally compared with those externally managed.

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This comparison has not been covered in literature, hence this represents a new finding. This finding can assist decision-makers with the selection of who should manage the AMT implementation by removing the chances of success from the equation. As the success of the AMT is not dependent on whether the implementation is managed internally or externally, other factors can be used to determine this decision.

6.11 Research hypothesis three

Hypothesis 3 (H3): Organisations that achieve the intended benefits of the AMT implementation exhibit a higher degree of organisational readiness with regard to the degree to which the defined organisational factors are in play during AMT implementation than organisations that achieve partial success

Null hypothesis 3 (H03): Organisations that achieve the intended benefits of the AMT implementation do not exhibit a higher degree of organisational readiness with regard to the degree to which the defined organisational factors are in play during AMT implementation than organisations that achieve partial success

An assessment of the validity of the established importance of the critical success factors that impact AMT implementation were assessed through this analysis. This was accomplished by identifying a correlation between achieving AMT implementation success and the degree of organisational readiness with regard to the ratings related to the extent to which the critical success factors were in play within the organisation. A comparison was therefore conducted on the current situation between organisations that achieved the intended benefits and those that only partially achieved them.

Differences were uncovered between groups for all four factors, with organisations that achieved full AMT implementation success displaying higher mean ratings with regard to the level at which the critical success factors were evident during implementation. The hypothesis was therefore accepted, indicating organisations that achieve the intended benefits of AMT implementation, exhibit a higher degree of organisational readiness with regard to the extent to which the critical success factors are evident within the organisation.

A correlation therefore exists between the critical factors and AMT implementation success and supports the established importance of the critical success factors

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identified. The more prevalent the critical factors are in play within an organization the increased chances of effecting a successful AMT implementation. The correlation developed and presented in the findings of this hypothesis presents a new contribution to the existing body of knowledge, where such a quantitative correlation of the identified critical organizational factors that impact AMT implementation and AMT implementation success could not be uncovered in current literature. Further to this, the correlation increases the strength of the findings related to the critical factors through the validation it accomplishes and therefore highlights the need to focus and prioritise the identified factors to enhance the chances of AMT implementation success.

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CHAPTER 7: CONCLUSION

The research has primarily setout to establish and quantitatively support critical organisational factors that impact the effectiveness of AMT implementations in the current South African manufacturing context. Key findings are brought forward in this section supported by a proposed model aimed at guiding effective AMT implementation. Other elements of the research objective put forward are addressed to conclude the findings accomplished in this piece of work. Recommendations directed at managers of organisations operating in the South African manufacturing environment are thereafter discussed, to provide guidance for practical application of the findings of this academic research. Finally to conclude the research, ideas for future research in the field of AMT implementation that will add value to the existing body of knowledge in this critical field of study is proposed.

7.1 Research findings

7.1.1 Benefits of AMT

Intended benefits targeted from AMT implementations were examined to identify the primary motivations behind the AMT implementations. The top six primary benefits targeted from AMTs identified in this study have been summarised in Figure 7.1. The majority of benefits targeted through AMT implementations in the context of this study are therefore represented by these benefits. It must however be noted that although these formed the key benefits, AMT implementations often have a range benefits that will be targeted from the investment and extend beyond the six highlighted. The benefits presented are therefore by no means exhaustive.

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Figure 7.1: Primary benefits targeted from AMT implementations in South African organisations

7.1.2 Organisational factors impacting AMT implementation

While AMT implementation has been relatively well versed in past research, limited research around the establishment of a well defined set of critical organisational factors that impact AMT implementation supported with quantitative data exist in current literature. No evidence of such work in the South African manufacturing context was evident. A set of organisational factors defined by sub-factors has been established together with a ranking of the importance of the various factors. This is presented in a proposed model (Figure 7.2) that can be applied across all manufacturing organisations within the South African context. Considerations related to the organizational size and the type of AMT that need to be taken into account when applying the model have also been established.

The model, built on theoretical foundations, is supported by quantitative data that not only highlights the relative importance of the critical factors, but is also tested for reliability through a simple correlation established between organisational readiness and AMT implementation success. The correlation highlighted that organisations that achieved higher success in AMT implementations had a higher degree of organizational readiness with regards to the degree to which the critical organizational factors were evident within the organization. Critical factors were evident at a higher level in organisations that achieved full success of the AMT implementation as

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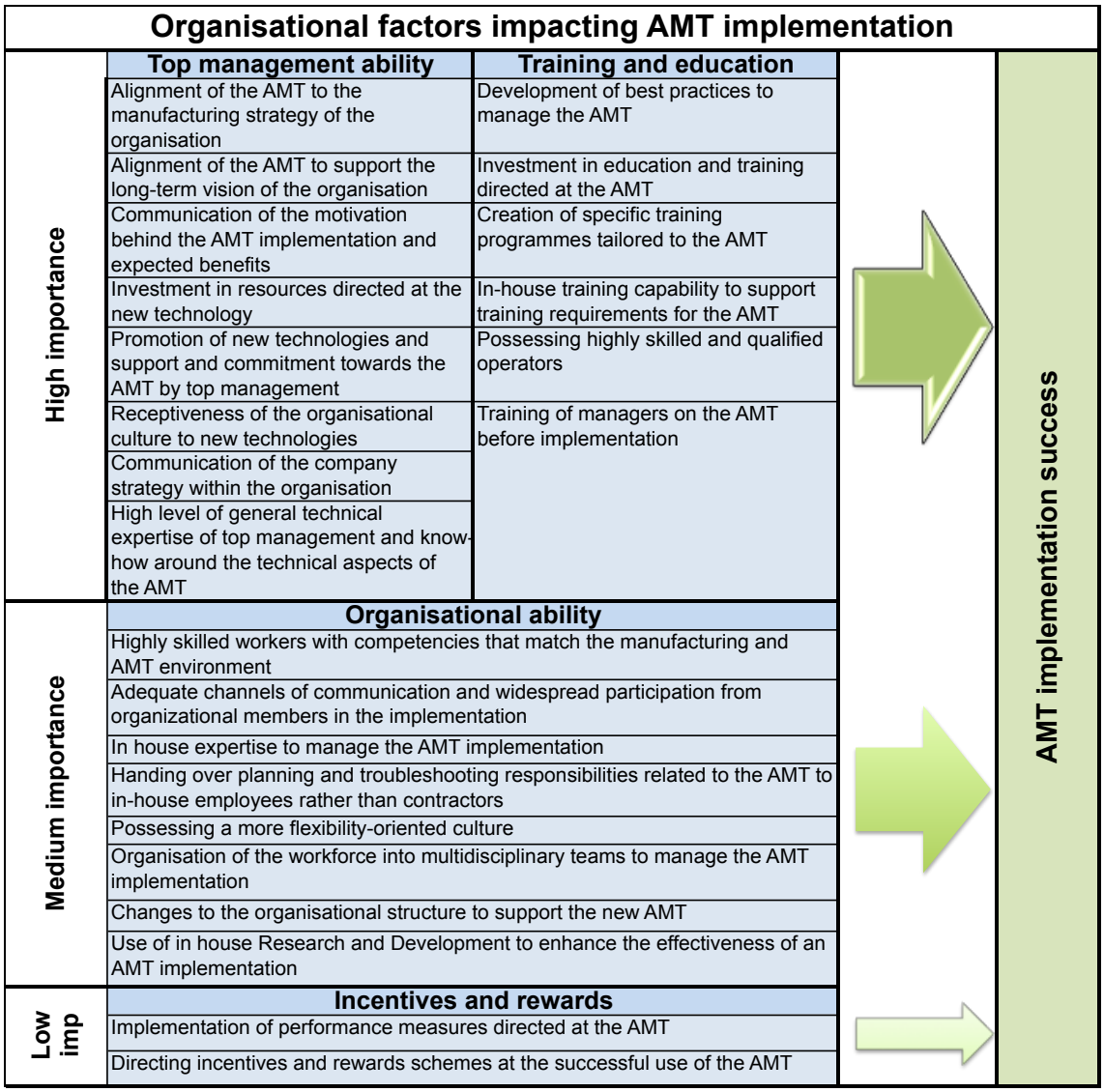
opposed to organisations that only achieved partial success. The testing supports the model put forward around critical organisational factors that need attention when carrying out an AMT implementation.

Figure 7.2: Proposed model – Organisational factors impacting AMT implementation



The proposed model takes the form of a hierarchy of organisational factors that impact AMT implementations. It is aimed at enabling the guidance of scarce resource allocation during AMT projects to enhance the extraction of intended benefits. To guide the model, four high-level constructs or organisational factors that impact AMT implementations have been defined using a selection of sub-factors and tested for validity. These factors include: top management ability; training and education; organizational ability; and incentives and rewards. The sub-factors used to define the critical factors are presented in the model and provide specific areas that need

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attention when implementing AMTs.

Top management ability ranked highest in terms of its importance in guiding effective AMT implementation but was found to be at the same level of importance as training and education. Organisational ability ranked on the next level of importance while the lowest level of importance is applied to incentives and rewards. While the rankings can be used as a guide for prioritization, all factors identified contribute to AMT implementation to some degree or another, therefore during AMT implementations effort should be made to focus on improving the level of all factors to contribute to a successful AMT implementation.

The organisation size was not found to impact the order of importance of the critical organizational factors. Large organisations were however found to place a higher emphasis on the importance of training and education than SMEs ranking training and education at a higher level of importance. This implies that large organisations require a higher focus on training and education than SMEs when introducing AMTs and will require a larger relative commitment of resources towards this.

Differences in the relative importance and ranking of the critical organisational factors that impact AMT implementation was noted between different AMT types. Rankings and level of importance was found to follow the entire group for computer hardware and plant and equipment. Computer software was found to rank training and education higher than top management. This finding implied a larger focus should be placed on training and education when implementing computer software AMT systems when compared with other AMT types. This is likely attributed to the generally higher level of integration expected from computer software type systems that increases the complexity involved with such implementations and hence training requirements.

7.1.3 Organisational readiness

Evaluation of the organisational readiness manufacturing organisations within South Africa, in terms of the degree to which the critical factors were in play within organisations versus the ideal situation indicated that overall, the current situation was found to be at a lower level than the ideal desired levels of readiness. This was the case for all the critical factors indicating room for improvement in all the critical areas, in order to improve the success of AMT implementations.

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Over two thirds of organisations reported achieving the intended benefits of the AMT with just over a quarter achieving only partial success. This points to a significant amount of organisations not extracting the benefits of the AMT and hence potentially not achieving the return on investment of the AMT. The organisations that achieved only partial success in the extraction of the targeted AMT benefits were found to have a lower level of readiness than organisations that were reported to fully extract the benefits of the AMT. This supported the importance of the identified factors in effecting successful AMT implementation and highlights the need to prepare the organisation for AMT implementation by directing resources to address the critical factors identified.

No differences were noted in the organisational readiness between SMEs and large organisations. Additionally no differences in terms of AMT implementation success was noted between these organisations. Organisational readiness in terms of the degree to which critical factors are in play is therefore an overriding factor over organisational size in terms predicting an organisations ability to successfully implement and extract the intended benefits from an AMT implementations.

Other interesting findings in the study revealed implementation success to be independent of whether the management is managed internally or by an external party. This implies that other factors should be taken into consideration when deciding whether to manage the AMT internally or externally, as the success of the AMT is not dependent on this decision.

7.2 Practical implications for managers of manufacturing organisations

The research clearly demonstrates a need to prepare ones organisation sufficiently to take up an AMT in order to extract the intended benefits and hence obtain a return from the investment. Technical aspects of the AMT form one aspect of the implementation challenge however the organisation needs to be strategically prepared to take up the AMT successfully. The critical factors identified and the rankings applied to these, highlight that the implementation should be primarily driven from the top of the organisation. There is a strong argument that without the commitment of top management to the AMT, inability to fully extract intended benefits becomes a more likely outcome.

Firstly by demonstrating high-level managerial capabilities by aligning the AMT to the

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manufacturing and overall organisational strategy, this acts to set the foundations for the organisation to take up the AMT. Driving a technologically focused culture within the organisation also sets the scene for a more receptive workforce. This should be supported by a strong commitment to the AMT from top management. Commitment is demonstrated by management actively getting involved in the AMT implementation and communicating motivation behind the AMT and the expected benefits through the organisation. Ultimate commitment is however demonstrated through allocation of resources to support the AMT implementation. These actions act to motivate the workforce and improve receptiveness to the AMT, a critical element in ensuring that the AMT is used to its full potential once implemented.

Investment in training and education while demonstrating a high-level of commitment from top-management, also acts to prepare the workforce to effectively take up and use the AMT. Training and education is a very resource intensive and expensive exercise that can often result in reluctance to commit the required resources to address this. This should be avoided at all costs by management and the necessary training should be committed to and carried out as the research has demonstrated the importance of this aspect of the AMT implementation.

The internal readiness of the organisation to take up and effectively use the AMT is also an area that should be taken under consideration by managers implementing AMTs. While ensuring the managerial and technical abilities of the workforce are at a high enough level to take on the AMT, putting in place the correct structures and processes within the organisation is also a key element. The workforce should be encouraged incentivized to take ownership of the AMT. This will pass on accountability to the users of the AMT, driving correct behavior in terms of usage and also motivating employees to use the technology to its full potential.

To summarise, the onus is on top management to gain buy-in and support for the AMT throughout the organisation. This will effectively motivate employees and drive correct behavior in-terms of the usage of the AMT. Commitment towards the AMT and communicating the benefits of the AMT through the organisation by top management, while aligning the AMT to the strategic elements of the organisation, will effectively form the driver of the effective diffusion of the AMT within the organisation. When embarking on an AMT investment, while technical aspects of the AMT need serious consideration, it is critical that managers also observe the investment in a strategic light

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and extend focus beyond the technical aspects to better prepare the organisation to take up the AMT.

7.3 Recommendations for future research

The study has established a set of well-defined critical organisational factors that impact AMT implementations within the South African context. These have been supported by a simple correlation between AMT implementation success and the degree to which the factors were evident. The options offered when answering questions related to the implementation success included, “yes”, “partially”, “no” and “not sure”. This could be improved by rather introducing a rating scale to determine the implementation success more quantitatively and allow a more numerical and measurable correlation between AMT implementation success and organisational readiness in future studies.

This can be further enhanced by gathering more data around the return on investment achieved from AMT implementations under investigation and relate this to the organisational readiness. This will provide stronger data around implementation success over the ratings that were used in the current study that can often be skewed by the human perception that comes into play around such questions.

The study did not look at the time taken to implement the AMT and to extract the intended benefits from the AMT. Developing correlations around the impact of the organisational factors on time to implement and time for the AMT to start functioning efficiently and extracting intended benefits will also be an interest area that can be studied.

Factors proposed in this study were developed from literature gathered from past studies in different contexts. Further insights, and perhaps unidentified organisational factors that impact AMT implementation may be uncovered through an inductive qualitative study. This may introduce additional factors that need consideration in the South African context, that have not been uncovered in research conducted in the past. An interesting approach may be in the form of a case study on a selected AMT implementation within a chosen organisation or several organisations, that will allow a deeper dive into the subject and allow more insightful insights around the subject to be obtained and a more complete picture of the AMT implementation.
Organisational factors that impact AMT implementation is said to be context specific.

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No recent studies containing side-by-side comparisons of organisational factors that impact AMT implementation could be uncovered in literature. This therefore presents an opportunity to conduct a study on manufacturing organisations in different contexts, to allow a comparison to be conducted and to assess the validity of the claims around the dependence of factor importance on context. Other areas that require further examining can relate to the training and education requirements of organisations of different sizes and different AMT types. This will build on some of the findings of this research that require further examination to gain deeper more meaningful insights in these areas.

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APPENDICES

APPENDIX A – Survey questionnaire extracted from Survey Monkey

Organisational factors impacting AMT implementation

Gordon Institute of Business Science
University of Pretoria

As part of my MBA studies at the Gordon Institute of Business Science (GIBS), I am conducting a research project aimed at identifying the critical organisational success factors that impact Advanced Manufacturing Technology (AMT) implementation. The research will also assess the dynamics that are in play during AMT implementations within South Africa and therefore allow us to compare this against the critical success factors identified. Ultimately this research will allow us to identify areas that can improve the receptiveness of our manufacturing organisations towards AMTs,.

AMTs are a variety of modern technologies designed to accomplish or support manufacturing tasks. AMTs can include computer software such as computer-aided-design (CAD), computer-aided-manufacturing (CAM), materials requirements planning (MRP), manufacturing-resource-planning (MRPII); computer hardware such as mainframe, local-area-network (LAN), shop floor capture data; and plant and equipment such as flexible manufacturing cells, flexible manufacturing systems and automatic assembly.

It would be appreciated if you could please take the time to complete this questionnaire to contribute to this research. It is ultimately seeking to benefit the manufacturing sector in South Africa. The questionnaire is mostly a tick box excercise and should not take longer than 10 - 15 minutes to complete. Participation is voluntary and you can withdraw at anytime without penalty. All data will be kept confidential. By completing this questionnaire it is taken that you have voluntarily agreed to take part in the research. If you have any further questions or concerns please contact the researcher or supervisor as below:

Researcher: Jason Knock (jasonivoknock@gmail.com); Tel: 079 880 2124

Supervisor: Irfaan Khota (irfaan.khota@gmail.com)

***1. Have you had experience with an advanced manufacturing technology (AMT) in your current or past organisation? (Please see below for list of some AMT examples to assist)**

- ○ Yes
- ○ No

Computer Hardware:
Examples: Local Area Networks (LAN); Micros (PC Computers); Graphics hardware; Mainframe; Online process instrumentation; Shop floor data capture; Wide area networks (WAN); Automated Vision-based systems used for inspection/testing of inputs or final products; Other automated sensor-based systems used for inspection/testing of inputs

Computer Software:
Examples: Computer-Aided Design (CAD); Computer-Aided Process Planning (CAPP); Computer-Aided Manufacturing (CAM); Database Management Systems (DBM); Material Requirements Planning (MRP); Manufacturing Resource Planning (MRP II); Just-in-time (JIT); Supervisory Control & Data Acquisition (SCADA)

Plant and Equipment
Examples: Programmable logic control machines or processes (CNC and NC); Materials working laser (MWL); Robots with sensing capabilities; Robots without sensing capabilities; Other Robots; Rapid Prototyping systems; High speed machining; Flexible manufacturing cells; Automatic assembly; Flexible assembly systems; Automated warehousing/order picking

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Organisational factors impacting AMT implementation

This section is aimed at gathering some general demographic data required to test the hypotheses put forward in the research. Please select the answer that is most applicable to you.

***2. What industry does your organisation operate in?**

- ○ Agriculture and Agri-processing
- ○ Automotive
- ○ Chemical (Including petro-chemical)
- ○ Information and communications technology (ICT) and electronics
- ○ Metals
- ○ Textiles, clothing and footwear
- ○ Food and beverage
- ○ Pulp & Paper

Other (please specify)

***3. What is the size of your organisation?**

- ○ Less than 500 employees
- ○ Greater than 500 employees

4. Is your organisation a multi-national?

- ○ Yes
- ○ No

***5. What was the most recent type of Advanced Manufacturing Technology have you experienced implementation of in your current or past organisation?**

- ○ **Computer Hardware:**

Examples: Local Area Networks (LAN); Micros (PC Computers); Graphics hardware; Mainframe; Online process instrumentation; Shop floor data capture; Wide area networks (WAN); Automated Vision-based systems used for inspection/testing of inputs or final products; Other automated sensor-based systems used for inspection/testing of inputs

- ○ **Computer Software:**

Examples: Computer-Aided Design (CAD); Computer-Aided Process Planning (CAPP); Computer-Aided Manufacturing (CAM); Database Management Systems (DBM); Material Requirements Planning (MRP); Manufacturing Resource Planning (MRP II); Just-in-time (JIT); Supervisory Control & Data Acquisition (SCADA)

- ○ **Plant and Equipment**

Examples: Programmable logic control machines or processes (CNC and NC); Materials working laser (MWL); Robots with sensing capabilities; Robots without sensing capabilities; Other Robots; Rapid Prototyping systems; High speed machining; Flexible manufacturing cells; Automatic assembly; Flexible assembly systems; Automated warehousing/order picking

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Organisational factors impacting AMT implementation

***6. What type of manufacturing system does your organisation employ?**

- Jobbing production
- Batch production
- Continuous/Flow-line

7. What was your primary role in the AMT implementation?

- Responsible for the decision to implement the AMT
- Involved in the project team responsible for the AMT implementation
- User of the AMT

8. Was the implementation managed primarily internally or by an outside contractor/supplier?

- Externally
- Internally

***9. What was the approximate value of the AMT investment(s)?**

- Less than R1M
- R1M – R5M
- R5M – R10M
- Greater than R10M
- Not sure/Can't disclose

***10. What was the primary benefit used to motivate the AMT implementation?**

- Reduced product development time
- Obtaining a competitive advantage
- Labour cost savings
- Material cost savings
- Production flexibility
- Increased throughput
- Improved quality
- Not sure
- Other (please specify)

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Organisational factors impacting AMT implementation

***11. Was the AMT implementation you were involved in successful in achieving the desired benefits set-out?**

- Yes
- Partially
- No
- Not sure

This section aims to rate the organisational factors according to how important or unimportant you perceive them to be in contributing to the effectiveness of an AMT implementation.

***12. Top management ability: Please rate the following factors based on your perception of their importance in contributing to the effectiveness of an AMT implementation.**

	Not at all important	Low importance	Slightly important	Neutral	Moderately important	Very important	Extremely important
Promotion of new technologies and support and commitment towards the AMT by top management	○	○	○	○	○	○	○
Investment in resources directed at the new technology	○	○	○	○	○	○	○
Alignment of the AMT to the manufacturing strategy of the organisation	○	○	○	○	○	○	○
Communication of the motivation behind the AMT implementation and expected benefits	○	○	○	○	○	○	○
Alignment of the AMT to support the long-term vision of the organisation	○	○	○	○	○	○	○
High level of general technical expertise of top management and know-how around the technical aspects of the AMT	○	○	○	○	○	○	○
Receptiveness of the organisational culture to new technologies	○	○	○	○	○	○	○
Communication of the company strategy within the organisation	○	○	○	○	○	○	○

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Organisational factors impacting AMT implementation

***13. Organisational ability: Please rate the following factors based on your perception of their importance in contributing to the effectiveness of an AMT implementation.**

	Not at all important	Low importance	Slightly Important	Neutral	Moderately important	Very important	Extremely important
Changes to the organisational structure to support the new AMT	○	○	○	○	○	○	○
Handing over planning and troubleshooting responsibilities related to the AMT to in-house employees rather than contractors	○	○	○	○	○	○	○
In house expertise to manage the AMT implementation	○	○	○	○	○	○	○
Adequate channels of communication and widespread participation from organizational members in the implementation	○	○	○	○	○	○	○
Organisation of the workforce into multidisciplinary teams to manage the AMT implementation	○	○	○	○	○	○	○
Use of in house Research and Development to enhance the effectiveness of an AMT implementation	○	○	○	○	○	○	○
Highly skilled workers with competencies that match the manufacturing and AMT environment	○	○	○	○	○	○	○
Possessing a more flexibility-oriented culture	○	○	○	○	○	○	○

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Organisational factors impacting AMT implementation

***14. Training & Education and Incentives & Rewards: Please rate the following factorsbased on your perception of their importance in contributing to the effectiveness of an AMT implementation.**

	Not at all important	Low importance	Slightly important	Neutral	Moderately important	Very important	Extremely important
Creation of specific training programmes tailored to the AMT	○	○	○	○	○	○	○
Development of best practices to manage the AMT	○	○	○	○	○	○	○
Directing incentives and rewards schemes at the successful use of the AMT	○	○	○	○	○	○	○
Investment in education and training directed at the AMT	○	○	○	○	○	○	○
Implementation of performance measures directed at the AMT	○	○	○	○	○	○	○
In-house training capability to support training requirements for the AMT	○	○	○	○	○	○	○
Possessing highly skilled and qualified operators	○	○	○	○	○	○	○
Training of managers on the AMT before implementation	○	○	○	○	○	○	○

Thanks for taking your time to make it to this section. ***This is the last set of questions that need answering to complete the survey.***

Questions in this section are based on a 7-point Likert scale.

Each question aims to explore the extent to which a particular factor was in play during an AMT implementation you were involved in. ***The answers to the question should be based on how strongly you agree or disagree as to whether a particular factor was evident during an AMT implementation you were involved in within the organisation where the AMT implementation was taking place.***

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Organisational factors impacting AMT implementation

15. How strongly do you agree or disagree with the following statements related to an AMT implementation you were involved in?

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree Nor Agree	Somewhat Agree	Agree	Strongly Agree
The companies manufacturing strategy was well communicated within the organisation	○	○	○	○	○	○	○
The AMT was aligned to the manufacturing strategy of the organisation as set-out by top-management	○	○	○	○	○	○	○
Top management expressed a keen interest and commitment towards new technologies and readily promoted the new technologies	○	○	○	○	○	○	○
The AMT implementation was aligned to and supported the long-term vision of the organisation	○	○	○	○	○	○	○
Top management possessed a high level of general technical expertise and know-how around the technical aspects of the AMT	○	○	○	○	○	○	○
The organisational culture was receptive to new innovations and technologies	○	○	○	○	○	○	○
Top management communicated the motivation behind the AMT implementation and the expected benefits to all members of the organisation	○	○	○	○	○	○	○
Top management was willing to invest in resources directed at new technologies	○	○	○	○	○	○	○
The organization possessed in-house expertise to manage the AMT implementation	○	○	○	○	○	○	○
Highly skilled workers with competencies that match the manufacturing and AMT environment were prevalent within the organisation	○	○	○	○	○	○	○
Planning and troubleshooting responsibilities related to the AMT were handed over to in-	○	○	○	○	○	○	○

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Organisational factors impacting AMT implementation

house employees rather than external contractors							
The workforce was organised into multidisciplinary teams to manage the AMT implementation	○	○	○	○	○	○	○
Adequate channels of communication and widespread participation from organizational members were evident during the AMT implementation	○	○	○	○	○	○	○
In house Research and Development expertise were utilised to enhance the effectiveness of an AMT implementation	○	○	○	○	○	○	○
The organisation had a more flexibility-oriented culture	○	○	○	○	○	○	○
Changes to the organisational structure were carried out to support the new AMT	○	○	○	○	○	○	○
The company had an in-house training capability to support training requirements for the AMT	○	○	○	○	○	○	○
Investment in education and training directed at the AMT accompanied the AMT implementation	○	○	○	○	○	○	○
Specific training programmes tailored to the AMT were introduced	○	○	○	○	○	○	○
Managers received the necessary training before the AMT implementation	○	○	○	○	○	○	○
Educational qualifications of operators were sufficient to effectively support the AMT	○	○	○	○	○	○	○
Best practices were developed to manage the AMT	○	○	○	○	○	○	○
Performance measures were adapted to align with the new AMT	○	○	○	○	○	○	○
Incentives and rewards schemes were directed at the successful implementation and use of the AMT	○	○	○	○	○	○	○

Thanks for taking your time to participate in this survey.

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APPENDIX B – Exploratory factor analysis

Responses to the agreement of the degree to which various factors were in play during the AMT implementation, consisting of 24 items, were run through a principle axis factoring extraction technique. Principle axis factoring, also known as common factor analysis, attempts to determine the smallest number of factors that can be used to best represent the interrelations between variables (Pallant, 2010).

To check the suitability of the data for factors analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value and the Bartlett's test of sphericity values were checked. KMO requires a value of 0.6 or above for data suitability. A KMO value of 0.846 therefore met this condition. Bartlett's test of sphericity requires that the Sig. value be below 0.05. This conditions was met with a Sig value of 0.000, thus confirming suitability of the data for factor analysis. The correlation matrix (Table B1) further supported the suitability of the data for factor analysis with the presence of correlation coefficients above 0.3.

Kaiser's criterion, or the eigenvalue rule, was used to determine the number of factors to retain. Only factors with an eigenvalue of one or more are retained (Pallant, 2010). The eigenvalue of a factor represents the amount of the total variance of the dataset explained by that factor. The total variance (Table B2) generated in the analysis provides the eigenvalues under the column Initial Eigenvalues. Only the first four components recorded eigenvalues above one and explain the total of 66.305% of the variance of the dataset. Four factors were therefore identified and retained as per Kaiser's criterion.

To aid the interpretation of the four components identified, oblimin rotation was performed on the data. The rotated factor matrix (Table B3) displays the maximum loadings of the different variables on the four respective factors. The variables loading on each of the factors are therefore identified for analysis to determine if any new constructs or themes could be revealed in those uncovered via exploratory analysis.

Table B1: Correlation matrix for exploratory factor analysis (Below).

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Correlation matrix for exploratory factor analysis

	TM1	TM2	TM3	TM4	TM5	TM6	TM7	TM8	OA1	OA2	OA3	OA4	OA5	OA6	OA7	OA8	TE1	TE2	TE3	TE4	IR1	TE5	TE6	IR2
TM1	1.000	.547	.656	.427	.547	.502	.500	.630	.355	.422	.376	.486	.453	.406	.495	.496	.444	.380	.510	.478	.399	.275	.408	.481
TM2	.547	1.000	.543	.475	.657	.670	.487	.607	.355	.510	.470	.591	.434	.310	.520	.585	.506	.390	.431	.504	.514	.434	.421	.546
TM3	.656	.543	1.000	.535	.604	.503	.514	.597	.332	.350	.332	.415	.311	.374	.446	.393	.339	.260	.325	.377	.236	.315	.320	.379
TM4	.427	.475	.535	1.000	.421	.561	.575	.611	.412	.441	.409	.431	.564	.419	.622	.452	.570	.421	.473	.412	.379	.489	.410	.513
TM5	.547	.657	.604	.421	1.000	.490	.565	.519	.228	.339	.379	.482	.331	.298	.440	.438	.332	.270	.323	.390	.292	.319	.426	.425
TM6	.502	.670	.503	.561	.490	1.000	.454	.529	.481	.517	.461	.553	.514	.357	.552	.467	.517	.617	.489	.523	.346	.484	.477	.492
TM7	.500	.487	.514	.575	.565	.454	1.000	.542	.423	.517	.471	.428	.449	.527	.600	.425	.483	.405	.390	.439	.304	.415	.465	.387
TM8	.630	.607	.597	.611	.519	.529	.542	1.000	.399	.459	.467	.521	.424	.405	.548	.547	.448	.366	.430	.485	.380	.423	.398	.527
OA1	.355	.355	.332	.412	.228	.481	.423	.399	1.000	.548	.509	.465	.380	.352	.609	.536	.453	.482	.350	.532	.339	.650	.462	.393
OA2	.422	.510	.350	.441	.339	.517	.517	.459	.548	1.000	.527	.553	.549	.439	.545	.571	.495	.553	.531	.454	.418	.528	.491	.469
OA3	.376	.470	.332	.409	.379	.461	.471	.467	.509	.527	1.000	.496	.453	.434	.450	.621	.417	.403	.338	.469	.471	.579	.528	.454
OA4	.486	.591	.415	.431	.482	.553	.428	.521	.465	.553	.496	1.000	.553	.411	.439	.615	.582	.509	.562	.531	.391	.434	.459	.472
OA5	.453	.434	.311	.564	.331	.514	.449	.424	.380	.549	.453	.553	1.000	.393	.512	.487	.504	.613	.619	.488	.405	.407	.527	.412
OA6	.406	.310	.374	.419	.298	.357	.527	.405	.352	.439	.434	.411	.393	1.000	.341	.441	.592	.350	.432	.419	.222	.420	.446	.341
OA7	.495	.520	.446	.622	.440	.552	.600	.548	.609	.545	.450	.439	.512	.341	1.000	.454	.529	.420	.427	.441	.404	.522	.380	.359
OA8	.496	.585	.393	.452	.438	.467	.425	.547	.536	.571	.621	.615	.487	.441	.454	1.000	.581	.439	.515	.602	.551	.574	.561	.560
TE1	.444	.506	.339	.570	.332	.517	.483	.448	.453	.495	.417	.582	.504	.592	.529	.581	1.000	.534	.616	.667	.537	.566	.576	.561
TE2	.380	.390	.260	.421	.270	.617	.405	.366	.482	.553	.403	.509	.613	.350	.420	.439	.534	1.000	.596	.541	.472	.588	.562	.537
TE3	.510	.431	.325	.473	.323	.489	.390	.430	.350	.531	.338	.562	.619	.432	.427	.515	.616	.596	1.000	.517	.509	.475	.528	.676
TE4	.478	.504	.377	.412	.390	.523	.439	.485	.532	.454	.469	.531	.488	.419	.441	.602	.667	.541	.517	1.000	.525	.637	.750	.614
IR1	.399	.514	.236	.379	.292	.346	.304	.380	.339	.418	.471	.391	.405	.222	.404	.551	.537	.472	.509	.525	1.000	.450	.488	.714
TE5	.275	.434	.315	.489	.319	.484	.415	.423	.650	.528	.579	.434	.407	.420	.522	.574	.566	.588	.475	.637	.450	1.000	.697	.559
TE6	.408	.421	.320	.410	.426	.477	.465	.398	.462	.491	.528	.459	.527	.446	.380	.561	.576	.562	.528	.750	.488	.697	1.000	.635
IR2	.481	.546	.379	.513	.425	.492	.387	.527	.393	.469	.454	.472	.412	.341	.359	.560	.561	.537	.676	.614	.714	.559	.635	1.000

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Table B2: Total variance explained (Exploratory factor analysis)

Total Variance Explained										
Factor	Initial Eigenvalues				Extraction Sums of Squared			Rotation Sums of Squared		
	Total		% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.932		49.719	49.719	11.538	48.074	48.074	4.544	18.933	18.933
2	1.779		7.412	57.131	1.403	5.847	53.921	3.482	14.510	33.443
3	1.187		4.944	62.075	.813	3.385	57.307	3.465	14.439	47.882
4	1.015		4.230	66.305	.644	2.683	59.990	2.906	12.108	59.990
5	.911		3.797	70.101						
6	.801		3.337	73.438						
7	.742		3.094	76.532						
8	.644		2.684	79.216						
9	.595		2.481	81.697						
10	.538		2.242	83.939						
11	.512		2.134	86.073						
12	.447		1.864	87.937						
13	.383		1.595	89.533						
14	.366		1.523	91.056						
15	.334		1.393	92.449						
16	.298		1.244	93.693						
17	.281		1.171	94.864						
18	.253		1.053	95.917						
19	.231		.961	96.878						
20	.190		.793	97.671						
21	.176		.734	98.404						
22	.152		.632	99.037						
23	.127		.530	99.566						
24	.104		.434	100.000						

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Table B3: Rotated factor matrix displaying loadings on factors (Exploratory factor analysis)

Rotated factor matrix				
	Factor			
	1	2	3	4
TM3	.761			
TM5	.726			
TM8	.668			
TM1	.661			
TM2	.655			
TM7	.561			
TM4	.496			
TM6	.486			
OA4	.416			
IR2		.751		
IR1		.646		
TE4		.572		
TE6		.571		
OA8		.492		
TE5			.706	
OA1			.700	
OA3			.537	
OA7			.496	
OA2			.466	
OA6			.348	
TE3				.662
OA5				.645
TE2				.556
TE1				.460

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Tables B4 to B7 display the factor items for each of the factors identified through the exploratory factor analysis, as well as Cronbach's alpha coefficients computed to test the internal consistency of the scales. All four factors were found to have good internal consistency with Cronbach's alpha coefficients all above 0.841. Cronbach alpha coefficients above 0.7 are considered significant in exploratory research (Hair, Anderson, Tatham, & Black, 1998).

Table B4: Factor items loaded on factor 1 and computed Cronbach's alpha coefficients

	Factor items		Cronbach's alpha
Factor 1	**TM3**	The AMT was aligned to the manufacturing strategy of the organisation as set-out by top-management	0.907
	TM5	The company's manufacturing strategy was well communicated within the organisation	
	TM8	Top management expressed a keen interest and commitment towards new technologies and readily promoted the new technologies	
	TM1	The AMT implementation was aligned to and supported the long-term vision of the organisation	
	TM2	Top management communicated the motivation behind the AMT implementation and the expected benefits to all members of the organisation	
	TM7	The organisational culture was receptive to new innovations and technologies	
	TM4	Top management possessed a high level of general technical expertise and know-how around the technical aspects of the AMT	
	TM6	Top management was willing to invest in resources directed at new technologies	
	OA4	Adequate channels of communication and widespread participation from organisational members were evident during the AMT implementation	

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Table B5: Factor items loaded on factor 2 and computed Cronbach's alpha coefficients

	Factor items		Cronbach's alpha
Factor 2	IR2	Incentives and rewards schemes were directed at the successful implementation and use of the AMT	0.872
	IR1	Performance measures were adapted to align with the new AMT	
	TE4	Specific training programmes tailored to the AMT were introduced	
	TE6	Investment in education and training directed at the AMT accompanied the AMT implementation	
	OA8	The workforce was organised into multidisciplinary teams to manage the AMT implementation	

Table B6: Factor items loaded on factor 3 and computed Cronbach's alpha coefficients

	Factor items		Cronbach's alpha
Factor 3	TE5	The company had an in-house training capability to support training requirements for the AMT	0.858
	OA1	Planning and troubleshooting responsibilities related to the AMT were handed over to in-house employees rather than external contractors	
	OA3	Changes to the organisational structure were carried out to support the new AMT	
	OA7	The organisation possessed in-house expertise to manage the AMT implementation	
	OA2	The organisation had a more flexibility-oriented culture	
	OA6	In-house Research and Development expertise were utilised to enhance the effectiveness of an AMT implementation	

Table B7: Factor items loaded on factor 4 and computed Cronbach's alpha coefficients

	Factor items		Cronbach's alpha
Factor 4	TE3	Best practices were developed to manage the AMT	0.841
	OA5	Highly skilled workers with competencies that match the manufacturing and AMT environment were prevalent within the organisation	
	TE2	Educational qualifications of operators were sufficient to effectively support the AMT	
	TE1	Managers received the necessary training before the AMT implementation	

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APPENDIX C – Normality checks on data

APPENDIX C1 – Normality check on Likert data related to all respondents for importance and agree questions

Table C1 below displays the normality tests conducted on the Likert responses for the importance and agree questions related to all the respondents taking part in the survey. All respondents fell into one group. Due to the size of the group being greater than or equal to 50 people, the Kolmogorov-Smirnov normality test was selected. All Sig. or p-values were less than 0.05, indicating non-normality for all the constructs measured for the entire group of respondents.

Table C1: Tests of normality on Likert-scale data for all respondents

Tests of normality on Likert-scale data for all respondents			
	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
TopManAbility_Imp	.206	140	.000
OrgAbility_Imp	.107	140	.000
TrainingEdu_Imp	.174	140	.000
IncentRewards_Imp	.237	140	.000
TopManAbility_Agr	.100	139	.002
OrgAbility_Agr	.133	139	.000
TrainingEdu_Agr	.091	139	.007
IncentRewards_Agr	.124	139	.000

a. Lilliefors Significance Correction

APPENDIX C2 – Normality check on Likert data for importance and agree questions for groups related to the size of the organisation

Table C2 below displays the normality tests conducted on the Likert responses for the importance and agree questions related to the size of the organisation of the respondent. Due to the size of both the groups being greater than or equal to 50 people, the Kolmogorov-Smirnov normality test was selected. Sig. or p-values were less than 0.05, indicating non-normality for the majority of the constructs for each group. For ease of reference, the data that exhibits normality has been highlighted in yellow.

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Table C2: Tests of normality on Likert-scale data for respondents based on organisation size

Tests of normality on Likert-scale data for respondents based on organisation size				
		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
TopManAbility_Imp	Less than 500 employees	.216	59	.000
	Greater than 500 employees	.193	81	.000
OrgAbility_Imp	Less than 500 employees	.153	59	.001
	Greater than 500 employees	.085	81	.200*
TrainingEdu_Imp	Less than 500 employees	.217	59	.000
	Greater than 500 employees	.132	81	.001
IncentRewards_Imp	Less than 500 employees	.238	59	.000
	Greater than 500 employees	.227	81	.000
TopManAbility_Agr	Less than 500 employees	.118	58	.042
	Greater than 500 employees	.106	81	.026
OrgAbility_Agr	Less than 500 employees	.126	58	.023
	Greater than 500 employees	.137	81	.001
TrainingEdu_Agr	Less than 500 employees	.101	58	.200*
	Greater than 500 employees	.084	81	.200*
IncentRewards_Agr	Less than 500 employees	.119	58	.039
	Greater than 500 employees	.123	81	.004

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

APPENDIX C3 – Normality check on Likert data for the importance and agree questions for the groups based on AMT type

Table C3 below displays the normality tests conducted on the Likert responses for the importance and agree questions related to the type of AMT of the respondent. Due to the size of the group being greater than or equal to 50 people, the Kolmogorov-Smirnov normality test was selected for the normality test on the Plant and Equipment group. The Shapiro-Wilk normality test was conducted on the Computer Hardware and Computer Software groups, which consisted of less than 50 people. Sig. or p-values were less than 0.05, indicating non-normality for the majority of the constructs for each group. For ease of reference, the data that exhibits normality has been highlighted in yellow.

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Table C3: Tests of normality on Likert-scale data for respondents based on the type of AMT

Tests of normality on Likert-scale data for respondents based on the type of AMT							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
TopManAbility_Imp	Computer Hardware				.880	44	.000
	Computer Software				.726	46	.000
	Plant and Equipment	.186	50	.000			
OrgAbility_Imp	Computer Hardware				.940	44	.024
	Computer Software				.808	46	.000
	Plant and Equipment	.095	50	.200*			
TrainingEdu_Imp	Computer Hardware				.883	44	.000
	Computer Software				.714	46	.000
	Plant and Equipment	.133	50	.027			
IncentRewards_Imp	Computer Hardware				.882	44	.000
	Computer Software				.807	46	.000
	Plant and Equipment	.246	50	.000			
TopManAbility_Agr	Computer Hardware				.957	43	.108
	Computer Software				.878	45	.000
	Plant and Equipment	.128	51	.037			
OrgAbility_Agr	Computer Hardware				.967	43	.239
	Computer Software				.919	45	.004
	Plant and Equipment	.122	51	.056			
TrainingEdu_Agr	Computer Hardware				.955	43	.094
	Computer Software				.932	45	.011
	Plant and Equipment	.070	51	.200*			
IncentRewards_Agr	Computer Hardware				.950	43	.060
	Computer Software				.917	45	.003
	Plant and Equipment	.099	51	.200*			

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

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APPENDIX C4 – Normality check on Likert data for importance and agree questions for respondents based on whether the AMT implementation fully or partially achieved intended benefits

Table C4 below displays the normality tests conducted on the Likert responses for the importance and agree questions or respondents based on whether the AMT implementation fully or partially achieved intended benefits. The Kolmogorov-Smirnov normality test was selected on the group of respondents who answered yes to the AMT achieving the intended benefits, as the size of the group is greater than or equal to 50 people. The Shapiro-Wilk normality test was conducted on the group that answered partially to achieving the intended benefits, as it consisted of less than 50 people. Sig. or p-values were less than 0.05, indicating non-normality for the majority of the constructs for each group. For ease of reference, the data that exhibits normality has been highlighted in yellow.

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Table C4: Tests of normality on Likert-scale data for respondents based on whether the respondent answered yes or partially to achieving the intended benefits of the AMT

Tests of normality on Likert-scale data for respondents based on whether the respondent answered yes or partially to achieving the intended benefits of the AMT							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
TopManAbility_Imp	Yes	.198	96	.000			
	Partially				.930	37	.023
OrgAbility_Imp	Yes	.127	96	.001			
	Partially				.980	37	.717
TrainingEdu_Imp	Yes	.149	96	.000			
	Partially				.925	37	.016
IncentRewards_Imp	Yes	.237	96	.000			
	Partially				.880	37	.001
TopManAbility_Agr	Yes	.153	93	.000			
	Partially				.975	39	.533
OrgAbility_Agr	Yes	.160	93	.000			
	Partially				.967	39	.294
TrainingEdu_Agr	Yes	.104	93	.014			
	Partially				.966	39	.274
IncentRewards_Agr	Yes	.144	93	.000			
	Partially				.916	39	.007

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

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