AN INTEGRATED APPROACH FOR DEVELOPING A TECHNOLOGY STRATEGY FRAMEWORK FOR SMALL- TO MEDIUM-SIZED FURNITURE MANUFACTURERS TO IMPROVE COMPETITIVENESS

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ABSTRACT

Low-technology firms, such as those found within the furniture manufacturing industry, have no framework or methodology to guide them successfully to acquire and integrate technology that enables them to operate more competitively. The aim of this article is to illustrate the development of a technology strategy framework for small- to medium-sized furniture manufacturers to assist them to improve their competitiveness. More specifically, this article presents an integrated technology strategy framework that enables management to integrate their business strategy with their technology requirements successfully, thus improving competitiveness.

OPSOMMING

Lae-tegnologie ondernemings, soos dié in die meubelvervaardingingsbedryf, het geen raamwerk of metodologie om hulle te lei in die suskesvolle aanwending van tegnologie met die oog daarop om hulle meer mededingend te maak nie. Die doel van hierdie artikel is om te illustreer hoe 'n tegnologiestrategieraamwerk ontwikkel is om klein- tot mediumgrootte meubelvervaardigers te help om meer mededingend te wees. Hierdie artikel bied dus 'n geïntegreerde tegnologiestrategieraamwerk aan wat bestuur sal help om hulle onderneming-strategie met hul tegnologievereistes te integreer en sodoende meer mededingend te wees.

1. INTRODUCTION

Even though furniture manufacturing is a low-technology industry, it has the capacity to provide jobs and foreign earnings. However, over the past decade several weaknesses and problem areas have been identified in the South African domestic small- to- medium-sized furniture manufacturing (SM/FM) industry.

This is especially evident when considering the domestic furniture manufacturing industry's position from a global perspective. In the global economy, many low-technology, labour-intensive sectors, such as the furniture industry, are achieving what would previously have been considered surprising levels of performance in job growth and foreign-earning capacity [1]. As the furniture industry is growing rapidly in many different countries, it often provides lucrative employment opportunities, upgraded skills, and increased revenue.

For example, between 1995 and 2000 worldwide trade in furniture grew by 36 per cent; and by 2000 it was the largest low-technology sector [2]. In 1996 the value of total world furniture was less than US$23 billion; but in 2005 it reached almost US$54 billion, which equalled an annual average growth of more than 12 per cent (nominal figures). In 2006 the value of global furniture exports in the sector amounted to over US$135 billion, and analysts predicted that the trend would continue at the then current rate of growth. Developed countries, led by Italy, Germany, and the United States of America (USA), have traditionally been the main manufacturers, exporters, and importers of furniture, exporting US$13.4 billion, US$11.5 billion, and US$7.5 billion respectively in 2006.

However, in the last ten years the world has seen fierce competition from developing countries, especially China, and to a lesser degree Malaysia, Vietnam, and Indonesia. For example, although China did not feature in the top ten exporters in 1990, by 2000 China was the world's ninth largest exporter. In 2006 China was rated first. Since then, China has been the leading exporter of furniture, exporting almost US$428 billion worth of furniture in 2006, which equalled 20 per cent of global exports. Table 1 illustrates the top ten global furniture exporters [3].

Table 1: Top ten global furniture exporters

Rank in 2006	Exporters	Value exported in 2006 (US$000)	Annual growth in value 2002-2006 (%)	Annual growth in value 2005-2006 (%)	Share in world exports (%)
	World estimate	135 403 909	13	9	100
1	China	27 955 148	30	25	20.6
2	Italy	13 489 272	7	4	10
3	Germany	11 545 506	14	8	8.5
4	USA	7 559 253	8	10	5.6
5	Canada	6 674 881	6	1	4.9
6	Poland	6 656 989	21	9	4.9
7	Mexico	5 894 846	8	3	4.4
8	France	4 222 692	8	7	3.1
9	Denmark	3 181 087	8	5	2.3
10	Belgium	3 169 910	7	2	2.3
43	South Africa	546 660	3	-8	0.4

The European Union (EU) has also been the leading importer of furniture, importing more than 50 per cent of the total furniture exported. In 2006 statistics suggested that imports from developing countries were increasing, a trend predicted as likely to continue. In 2001 imports from developing countries constituted 16 per cent of total EU imports, increasing to 28 per cent in 2005. By 2006 China was the greatest exporter to the EU, followed by Indonesia, Malaysia, and Thailand. From Table 1, it is evident that countries other than

South Africa are increasingly competing more effectively. This is further corroborated by South Africa's rank decreasing from 34 in 2005 to 43 in 2006.

South African manufacturers, therefore, need to respond to the global trends if the sector is to achieve growth and improve its competitiveness. However, research by the Resource-based Industries Enterprise and Industrial Development Division (EIDD) and the Department of Trade and Industry (DTI) [3], Dunne [4], Moodley [5], and Kaplinsky et al. [2] indicates that the industry has not kept up to date with technology development and global skills. The industry has also not adopted new methods of production or work organisation to improve productivity, quality, efficiency, innovation, and product design [3,4,5,2]. These findings concur with the evaluation by the Swedish International Development Cooperation Agency (Sida) [6], that:

- the South African furniture industry has experienced a significant loss of employment, and future prospects were unclear in the face of strong competition from imports;
- a major weakness of the South African furniture industry is product design and quality, low levels of automation, a lack of skills development, and the failure to develop a commitment to quality in the labour force; and
- global retailers sourcing furniture from South Africa have experienced problems with quality, delivery reliability, cost control, and cost effectiveness.

The result of this is a slowly declining industry that is marginalised in international markets. In 2008 it was highlighted that the industry had not only lost jobs in the preceding years, but that the rate of investment had also declined. One of the suggested reasons for the decline was that the industry had not kept up with global trends in skills development and technological advancement. The result is a South African furniture industry struggling to compete with imports [3].

In 2008, the DTI flagged the issue of the industry's competitiveness as a concern, and proposed that urgent initiatives were required to raise the level of competitiveness significantly to enable the industry to compete with top global players [3]. In addition, the industry is becoming less effective, with a resultant negative effect on market position, exports, and long-term viability. Furthermore, the industry in general is hesitant to make large long-term capital investments in equipment and technology, which is expected to have a negative impact on the industry in the long term. The industry is also not able to compete with imports. This is evident in feedback from domestic retailers who indicate that the domestic market must implement measures to narrow the price gap, improve quality and service levels, and produce more innovative designs and styling [3].

It is suggested that the industry should seek to compete at a level of quality, reliability, and differentiated designs, rather than at a low price/quality level [7,3,8]. In addition, the export market, rather than the domestic market, will provide higher prices and volumes that will lead to superior growth of the industry. Investments in people and machinery should be made, along with an emphasis on a renewed focus on automation, product design, and quality. The premise that technology acquisition and implementation may lead the industry to greater competitiveness underlies these suggestions [5,1,6].

The research conducted by Da Costa et al. [9], Lui & Barrar [10], Efstathiades et al. [11], Lefebvre et al. [12], Sohal et al. [13], Small [14], and Raymond [15] is particularly relevant in the context of developing a technology strategy for SM/FM. All the researchers cited found that implementing various levels of technology improves speed, variety, flexibility, productivity, quality, and innovation. They recognised that manufacturing technologies contributed to goal attainment, and that they are a necessity for businesses to survive and gain competitive advantage. Manufacturing technologies can enable smaller businesses to serve mass markets, and blend batch and custom orders to allow for concurrent low cost and differentiation strategies. Another critical technology consideration is that the needs of customers are constantly changing and evolving, and the industry must be able to respond to those needs if they are to remain or become competitive. The implication is that the

particular strategic flexibility – which is achievable with technology – is critical to designing new products and competing on time.

Furthermore, the researchers collectively emphasise that strategy and technology are not mutually exclusive [16,17]. According to their research, business managers indicated that aligning the technology strategy with the business strategy is vital for the success and survival of the business.

The importance and potential of SM/FMs, and the potential benefits associated with technology application, gave rise to the need to develop a technology strategy framework to improve the competiveness of SM/FM. A framework can serve as a roadmap for the technology strategy development process to facilitate acquiring and implementing the most appropriate and suitable technology successfully.

This research presents the theoretical development of a technology strategy framework (TSF) for SM/FMs to improve their competitiveness. The aim of the TSF is to supply strategic thinkers with a broad framework for integrating business strategy with technology strategy. The proposed TSF was developed from an extensive literature study.

2. METHODOLOGY

Relevant literature was identified, studied, and analysed to identify strategic framework components that would contribute to the formulation of a technology strategy and inform technology choices within SM/FM. This included the technology selection process, its integration with the business strategy, and finally determination of the critical success factors (CSF) relevant to the industry that will be indicative of a successful technology strategy. This paper presents the theoretical development of a TSF for SM/FM to improve their competitiveness.

Although not presented in this research article, the TSF was tested quantitatively and the results were triangulated qualitatively.

3. IDENTIFYING STRATEGIC FRAMEWORK COMPONENTS

A starting point for developing a TSF was to adopt a strategic approach, by theoretically researching the generic strategic management process. The next step was to locate technology related strategies. The aim was to identify components and activities that are either unique or common to the development of a technology strategy and to a generic strategy. Technology strategy-related frameworks reveal that many of the principles involved are similar to those of the strategic management process, and illustrate the interdependency between strategic management and strategic technology management [18,19,20]. It was evident that the starting point for developing a TSF for SM/FM was the identification of the business strategy. The technology strategy must be based on the business strategy, as technology must bring the business strategy to fruition. Therefore the success of the technology strategy depends on a well-developed and defined business strategy, as all subsequent technology strategy tasks will be executed based on the business strategy.

In summary, the technology strategy development process is similar to the strategic management process, but with technology being the driver of the business strategy to achieve competitive advantage. Therefore the business strategy is the most critical starting point both in developing a technology strategy and in the process of identifying the technology required for a successful technology strategy. The process of developing a technology strategy must actively consider technology options in every step as a means to achieving the business strategy – and therefore attaining competitive advantage.

Further to identifying the components of a strategic framework, it was possible to group the components into three phases; strategy identification, technology considerations, and

evaluation. With the three phases as a foundation, it was possible to start developing the TSF.

4. DEVELOPMENT OF TSF

The proposed TSF consists of three phases; strategy identification, technology considerations, and evaluation. Phase 1 is illustrated in Figure 1.

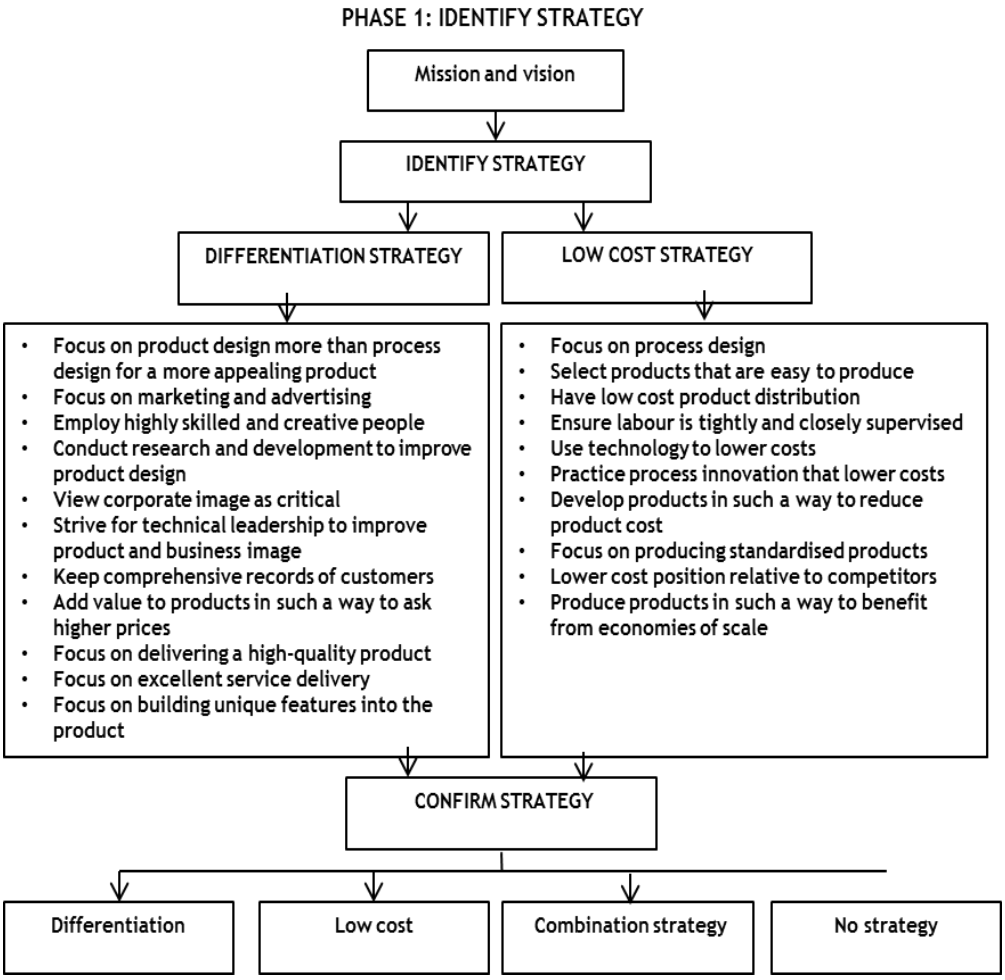

Figure 1: Phase 1 – Strategy identification

Phase 1 (Figure 1) can be explained as follows:

4.1 Phase 1: Strategy identification

An understanding and definition of the business strategy is important to the SM/FM, both in view of its emphasis as the starting point to develop a technology strategy, as well as the importance of the business strategy in relation to the technology strategy. Various business strategies can be developed [21,22,23,24].

A differentiation and low-cost strategy can be followed independently or simultaneously, and technology can be used as an instrument to achieve the desired critical success factors (CSFs). The CSFs for the furniture industry are identified as value, speed, innovation, and flexibility, and are based on research findings [7,4,2,25].

Speed is defined as volume flexibility, delivery speed, and delivery dependability, while *value* includes low cost, providing value for money, product reliability, and quality (conforming to specifications) [26,27]. With regard to *quality*, the aim is to gain advantage by stabilising the quality of the product at a level comparable to competitors, and by statistical control of supplies and production, quality circles, and formalisation and standardisation of processes. *Flexibility* is described as product- and process-flexibility to respond quickly to demand variation. This is achieved by fast and concurrent design, targeting specific needs, shortening production lead-times, and decreasing inventory levels. *Innovation* focuses on introducing new products, design quality, and improving production and management techniques, as well as providing products of premium value for the customer [28,29,25]. The business strategy, be it differentiation or low cost, can focus on a broad or narrow market. For the purpose of this study no distinction is made, because research findings suggest that it is particularly difficult to make such distinctions in the case of small-manufacturing businesses, which usually tend to focus on narrow-market segments [12].

Once the CSF pertinent to the SM/FM is understood, it must then be decided whether the most suitable strategy would be differentiation or low cost. In the sections below, the characteristics of both a differentiation and a low cost strategy are discussed.

4.1.1 Identifying a differentiation strategy

There are several criteria for a differentiation strategy. The business following a differentiation strategy will focus on marketing and advertising in addition to product design, rather than process design, for a more appealing product. The business will employ highly skilled and creative people, conduct research and development to improve product design, and view corporate image as critical. The business will strive for technical leadership to improve product and business image, keep comprehensive records of customers, and add value to products so that it can ask higher prices. Additionally, the business must focus on delivering high quality products and excellent service, and build unique features into the product [22,28,30].

The characteristics of a differentiation strategy can be categorised under each of the identified CSFs of value, speed, flexibility, and innovation. The focus of a differentiation strategy is innovation, and the business must strive to meet most of the CSFs linked to innovation. Therefore the business must focus on designing and producing better quality. To do this, it must attract skilled and educated labour, and differentiate its products from those of its competitors. In this process it must focus on building good customer relations and develop a reputation as a leader in using related technology.

4.1.2 Identifying a low cost strategy

To follow a low cost strategy, the business will focus on process design and produce products that are easy to manufacture. The business will seek to find ways to lower distribution cost, and labour will be tightly and closely supervised. It will produce products in a way that benefits from economies of scale. Process innovation and product development will be practised to lower cost. Additionally, they will use technology to lower costs and produce standardised products, and their costs must be lower relative to their competitors'. In other words, the business's emphasis will be on actions and policies that reduce overall costs relative to competitors. Again, all the identified CSFs are important, but the focus is on driving cost down to facilitate competing on a low cost basis [22,30,28,29].

The checklists presented in Figure1 will assist the SM/FM to define and identify its business strategy. When developing a new business strategy, the SM/FM will identify objectives, and establish which CSFs will contribute to achieving its objectives, and how they link to the business strategies. The checklists presented in Figure 1 will also serve as a guide to keep the business focused on the selected strategy. On conclusion of Phase 1 (identifying the strategy) Phase 2 will begin. Phase 2 examines all technology considerations.

4.2 Phase 2: Technology considerations

Once the business strategy has been identified, a process is followed to determine the most suitable technology to allow successful execution of the business strategy [18,19,20,31]. Kruger & Snyman [18], John & Buys [19], Oerlemans et al. [20], and Granger [31] proposed that an external technology analysis be conducted to discover the various technologies available to SM/FM. It is critical for the SM/FM to select the most appropriate technology that matches the need, the business, and the strategy. The SM/FM must actively plan, predict, and manage the technology acquisition process. Consequently, it is important that all external and internal aspects are recognised and considered. As a result, phase two begins with an external technology audit, followed by an internal technology audit.

4.2.1 External technology analysis for a future situation

Technology scanning and forecasting are major activities that will recognise and prioritise leading technology; and the aim is to observe the development of technologies that are new, or new to the business. There are several uses, applications, and combinations of applications, and the business must explore these to learn what is most suitable to the business and the strategy. The process to conduct an external technology analysis is illustrated in Figure 2.

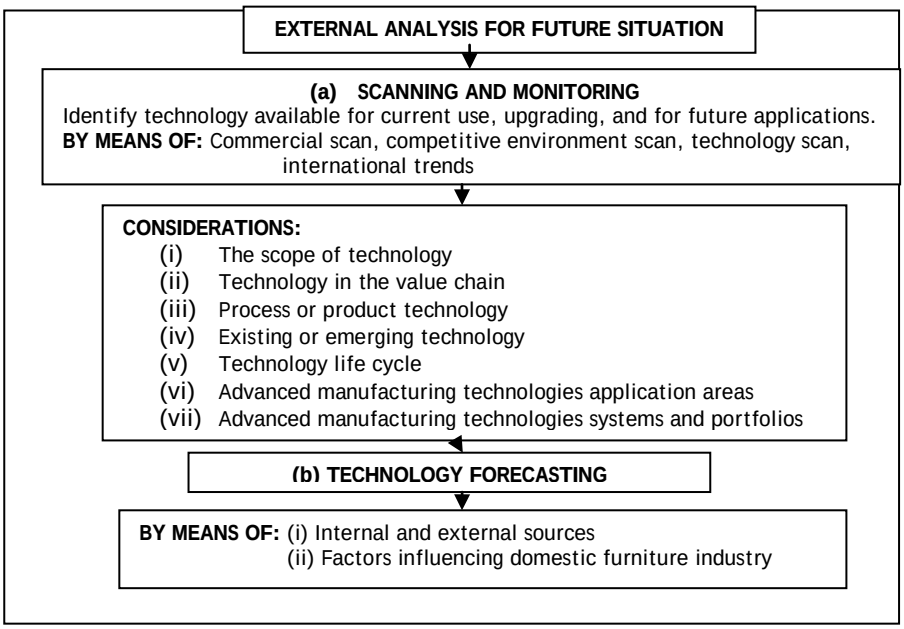

Figure 2: Phase 2 - External technology analysis for a future competitive position

Phase 2 (Figure 2) can be explained as follows:

Scanning and monitoring activities must be conducted to identify technology available for current use, for upgrading, and for future applications. Scanning and monitoring take place using commercial scans, competitive environment scans, and technology scans, and by keeping up to date with international trends.

a. Technology scanning and monitoring will reveal choices and options as follows:

(i) <u>The scope of technology</u>

The scope of technology includes hardware, software, 'brainware', know-how. Although most SM/FMs are familiar with, and apply, basic technology, the environment must still be scanned and evaluated to discover technology that is new, being developed, applied internationally, as well as technology that is new to the business [32,33].

(ii) Technology in the SM/FMs' value chain

Business managers must be aware of technology developments that affect their value chain and influence productivity and competitiveness. The SM/FMs must also be able to recognise the effect of a technology acquisition on the complete value chain. No new technology application will operate in isolation, and so the technologies that are suitable for specific areas of the value chain with the most impact on the business strategy must be selected [34,5,2].

(iii) Product and process technology

Product technology refers to the output of the business, and it is usually a hardware choice. In accordance with the business strategy, the SM/FM must make the choice, when acquiring technology, between that which improves the processes and that which improves the product [35].

(iv) Existing or emerging hard or soft technology

Emerging technology is an unlikely investment for a SM/FM that operates within a traditionally low-technology sector. However, the business still needs to be aware of emerging and existing technologies and all their potential applications and competitive implications [33,32].

(v) The life cycle of the technology (emerging, pacing, key, base)

The life cycle of technology includes the emerging, pacing, key and base phases. Emerging technology is not yet fully commercialised, but available for commercial use within a five-year period [33]), pacing technology is further along the curve of progress and has demonstrated its potential for changing the basis of competition [36]). Key technology is the type of technology that allows the business to develop a proprietary position in products and processes [32]). Maturing technology, known as base technology, is necessary for participation in business without providing a competitive advantage [36].

Technology can be classified according to what is needed for success, and then classified according to impact. To make good informed decisions, the SM/FM seeking to improve competitiveness must be aware of the life cycles of the different technologies influencing the industry. This is important because a base technology might be new technology to a SM/FM that is not familiar with the specific technology. However, due to the age and the extended life of the technology, it would be a wiser choice to invest in pacing or key technologies [32,36].

(vi) Several advanced manufacturing technologies are available

Advanced manufacturing technologies (AMTs) include applications in various areas: technology relating to product design (software such as CAD); the engineering process (software such as CAE, and hardware such as RP); manufacturing (hardware such as CNC, FMS, AGV, and AMHS); and materials handling and management (hardware such as FMS and AS/RS). Technology applications for control (such as software for SPC), planning (such as software for MRP, MRPII, and ERP), office systems (such as software for OA and EDI), and financial systems (such as software for ABC) are also available [10,37].

(vii) Combinations of advanced manufacturing technologies systems and portfolios of varying degrees of complexity

A stand-alone intermediate or integrated system can be developed for specific future strategies and needs. The combination of technologies will indicate a low, medium, or high complexity technology portfolio. Businesses can plan to build the technology portfolio from low to medium to high complexity as the technology strategy unfolds [38,39,14].

Technology will constantly change as new technologies reach the commercial market. SM/FMs must stay updated with technology developments by using their various sources of information.

b. Technology forecasting

Technology, as found in the external environment, is continually advancing, affecting all aspects of a business's performance – research and development, design, services, or driving strategic planning [17]. The impact of new technology is evident in greater production efficiency, and in improved corporate structures, communication, and creativity. This suggests that technological change and adaptation is a critical factor in gaining, retaining, and sustaining competitive advantage. Berry & Taggart [40] concluded that "to gain comparative competitive advantage by complex, costly and rapidly changing technology, businesses need to manage technology strategically". This statement implies that technology forecasting is an element of strategic-technology management, and that the business must be aware of advancement, developments, and upgrades of technology to gain and/or maintain competitive advantage. This is achieved through technology forecasting.

Various sources exist in the internal and external environments that serve as sources of information to the SM/FM.

(i) Sources of information

Technology forecasting is conducted using various internal and external sources of knowledge and information available to SM/FMs. Forecasting information can be obtained from the SM/FMs' networks, including suppliers and customers. Sources of information can include [32,20,41,42,43]:

- Predictions or estimations
- Research and development, qualified researchers
- Adapting new technology, internal experimentation, interactive learning
- Experiential learning, cross-training, new personnel
- Knowledge consultants, technical consultants
- Collaborations with other businesses, cooperative agreements
- Trade shows, overseas visits
- Subject journals, internet, subject magazines
- Informal networks of customers, suppliers, social groups

Technology that is available, as well as what is new and under development, will allow the SM/FMs to make forecasts about the development of the industry. It will also allow SM/FMs to plan, predict, and strategise for the best approach to achieve their business strategy.

(ii) Environmental factors influencing domestic SM/FMs

An external analysis must consider the domestic factors influencing technology management, selection, and acquisition. Economic, political, operational and financial, technical, and human resources are factors to consider when making technology decisions and forecasting future applications and developments. The shortage of skilled staff and low educational levels are a major consideration when purchasing expensive and complicated technology, as is the lack of technology-related knowledge and research within the industry [44,3]. Technology decisions are made even more challenging by the lack of technology applications within the industry, as there appear to be few domestic benchmarks and references that a SM/FM can consult. The SM/FMs must also take into account that limited strategic partnerships exist between the government and industry in pursuit of exports, and there is limited knowledge on new and unfamiliar export markets.

Various methods and sources of scanning and forecasting will be used to determine the type and application of technology available. Having executed an external analysis, the next step is to conduct an internal analysis.

4.3 Internal evaluation for current situation and technology selection

Having decided where the business wants to be, the SM/FMs must look at where the business currently is. This is done by means of an internal technology audit.

Various authors suggest understanding internal capabilities through an internal technology audit. This will expose the competencies, knowledge, know how, process management, and strategic leadership inherent in the business [45,18,19,20,31]. An internal audit can be viewed as a diagnostic tool to determine and evaluate the current technological competencies and applications, assets, capabilities, strengths, and weaknesses of the business [19,32,46].

An audit tool can be used to determine the flexibility requirements in a manufacturing facility that will allow changes, as well as a more informal technology-planning process to ensure flexibility, creativity, and strategic thinking [47,48]. Technology roadmaps are used to support the development and implementation of integrated-business strategies and technology plans [49].

On completion of the audits – and therefore the assessment of the SM/FM's current situation – the technology gap can be determined. This is done by comparing the current situation with what is needed to get the business where it wants to be. The various hardware, software, and business models required to fill the gap are assessed by determining the fit of the technology with the business strategy. If it is determined that the technology will not complement the business strategy, then the SM/FM will revert to the stage of identifying suitable technology.

The process of internal evaluation of the current situation and technology selection is illustrated in Figure 3. Figure 3 can be explained as follows:

a. Technology audit

The technology audit will indicate the technology status quo, the SM/FM's position in the industry relative to competitors, whether it regularly outsources (possibly implying a shortage of skills and technology), and whether it is in possession of certain skills and technologies required by other SM/FMs in the industry.

The technology audit assessment must include the technologies and the expertise that the business depends on, and the business's technology position compared with that of its competitors. The audit must indicate the business's strengths and the value of its technology, compared with that of its competitors. The audit should also lead to the discovery of a big technology gap, if it exists. Filling a gap that has been identified through this process would give the business an advantage in knowledge as well as in pricing its products. It would also give the business the opportunity to use the emerging or developing technologies that can influence customers or affect the business's market position. The audit must examine the social, political, and environmental factors that can impede the natural progress of a business's technological plan, and whether the business has technical assets that can be shared with other businesses. The technology audit will show the flexibility of the business in accommodating technology, and the influence of technology on other business functions.

The audit relates to the internal processes, the customer, outsourcing, and the external environment. The audit answers will uncover strengths and weakness within the business, current capabilities, the business's position compared with its competitors, and core technological competencies.

A formal- or informal-technology audit is considered a suitable tool to determine the uses, perceptions of, opportunities for, and status quo of technology in SM/FMs [48]. The technology audit places the application and use of technology in perspective. It is also clear that the external and internal audits cannot be conducted independently or in isolation. This is because the audits are interlinked, and internal and external customers must be considered in the questions relating to the internal processes. Likewise, the information obtained from scanning and forecasting will predict future customer requirements, which relate to the internal and external customer.

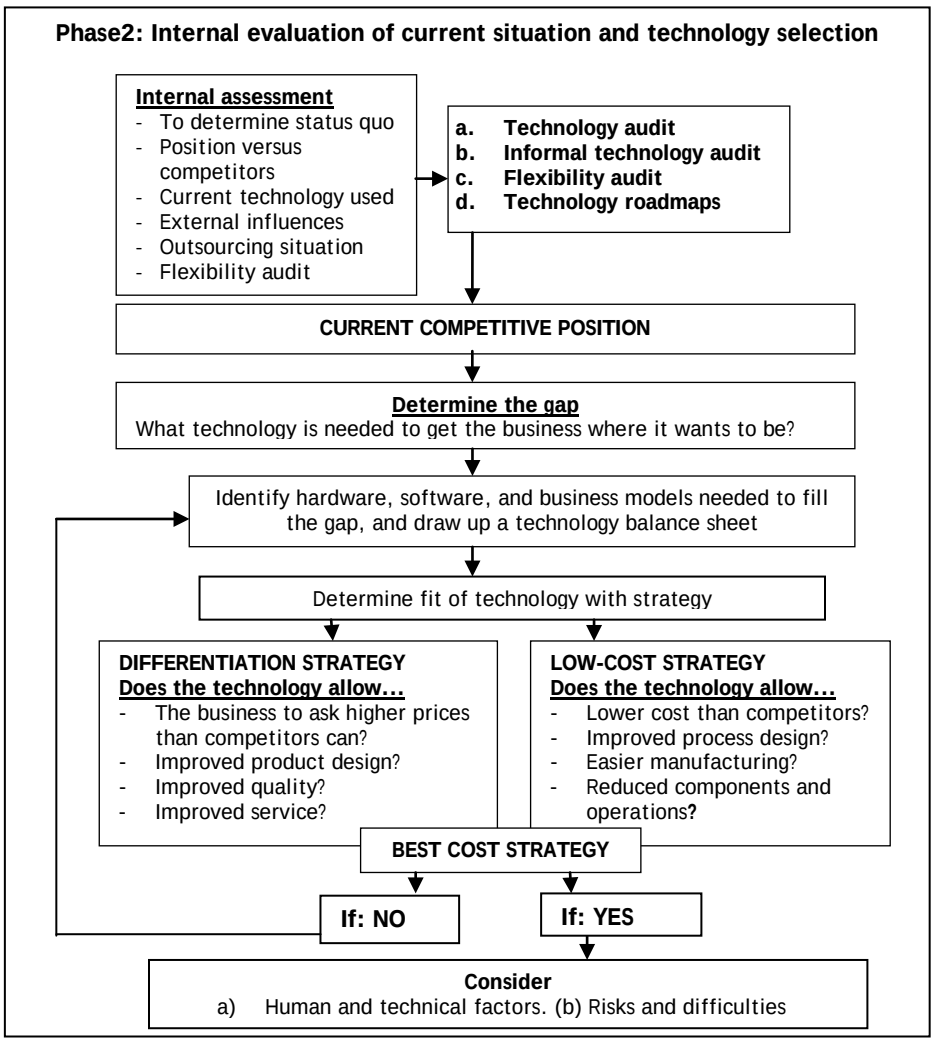

Figure 3: Phase 2 – Internal evaluation of current situation and technology selection

b. Informal technology audit

A more informal technology-planning process may ensure flexibility, creativity, and strategic thinking [48]. Salmela & Spil [48] warn that comprehensive, detailed planning might not provide the necessary flexibility to be effective in a changing business environment. In preparation for the future, three tasks are identified: planning the technology infrastructure, planning the technology organisation, and developing a preliminary project portfolio [48]. These tasks will consider the resource capacities and constraints, while the preliminary project portfolio will include technology-development projects and projects for improving the technology infrastructure. Furthermore, a comprehensive list of tasks for making technology decisions is compiled by diagnosing the current state of the technology, and by providing functional descriptions for each process, identifying inefficiencies, creating new business process models, and analysing the organisational processes.

c. Flexibility audit

A flexibility audit is a tool for determining the flexibility requirements in a manufacturing facility that will allow changes [47]. Flexibility will enable the production of multiple and diverse products, upgrading and redesigning of products in short life cycles, and the executing of efficient production changeovers. The flexibility audit tool is designed to

support managers in their efforts to build flexible manufacturing solutions, and its objective is to estimate the needed flexibility by linking it to possible uncertainty experiences of the manufacturing operations.

A flexibility audit is recommended if operating performance is being adversely affected by several environmental changes; if management plans to reconfigure operations to improve performance; or if there is an expectation that more manufacturing flexibility will be required. The audit process will identify changes experienced by the business, assess their impact on performance, and investigate whether a conventional solution can and should be used. Generally, conventional solutions initially cost less than unconventional solutions, but subsequent benefits are also lower.

d. Technology roadmaps

Technology roadmaps have great potential for supporting the development and implementation of integrated business strategies and technology plans, providing that the business has the information tools and processes to produce them [49]. Roadmaps and the road-mapping processes enhance the business's radar for extending planning horizons and identifying and assessing possible threats and opportunities in the business environment. For example, roadmaps can be used to assess the impact of certain technologies on business plans and systems. A technology roadmap will explore and communicate the dynamic linkages between technology resources, organisational objectives, and the changing environment.

Once the audits and analyses have been concluded, as referred to in Figure 3, the SM/FM can compare which technology it requires to meet the business strategy with what it has, thus indicating the technology gap. A technology balance sheet is developed to analyse and compare the current technology with available technology and the proposed new technology.

Deciding on the most suitable and appropriate technology to eliminate or narrow the technology gap will involve another process with predetermined selection criteria.

4.3.1 Selecting the appropriate technology

On completion of the internal and external audit, and once the technology gaps have been identified for the hardware, software, and business models, the first consideration is whether the proposed acquisition fits with the business strategy.

Figure 3 illustrates that the most important question to ask, assuming the selection of a differentiation strategy, is the following:

- Does the technology allow the business to ask higher prices than its competitors can?
- Does the technology allow for product design or quality or service improvement?
- Does the technology allow unique features to be built into the product or service provided?

If selecting a low-cost strategy, the following questions must be asked:

- Does the technology allow for lower cost than in the case of competitors?
- Will it allow for improved process design and easier manufacturing by reducing the components and operations?
- Does the technology allow for a reduced set-up time?

A best cost strategy will allow for combining more value for money by providing exceptional product attributes at a lower cost than in the case of rivals [22]. Determining whether the technology will lead to achievement of the business strategy is the most important criterion, and the basis for the technology-acquisition decision.

Thereafter, consider the human, application, and technical factors in the light of the difficulties, risks, and obstacles.

a. Human, application and technology considerations

The decision rationale for hardware, software, and business models requires certain considerations regarding employees operating the technology, as well as the possible uses of the new or upgraded technology to ensure maximum capitalisation of the technology purchase or upgrade [33]. Safsten et al. [50] argue that decisions about technology acquisition require consideration of the possible advantages of choosing between the different levels of automation that are appropriate for different functions and different situations. Such decisions must first support the business strategy to deliver the expected advantages. As decisions regarding technology affect the business as a whole, all decision areas, including suppliers, must be considered. The quality-management system must support the technology level of the business, and the skills level of employees must match the technology being implemented.

Lundi-Jenkins [33] considers hard-technology acquisition – with support from the supplier, and with the employees' ability to master the new hard-technology – as critical. The supplier must support the business in training, maintenance, and problem solving. Therefore, the ability of employees to learn and acquire the required skills to manage the technology effectively and efficiently is a very important consideration when acquiring expensive and complicated technology.

Lundi-Jenkins [33] finds that hard-technology acquisitions result in rapid prototyping, faster machining, and improved measuring tools. Hard-technology implementation benefits the business by improving productivity, throughput time, quality, planning, and control. The general application factors to be considered include the breadth of the application possibilities, as optimal use is especially important to the small business, along with affordability, the lifespan and reliability of the equipment, and the general history and reputation of the supplier. Rahman [51] proposes that businesses develop strong supplier relations, ensuring that their supplier selection process considers the ability to develop a close relationship with the chosen supplier.

The human factors to consider when upgrading or acquiring new soft technology are the ability of employees to sustain a high-level of competency, even if the software is not frequently used. Examples of such soft technology are computer-aided drawing, simulation tools, project management and scheduling software, knowledge management, and knowledge-based engineering tools. General application factors to be considered are the affordability of the technology, the possibility of concurrent engineering to allow simultaneous product and process engineering, and the ability to capture and leverage corporate knowledge combined with the level of complexity or ease of use [33].

According to Lundi-Jenkins [33], the acquisition and effective use of business-model tools requires employees with international marketing competencies and well-developed collaboration skills. Business-model tools are applied in the areas of global communications, e-commerce, and supply-chain integrations. The acquisition of this technology usually depends on factors such as the breadth and depth of the technology's capability, as well as local- and global-application possibilities. Economic justification will depend on the scale of the business, as well as the possibility of achieving the benefits of business performance benchmarking, and of infiltrating new markets and initiatives via the application of the new business-model tool.

It is apparent that businesses need competent employees and training and support from suppliers to gain the most benefit from technology applications. De Jong & Marsili [52] confirm this by asserting that a positive attitude towards innovation correlates with continuous attention to innovative opportunities that provide employees with support for their innovative behaviour. Thornhill [53] finds that the combination of training investments and improvements is positively associated with revenue growth in the low-technology sectors.

Erasmus [54] finds that employees in the domestic-furniture industry need to upgrade their technical and practical skills, and that the occupational category needing skills upgrading to the largest extent is labourers, followed closely by skilled employees and professionals. Furthermore, small- to medium-sized businesses often make no provision for training, bursaries, study leave, or other training measures. The Jet Education Services, Manto Management and CASE [55] survey of SMMEs in furniture manufacturing confirm this trend, and find that poaching of trained staff, and the mobility of staff once trained, contributes to a reluctance to train in this industry. The DTI [3] identifies the shortage of technical manufacturing and design capabilities as important constraints to competitiveness. The DTI [3] also finds a limited knowledge of new and unfamiliar export markets and weak branding of South Africa's products in international markets to be a serious weakness. The apparent shortage of technically skilled employees creates a serious problem for SM/FMs in the technology acquisition process; it may even prevent technology investments. The DTI [3] also states that under-investment in people, processes, and equipment will lead to a progressive inability to meet onerous international buyer requirements.

The current domestic situation appears to create a vicious cycle: businesses do not invest in technology because employees are not skilled and trained, yet they cannot become skilled and trained in technology applications if the industry does not invest in technology. If the industry is to become more competitive, investment in training and education is required.

b. Perceived difficulties, risks, and obstacles in the technology-selection process

According to Lefebvre et al. [12] small business generally doubted that the barriers and problems could be outweighed by the benefits associated with the adoption of technology. Contributing to the creation of this perception has been the unclear relationship between small business, competitive advantage, and technology adoption. Kim & Jee [56] affirm the findings of Ellitan [57], Lefebvre et al. [12], and Sohal et al. [13] by stating that smaller businesses frequently lack the ability to implement a technology strategy, as they do not often hire technology specialists. West & Sinclair [58] offer a solution to the lack of an in-house technology specialist by suggesting that the adoption process in smaller businesses is positively influenced by providing technical assistance or by allowing technology to be used on a trial basis.

Moodley [8] studied the impact of electronic commerce in the South African wooden-furniture sector, and found several obstacles to adopting this type of technology. These include a limited understanding of the electronic-commerce concept, and an over-dependence on the reduction of employee and input costs as a competitive advantage rather than pursuing a knowledge and growth trajectory. Porter [59] argues that managers often have a 'laager' mentality that locks business into an insular, inwardly-orientated way of thinking. He also finds that the lack of adequate infrastructure, skills, and capabilities is a possible barrier to technology implementation, along with the lack of expertise to develop strategies for marketing, web design, and back-end processing [60]. Furthermore, Porter [59] lists security issues, uncertainty, high investment cost, and the lack of internal support systems as possible obstacles to overcome in the adoption of electronic commerce. The DTI [3] also finds that constraints in the industry that keep SM/FMs from investing in technology include the lack of capital to invest in technology, the size of the business, a shortage of skills, and generally low-education levels.

When the selection process is finalised, the implementation is planned, and the process is continuously controlled and evaluated. It is important to emphasise that the process is not static: several of the suggested steps and processes will overlap. Therefore the proposed framework provides a roadmap with many critical activities and considerations for the process of developing a technology strategy.

The final phase in the TSF is to determine the success of the technology strategy.

4.4 Phase 3: Evaluation process

If the outcome of testing the fit of the technology with the business strategy is positive, the SM/FM can proceed with the planning and implementation phase. If the outcome is

negative, then the process must start again from the beginning, as this will mean that the business strategy and technology are not aligned. The success of the technology strategy will be evaluated by measuring whether it resulted in certain benefits. The SM/FM must evaluate whether the application of technology has led to one or more of the following:

- more unique products designed and manufactured;
- more consistent quality;
- market share increase;
- reduced production times;
- overall cost reduction;
- better after-sales service;
- improved innovation in products and services;
- greater flexibility;
- improved deliveries to customers;
- productivity improvement; and
- inventory reduction.

The technology strategy must also be evaluated to determine whether success was achieved in one or more of the following:

- improving overall competitiveness and productivity;
- improving sales turnover;
- increasing number of customers;
- increasing market share;
- increasing annual growth;
- adding value to products so that higher prices relative to those of its competitors can be commanded;
- solving specific manufacturing problems that allow it to cut costs;
- improving overall quality; and
- improving the overall working environment.

Evaluation and monitoring is a constant dynamic process. If the objectives listed above are not reached, then the technology strategy is not successful, and corrective steps must be taken.

5. FINDINGS

In this study, the findings of the literature study led to the development of the proposed technology-strategy framework, as illustrated in Figures 1, 2, and 3. The quantitative investigation of this study centred on certain aspects of the proposed technology-strategy framework [60]. Since the purpose of the qualitative approach was to triangulate quantitative findings, the qualitative-conceptual framework was based on the proposed technology-strategy framework and the quantitative hypothesis. The qualitative investigation intended to confirm, or better understand, the quantitative findings [60].

This study confirms a significant association between competitiveness (measured by business performance and technology-competitive advantage) and technology.

This study found a strong association between business strategy, technology application, technology purchasing strategy, technology information sourcing, and competitiveness (as measured by business performance and technology-competitive advantage) [60].

The results indicate a strong association between technology application and technology-related benefits. The results imply that the higher the technology level, the more significant the benefits to the business [60].

The study found that the SM/FMs perceived that they were mostly successful in producing unique products of consistent quality while meeting their delivery schedules and successfully decreasing inventory levels. Furthermore, the study found the sample to be

successful in providing efficient after-sales service, being flexible in meeting customer demands, and improving innovation of products and service. They felt least successful in reducing cost and production times owing to the relatively low-technology application level. This study found that not all SM/FMs actively plan for technology acquisition and implementation [60].

This study contributes to the body of knowledge that encompasses approaches to improving competitiveness in the small- to medium-sized furniture manufacturing industry, including how to identify, forecast, integrate, and evaluate technology and business strategy [60].

6. CONCLUDING REMARKS

This article presents the proposed TSF, and is a culmination of the findings of a literature research study. The article also examines the proposed TSF by discussing and explaining the process that a SM/FM can follow to develop a technology strategy to improve competitiveness.

The process takes into account the business strategy of the SM/FM, internal- and external-technology audits, the process of selecting the technology that fits the business and business strategy, and evaluating the success of the technology strategy. The selected business strategy is considered throughout the technology strategy development process, because the technology strategy is based on the business strategy, and the technology must facilitate achievement of the business strategy. This interdependence is evident in the first step of the process that identifies the business strategy, and the last step of the technology-acquisition process, which links the potential uses and benefits of the considered technology application back to the business strategy.

The framework described in this article makes provision for all relevant and important considerations by suggesting in-depth internal and external technology-related audits. This allows the SM/FM to scan and monitor current technology, forecast future technology, and compare it with its current technology situation. The framework also specifies several pertinent technology-acquisition considerations that will assist in decision-making. The final step in the process is to evaluate the success of the technology strategy by evaluating the benefits of the technology acquisition. It is important to recognise that the process is not static, since several of the suggested steps and processes will overlap. Monitoring and evaluating is also a continuous activity to ensure that the technology strategy is implemented as planned. The proposed TSF provides a roadmap with many critical activities and considerations for the process of developing a technology strategy.

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