

## A SYSTEMS THINKING CONCEPTUAL MODEL FOR VALUE CREATION IN THE AFRICAN CEMENT MARKET

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### ABSTRACT

Cement is the world's most important building material, and it has made Africa, as an emerging market, dependent on the cement industry as a critical tool to promote economic infrastructure growth. Today's challenging economic climate has also made cement producers increasingly dependent on specialists to upgrade, modernise, and maintain their operations. The objective of this research was to evaluate how engineering service organisations operating in Africa currently conduct their business with these cement producers. The research also showed that the literature on systems engineering does not make full use of value engineering concepts. The study identified this lack of collaboration, and proposed a new value engineering systems model that can be used to promote and strengthen the use of engineering services and products in the African cement industry.

### OPSOMMING

Sement is die wêreld se belangrikste boumateriaal, en dit het Afrika, as 'n opkomende mark, afhanklik gemaak van die sementbedryf as 'n kritieke instrument om ekonomiese infrastruktuurgroei te bevorder. Vandag se uitdagende ekonomiese klimaat het sementprodusente ook toenemend afhanklik gemaak van spesialiste om hul bedrywighede op te gradeer, te moderniseer en in stand te hou. Die doel van hierdie navorsing is om te evalueer hoe ingenieursdiensorganisasies wat in Afrika werkzaam is tans hul sake met hierdie sementprodusente bedryf. Die navorsing toon dat die literatuur oor stelsel ingenieurswese nie ten volle gebruik maak van waarde-ingenieurskonsepte nie. Die studie het hierdie gebrek aan samewerking identifiseer en 'n nuwe waarde-ingenieursstelselmodel voorgestel wat gebruik kan word om die gebruik van ingenieursdienste en -produkte in die Afrika-sementbedryf te bevorder en te versterk.

## 1 INTRODUCTION

Cement is the most broadly used manufactured material worldwide, with an annual estimated global production of about 10 billion tons [1]. The demand for cement is expected to increase substantially, from 4.6 Gt/yr in 2015 to between 6 and 13.5 Gt/yr by 2050 [2]. The cement market size globally is expected to reach US\$682.4 billion by 2025 and, according to the latest report by Grand View Research [3], it will grow at a compound annual rate of 7.85% during this forecast period. Grand View Research [3] anticipates that the market will experience rapid growth in the near future, mainly owing to growing infrastructural development projects around the world. Concrete as a building material is relatively affordable, and can be made anywhere in the world that is accessible by road, rail, or ship. Concrete has become indispensable for building infrastructure, and is the trigger of global networking and a lifeline for local development. Concrete has always been very important for creating adequate housing that provides safety and shelter, while letting the population take part in the growth and wealth of their economies. For this reason it creates a foundation for future perspectives and an acceptable life, which significantly contributes to the reduction of global social problems such as health-related issues, migration, or social unrest. This makes cement and concrete technologies essential globally, while gradually having a more significant role in the development of economies.

Africa is currently the third-largest continent in population and land mass, despite its often-mismanaged economies. The continent offers continuous unexploited business opportunities for corporations, institutions, and entrepreneurs globally [4]. The fast-growing population of Africa and its economies offer significant opportunities for organisations in a slowing global growth environment [5]. Some of the world's fastest-growing economies are also found in Africa, and are attracting the interest of the economic community globally [6]. The number of new cement plant installations is increasing at a dramatic pace across Africa and, in addition, more cement will continue to be imported into the continent from countries such as Indonesia, China, Pakistan, and Turkey as a result of overcapacities in those countries [2]. These developments are creating an attractive potential for possible investors, and also giving rise to numerous challenges to be navigated. According to the African Development Bank Group [7], the continent was in a generally good state.

During December 2019, the 2019 novel coronavirus (COVID-19) was first discovered in Wuhan in the Hubei Province of China, and it has since developed into a global pandemic with a far-reaching impact [8]. COVID-19 has had an impact on Africa, but it has thus far been less severe than in many other parts of the world [9]. Cemnet [9] adds that this could be partly due to the young average age of Africans: only 3% of the total population in sub-Saharan Africa is over 65, which reduces exposure to the pandemic and thus the impact on health. The African economic growth rate steadied at 3.2% for 2019, and was forecast to increase to 3.6% in 2020 and 4.2% in 2021. However, economic growth has been negatively impacted by the COVID-19 pandemic, with a real -3.4% growth rate in 2020, and it was expected to recover again to 3% in 2021 [7]. It is difficult to anticipate how the virus will ultimately affect Africa and the world, but some research sources predict accelerated turmoil and weaker markets overall. Because it is unclear how the global spread of COVID-19 will impact the world in the future, it will not be discussed further in this study.

Currently, various countries on the continent are thriving at a steady and increasing rate. This development may cause global cement production to increase by 25% until 2030 [2]. Together with this improved economic situation come various activities in the construction sector. The numerous challenges that come with infrastructure development can only be solved by using concrete and cement as construction material [2]. The population of cities in this region is expected to double within the next 25 years owing to rapid urbanisation, and with it the rising hopes for innovation, productivity, and economic diversification that such trends have brought to other continents [10]. With this growing market, the continent also faces some clear challenges. These differ from region to region, but they mainly include the following [11]:

- Rising fuel prices
- Increasing emissions regulations
- Lack of access to experienced employees
- Political instability in some regions
- Increased market competition
- Barriers to entry
- Unpredictable consumer behaviours and consumer patterns

Africa also has excellent potential as a context for management research, and more conceptual and empirical work is required to describe the richness of the opportunities on the continent and to solve the numerous challenges raised by these opportunities [12]. From an institutional perspective, Africa appears to be a fertile ground to test and enhance new and existing institutional theories [13]. For this to happen, institutions in Africa need to be the leading experts on local problems and also be the primary sources of research solutions to these local problems [14]. The African continent should also involve managers and leaders of business in attaining and maintaining real corporate growth and development, while striving for effectiveness, global presence, and sustainable organisational competitiveness [13]. Zoogah, Peng and Woldu [13] add that research in the management field has made substantial progress in introducing new business models around the world. In comparison, companies in Africa have remained the missing link in the exploitation and application of these potential models. This study argues that business models and developed management research focusing on Africa might be necessary to help solve the organisational issues related to effectiveness and efficiency on the continent. This study therefore aims to contribute to the body of engineering and technology management theory by proposing a suitable business model or process for targeting the cement manufacturing industry.

## 2 HISTORICAL DEVELOPMENT AND FUTURE FORECAST FOR THE AFRICAN CEMENT MARKET

Cement as a commodity is relatively low in value and high in weight, and can typically cost up to 30% of the product price to transport by land. Owing to its weight, supplying cement is ideally limited to an area within a 50km radius of any plant site, but it can be delivered beyond a 300km radius in special circumstances. However, notwithstanding the localised nature of the industry, cement producers in the different countries in the region are able to export surplus cement to their neighbours [15]. The Dangote Group is set to become one of the leading clinker exporters in the world by exporting clinker from its terminal in Nigeria to various African countries [16]. In the same way, Whale Rock Cement in Namibia and numerous South African cement producers are exporting to countries in Africa [17]. The competitive interaction between cement manufacturing firms that happens in geographic markets depends on where production is located, the location of the primary consumption, and logistical infrastructure costs [15].

The number of cement plants in Africa at the end of 2015 was 181, with an additional 10 new greenfields cement plant projects underway [18]. These 10 greenfields projects would have taken two to four years until they could start production, leading to an estimated population of 191 cement plants in Africa by the end of 2019. The five largest producers of cement in Africa are Nigeria, South Africa, Ethiopia, Kenya, and Senegal. The leaders of Africa, their countries' policy makers, and their international allies should all understand and focus on economic transformation as a primary tool to reduce poverty and promote sustainable development [19]. This has been communicated in the African Union's (AU) Agenda 2063. Given the smaller size of most national markets and the large number of landlocked countries in Africa, boosting regional integration is also a key objective for the continent through infrastructure investments, trade facilitation, and free trade areas. Regional integration and industrialisation are both priorities for the African Development Bank, with a ready acceptance that the continent's economies need to encourage diversification and move away from exporting raw commodities to value-addition and processing. According to the African Union Commission [19], these five priority areas will boost cement use in the region through infrastructure development projects.

The African continent's cement industry is largely dominated by four multinational companies: Dangote, PPC, Heidelberg, and LafargeHolcim [20]. In Southern, West, and East Africa, local cement industries were acquired by global manufacturers such as LafargeHolcim from France, while Pretoria Portland Cement from Southern Africa and the Dangote Group from Nigeria have become progressively important players in the African cement industry [21]. While Heidelberg's operations are concentrated in West and Central Africa [20], Afrisam has operations in South Africa, Lesotho, Botswana, Tanzania, and Swaziland [21]. This has been changing somewhat with the entry of Dangote Cement of Nigeria in 2000 and its expansion into fourteen other African countries to become the single largest continental producer [22]. The continent has tremendous business potential in various sectors, including natural resources, infrastructure, energy, agriculture, information, and communications, offering great opportunities for entrepreneurs [23]. The continent also offers opportunities for entrepreneurs in the mining sector, as it has the world's biggest reserves of aluminium, chromium, manganese, gold, diamonds, vanadium, platinum, phosphate, and cobalt.

In summary, the forecast outlook for Africa is positive, as the per capita cement consumption should trend in a positive direction, mainly supported by strong gross domestic product growth. Urbanisation and population growth are the main contributors to the increased demand for cement. Ultimately, the demand for commercial and housing building infrastructure will drive consumption in the region. Despite the troublesome outlook mentioned above, it was expected that cement consumption in sub-Saharan Africa would grow by a compound annual growth rate (CAGR) of 7.2% between 2010 and 2017, compared with the total global average of 2.7%. Historically there has been massive under-investment in African countries, which has caused a trend of governments trying to close all the infrastructure gaps. Countries such as Kenya, Tanzania, Ethiopia, and Rwanda all featured in the Africa Development Bank's index of ten fastest growing-economies in 2019. The importance of cement in today's society – and especially in emerging markets such as Africa – makes this industry important for current and future research. Seeing that each country in Africa differs in economic size, growth rate, cement dependency, cement industry size, and challenges, companies end up reinventing the wheel when starting operations in the region. The unique and diverse nature of Africa raises the need for a systems model to assist businesses operating in Africa. This study intends to propose a model that an organisation operating in this region could use to market and sell its engineering products and services to companies in the cement industry. Systems thinking and value engineering as primary elements for the proposed conceptual model are discussed in more detail in the next section.

### 3 SYSTEMS THINKING AND VALUE ENGINEERING

Abundant literature sources are available in the fields of both systems thinking and value engineering pertaining to the global market – and, more importantly for this study, to the African market. The literature indicates that systems thinking presents various viewpoints and concepts, many of which are very different from one another. This research reviewed various literature sources, and identified the following coherent definition that can be used going forward. Systems thinking is, first, a perspective that recognises systems as a collection of various necessary and interrelated components in which the relationships between them are as important as the components themselves. Second, systems thinking is a language that is centred on the iceberg model, which includes system dynamics, emergence, causal loops, and unintended consequences. Systems thinking is, last, a collection of tools comprising systemic root cause analysis, interpretive structural modelling, system dynamics/ computer modelling, main chain infrastructures, and behaviour over time graphs, stock and flow diagrams, causal loops with feedback and delays, archetypes, and systemigrams.

With all of these tools being available, it is apparent that systems thinking offers a great deal of value and power. Systems thinking can be used for solving complex problems that normally are not easily solved by the conventional approach of reductionist thinking, as systems thinking looks at the relationships between the system's components and at the individual components. It creates a focus for the properties of the whole system, which is seen as being neither predictable nor attributable to the properties of each of its components. It can also be used to understand complex socio-economic problems, predict behaviours, and identify leverage points. What makes systems thinking valuable for the model proposed in this study is that it can be used to understand and explain the illogical behaviours of countries, organisations, and individuals.

Value engineering, as described by Sharma and Srivastava [24], is the systematic application of known techniques by a multi-disciplinary team that lists the functions of a service or product; determines a value for these functions; uses creative thinking to generate alternatives; and reliably provides the needed functions at the lowest overall cost. Value engineering is essential to improving the functionality of a project and to creating significant cost savings throughout the complete life cycle of a product or service [25]. This service or product cost reduction is a result of the special attention that was given to it to improve the methods of production/service delivery, standardisation, and simplification. Value engineering creates quality and cost consciousness in the organisation, and helps the company's employees to understand their functions better. Value engineering also assists management with the task-specific expenditure for the services and products under investigation. Value engineering ultimately holds substantial potential for companies that are investigating the reduction of their service and product costs with a focus on targeting a unique market such as Africa.

In conclusion, both of these fields of study hold potential for organisations. The literature study reveals that there are very few or no linkages between systems thinking and value engineering in the literature. This distinct disconnect in the literature indicates that there could be an opportunity to combine the concepts. Doing so, and managing the risks through a good risk management tool, could have tremendous potential for an organisation that is focusing on expanding its business. In the next section, this research proposes a novel conceptual model that can be used to combine both concepts, and discusses it in more detail.

## 4 THEORETICAL MODEL USED

### 4.1 Introduction

The initial idea for this conceptual model came from the need for a process or model to assist with the diffusion of engineering products and services to the African cement industry. The author of this research study found that there was no clear way of selling these market-specific products and services to the industry. The initial investigation for such a model revealed way to creating a simplified three-stage model, but after completing a literature review and market-related research [26], it evolved into a more intelligent model, as shown in Figure 1. Owing to the unique market challenges and diverse market conditions in Africa, it is recommended that a micro-marketing strategy be implemented for individual markets. The considerable risks of doing business in Africa justified the use of a risk management system in the proposed model. By implementing a causal loop/policy structure diagram in the standard value engineering work plan shown in Figure 1, an organisation can create a model with continuous feedback loops for information that could improve product, service, logistical, and marketing costs that are tailored to a specific market. Mapping the possible intended and unintended consequences of actions in the proposed causal loop

diagrams can help the user to anticipate and address various problems before they arise. This model also takes into account the unique challenges of the African market. The different model stages have been linked and motivated using references from the literature. The individual stages are explained in more detail in the next section.

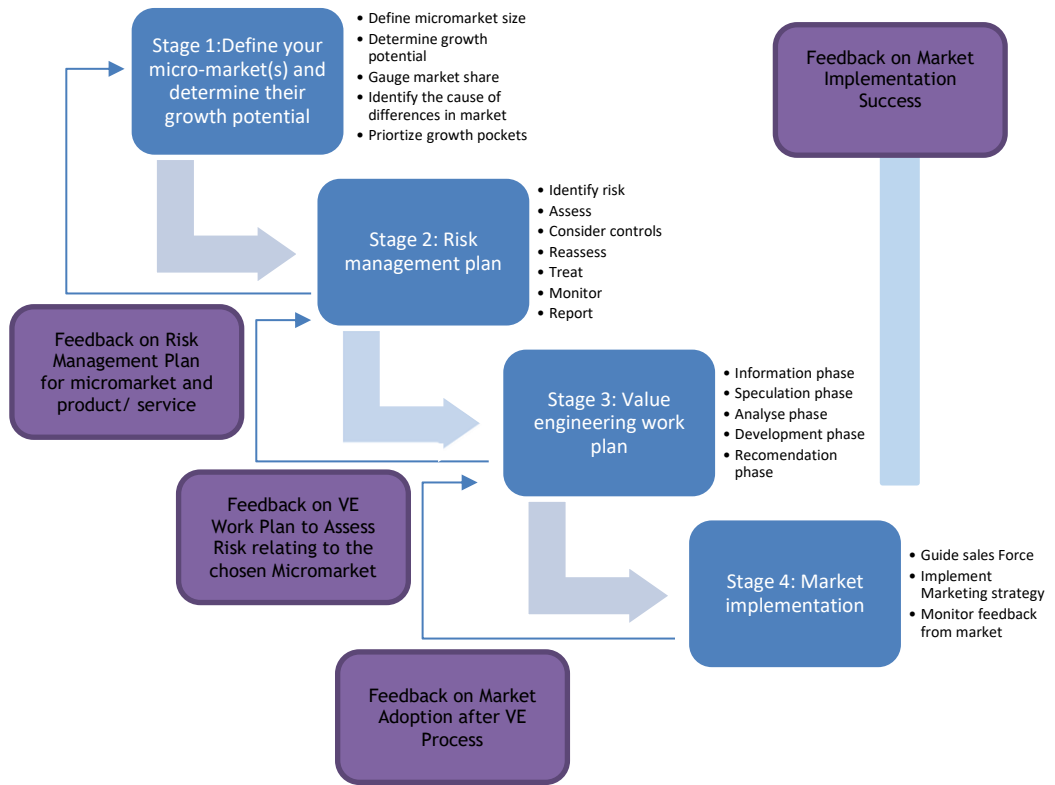


Figure 1: Proposed new value engineering systems model

#### 4.2 Proposed conceptual model explained

The model follows a four-stage process flow, consisting of the steps below: define the micro-markets and determine their growth potential; the risk management plan; the value engineering work plan; and the market implementation stage. Value engineering is included in the model under Stage 3, and is divided into five sub-phases. The four stages are then supported by using the systems thinking tool – feedback loops – after each stage in order to improve the overall quality of the process and the model’s end result. The four stages are now discussed in more detail.

##### Stage 1: Define the micro-markets and determine their growth potential

The unique market challenges and the diversity of market conditions in Africa motivated the use of a micro-marketing approach to define the risk context. Few academic sources motivate the use of a micro-marketing approach when operating in various African industries. There are, however, various sources that describe the unique and micro-market nature of the African continent, comprising countries with a significant proportion of micro-enterprises and diverse population groups. The first step in following a micro-market strategy is to create an opportunity map of potentially lucrative hot spots [27].

- Define the micro-market’s size: The optimal micro-market size needs to be determined. Identify the points at which a market dynamics shift should be identified. This can be seen as the boundary where the customer density changes, or where the competitor’s market area limits are set.
- Determine growth potential: One needs to check what drives the customers, as this will help to gauge the growth potential in that micro-market. Determine to what degree each driver influences customers’ purchases.

- Gauge market share: Make use of sales data to determine the market share for each potential micro-market.
- Identify the causes of differences in market share: One needs to establish what accounts for the differences in the micro-market share. One also needs to collect external and internal data on the sales and marketing activities that could impact the market share.
- Prioritise growth pockets: Top-down guidelines for the approach should be developed by senior management.

### **Stage 2: Risk management plan**

Risk management aims to find an efficient balance between minimising vulnerabilities and losses and realising opportunities for gains. Risk management plays an important role in the organisational strategy of a company. A study by Taran, Boer and Lindgren [28] supports the proposal that risk management implementation throughout the innovation process aids risk reduction related to the complexity and uncertainty of developing and applying a new business model. In the proposed model, the risk management process consists of the following seven stages:

- Identify risk: The different tools available in the literature are used to identify the risk.
- Assess: Assess the identified risk in terms of its impact and the likelihood of it happening.
- Consider controls: Identify the controls, including actions that would help to minimise the risk.
- Reassess: Reassess the impact and likelihood, using the same matrices as for inherent exposure. It can help one to decide which risks are the most important, and to prioritise and plan actions.
- Treat the risk: The type and level of treatment needs to be planned for each risk, and will vary.
- Monitor: The identified risk needs to be monitored while it is being addressed to ensure that action plans are working in a changing environment.
- Report: The risk register is used to record the risks, threats, and opportunities in each process stage, and to provide an on-going action plan that is used to address the risks.

### **Stage 3: Value engineering work plan**

Value engineering is used in this model essentially to solve problems and eliminate unwanted costs, while at the same time improving quality and function. The literature uses both risk management techniques and value engineering in various industries such as the construction, corporate, and energy sectors. Integrating both approaches creates a clear link to achieving the project's objectives in terms of cost, quality, and time [29]. Sabzkohi and Pourrostan [30] state that combining value engineering and risk management in a business model could eliminate contradictions and ambiguities and promote a common language for understanding in teams, and help to achieve the project objectives. The value engineering work plan consists of five phases:

- Information phase: Decide on a desired product or service that needs to be sold into the market. Evaluate the functions of the item that could yield the biggest potential for eliminating unwanted costs.
- Speculation phase: This phase generates various alternative methods of achieving the same functions. This process can make use of several techniques, including brainstorming. Then market knowledge should be used to influence the ideas generation process by looking at product and service preferences in the market.
- Analysis phase: The alternatives generated in the preceding phase should now be evaluated, and the best cost-saving alternative should be selected. Make use of the customer knowledge to identify which alternative would yield the best cost saving.
- Development phase: At this point, a small number of ranked alternatives that have been identified are moved forward to be developed. These selections are expanded with more detail so that an improved evaluation of the implementation, cost, and performance can be made.
- Recommendation phase: In this final phase, a comprehensive proposal is made to top management. It is crucial that the correct effort is made in this phase, as all the work of the previous phases could be undone if the proposal were not presented effectively. If management does not approve the proposal, the company should go back to the speculative phase.

### **Stage 4: Market implementation**

The marketing strategy establishes tangible and solid goals, thus helping an organisation to understand the customer and target markets in question, while at the same time serving as a strong foundation for future communication campaigns. The creation and effective implementation of the marketing strategy can make the difference between a business swimming and sinking [31]. Good marketing strategies do not necessarily lead to successful marketing performance by an organisation: much depends on how the marketing people translate the strategy into action [32]. The successful implementation of marketing strategies is the most important managerial aspect in the strategic marketing process [33]. Successful market implementation rests on three steps: guiding the sales force, implementing the market strategy, and monitoring the feedback from the market. These steps are discussed below.

1. Guiding the sales force: The organisation should start by identifying groups of micro-markets that share similar characteristics. Marketing managers should develop a strategy for each peer group, as it is the best way to sell into that market or set of customers. This includes guidance on pricing, tailored collateral materials, and market communications. The sales training has to be experiential in order for the micro-market to succeed. Opportunity maps should be used by the sales personnel to help reveal 'hot or 'cool' micro-markets, and then test their instincts against reliable data. The sales representatives will require special coaching on specific pitches.
2. Implementing the marketing strategy consists of eight steps:
  - Set the right expectations: Marketing takes a lot of hard work and input at first to lay a good foundation, but once this has been done, one starts to see the momentum building and, in time, achieving what is required in the business.
  - Building the team and securing resources: It is important to decide who and what resources will be part of one's marketing implementation team. This can include employees at the company, such as personnel from the customer service department, sales team department, or marketing department.
  - Communicate the plan: In order to understand the goals that have been set, it is important to communicate the marketing strategy successfully, once the marketing team has been established.
  - Build a timeline and tasks: A detailed project timeline should form part of the marketing strategy. It can be very helpful to use project management software when implementing this.
  - Monitor and check-in regularly: As soon as one establishes the measurement dashboard, it should be easy to plug in the required information as required. In doing so it will help one to measure easily the temperature of the marketing efforts.
3. Monitor feedback from the market: After implementing a marketing strategy it should be monitored to see whether it is successful or requires any changes to the strategy.

## 5 CONCLUSION

The process and the conceptual model described in this paper aim to identify potential markets and their opportunities correctly, and to align these opportunities with the organisation's goals. Risks would be identified early on in the product and service life cycle, thus minimising the vulnerabilities and losses. By following a value engineering approach in the process, costs can be optimised to match the market's need for the company's products and services in order to implement a competitive market strategy. With various feedback loops in the system, the process can be adapted to improve efficiency and costs. This model also takes into consideration the unique challenges identified in the African market, and can be used to check potential overall risks.

The following benefits and advantages have also been identified if the model were to be implemented:

- Identifying markets that suit the organisation's objectives.
- Delivering added value by enhancing the market and organisational fit.
- Taking advantage of the micro-market approach.
- Adapting to market changes early on in the product/service life cycle.
- Reducing product and service costs, as the majority of African countries are cost-sensitive in respect of products and services.
- The feedback loops aim to cut costs caused by rework, delays, and changes.
- Reducing unproductive tension by reducing start-up delays, and planning around technical design and delivery.
- Management provides guidance and practical advice to employees during the evaluation work plan process.

- Market factors are taken into account during the value engineering process.
- The process is more robust owing to the real-world nature of the model.
- Each unique product and service can have its own model for selling into a specific market. This allows for tailored product- and service-specific marketing strategies.
- Market- and client-specific challenges are identified early in the process, thus reducing organisational costs.
- Getting value for money by allocating the risks to a party that can manage it more effectively.
- Providing an understanding of the target customers and markets.
- Reducing the risks associated with market uncertainty and complexity.
- Allowing for feedback monitoring from the market after implementation of the business plan.

The unique nature of the proposed new value engineering systems model, with its focus on the African market, could have great benefit for the industry as a whole, and not just the cement manufacturing industry. Owing to the large size and diversity of the industries operating in Africa, one would implement the proposed model only in the African cement manufacturing industry to see whether it could add value to this specific industry. The success of this model would ultimately be determined by management, which has to communicate clear expectations of and goals for this model, and to provide their staff with the required resources to help the organisation to achieve its goals. This approach could also be the focus of future research efforts in this context.

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