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A systems dynamics approach to SME digitalization

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Abstract

In the current global scenario Small and Medium Enterprises (SME's) contribute to the GDP of nations through employment opportunity, productivity and growth. The small and medium business space is a challenge to operate, more especially in these times of COVID-19. The world of digital delivers opportunities for optimization in order to survive these challenges. The South African situation runs parallel to these observations despite formidable support from stakeholders in creation of "Innovation hubs" and other mechanisms to ameliorate. This calls for a close investigation of smart business solution enabled digitally to address the needs of the enterprise and provide support. This article aims to explore System Dynamics (SD) modelling to provide strategic business support to small business. The research presents an approach to SME support comprising skills development and digitalization as applied through an innovation hub. The SD model is adopted to simulate the impact to an SME's development.

Keywords: SME (Small and Medium enterprise); stock and flow diagram; business solution; system dynamics (SD)

1. Introduction

Global economic projections by IMF indicate GDP of 3.3% for 2020 [1] compared to 3.6% in 2018. Regionally, only Sub-Saharan Africa, as well as South and Central America are in progressive front towards accelerated growth in 2019 compared to 2018. The growth projection in Sub-Saharan Africa has been moderate with 3.7% in 2018, 3.5% in 2019 and 3.5% in 2020 [2]. Growth prospects for the South African economy are expected to gradually improve over the three-year outlook period projecting to 3.2% by 2022. After a dismal performance in 2018 it has been a

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serious economic problem in 2019 with many sectors trailing in growth. Despite escalating unemployment rate in South Africa, the potential for economic growth is enormous owing to youth workforce, demographic dividend coupled with technological advancements. National Development Plan, recent Jobs Summit and the Youth Employment Service (YES) have stressed the need for enterprise development and entrepreneurship. This is a crucial factor to catalyse economic growth. World Economic Forum on Africa held at Cape Town introduced programs to promote sustainability to Africa's entrepreneurs and start-up enterprises to become internationally competitive [3].

In South Africa the role of SME is critical as per the government's National Development Plan 2030 with scope for employment and drivers of growth [4]. The young and vulnerable enterprise in a survey show revenue generation of R200, 000 annually (71%) whilst 20% of SMEs generate between R200, 000 and R1-million. Globally, 95% of enterprises are small and medium-sized businesses and provide 60-70% employment, meaning the trend remains constant irrespective of economic health of the nation. Despite promise, SMEs are faced with challenges owing to financing, administrative burden, talent acquisition and retention, shortage of key technologies and management skills, access to finance, insufficient digital infrastructure and efficiency pressures (time) [5-7]. Innovation, skills of the future with special emphasis on digitalisation are the derived levers for growth. SMEs in South Africa suffer due to lack of access to finance and markets, insufficient digital infrastructure, pervasive shortage of digital skills, inefficient bureaucracy [8-10]. In SA skills development is a strategic government centred initiative, delivered via the Sector Education, Training Authorities (SETA's).

The models to support the SME are innovation hubs and business incubator program with South Africa adopting the latter, as of 2016, the GSMA Ecosystem Accelerator suggested there are 314 active tech hubs in Africa. The insight is, hub integrates the stakeholders for productivity but the reality is that "no more than 50% of SMEs survive the first five years from commencement" [11]. The focus being sustainability of SME through digitalisation and plausible business support, the article attempts to gather insight from the literature and articulate the enablers and barriers (variables) from this knowledge. An initial investigation with few variables is set to constitute the arguments of this article through an SD approach. The prime objective is to provide a sustainable business support with a good business plan as the fundamental, which is digitally enabled. This enables the SMEs to plan resources and manage operations. The entire scheme revolves around how digitalization, impacts business process. The concern is specific to the knowledge base to train and tune the resources in response to skills in need for 4IR. This is apart from the conventional skill requirements.

2. Role of digitalization and business model in SME growth

SMEs are key players in job creation and boosting the economy. The World Economic Forum [12] survey points to lack of business skills training at educational institutes as one of the obstacles limiting entrepreneurship potential. In current context volatile market with growing demand due to customer centric objectives in service industry, strong supply chain management with robust technology is imminent. Social networking and drivers of 4IR have contributed to services and products. Five digital trends that possibly govern the future work culture for SMEs [13] are:

- Businesses tend to operate online.
- Usage of Chat bots will be crucial.
- Businesses are adjusting according to millennials.
- Social media will reign the business operations of SMEs.
- Adoption of cloud technology

This demands a strong business strategy to enable SMEs at different phases of business metamorphosis through a smart business solution protocol powered by interpenetrating digital applications for profitable venture. In principle the requirement of Business Model (BM) to attract professional investors and start-up competitions are well documented [14] and hence becomes a minimum document, an institutionalized activity for any novel entrepreneur [15]. A business model is most commonly considered as a structured and analytical model that defines the logic "by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" [16]. Reference [17], have demonstrated a theoretical contribution to understand the effect of digitalization in the context of BMI (Business Model Innovation). The idea is to stimulate SMEs to use IT, big data and social media

as a means for practicing more on BM experimentations as well as implementing new strategies in their ventures towards digitalization.

The BM carries a specific configuration of interrelated components [18-21]. The components are the enterprise value proposition, the value chain, the sector, the value capture mechanisms and the thread of interrelationship but also the connection with external environment. Feedback and circular causality are imposed by these links to the BM [22-23] and cause non-trivial dynamic behavior. The business process model enables simulation of operation in practical day-to-day situation. The concept of transforming the inputs into desired outputs via series of activities are prescribed by the business process [24] and are governed by management policies which specify a process operated over time. Evaluation of business process through a validated process model (simulation) helps to arrive at outcomes through what-if analysis and to improve process design through re-engineering. Simulation of the business process are achieved using business process flow charting, discrete event simulation model and system dynamics. SD is a computational approach to enhance analysis and decision-making in complex systems [25].

3. Methodology

A literature survey is conducted to ascertain the status of SMEs in South Africa (SA). It is evident SMEs have enormous potential is contribute to nations GDP. The SA SME poor performance are detailed in a thesis [26] which delineates lack of skill, digitalization, finance, resource, infrastructure, quality, market sense, corruption and above all business strategy. With this information a list of enablers and barriers are chosen which forms the basis of our investigation and to estimate the effect of digitalization on SME's. The key objective is to simulate the impact of variables so as to inform business strategies of SME's. Reference [27] have qualitatively arrived at the internal factors affecting digital transformation of SMEs as capabilities fit, resources fit and factors related to changes in the business model.

Table 1. Enablers and barriers to support SME business process.

Barriers	Enablers
Lack of idea/Innovation	Smart business solution
Lack of entrepreneurship attitude	Innovation, R&D
Lack of know-how, R&D	Regulatory affairs, QA,QC
Lack of finance	Marketing strategy (scan, update etc.)
Lack of resource	Social networking
Lack of infrastructure	Ease and choice of technology
Lack of skill (technical, digital)	HR –Talent acquisition and retention
Change in economic and non-economic environment.	Finance knowledge (venture capital etc.)
Difficulty in entering supply-chain cycle	Digital platform for process and production
Administrative barrier	Training
Brain drain	Partnership
Lack marketing sense	IPR
	Quality HE
	Tax incentive mechanism

System Dynamics (SD) approach is employed to understand the "cause and effect" relationship between the variables and to arrive at stock and flow diagrams to manage simulation of the system. The concept gains strength by supporting business planning and decision making [28]. The entrepreneurs have the liberty to test alternate scenario and find what "might have happened" – or "what could happen" – under variety of conditions and decisions. The structures of the model are realized through relevant variables which evolves the "behavior" of the system over time. The feedback loops are central to observe the dynamics of these model and their interactions explains the system behavior. System dynamics provides visualization of complex interaction amongst variables (feedback loops) and

provides information about "cause and effect" relationship. This implies a variable (keeping conditions constant), influences another variable: positively (i.e. an increase of the one corresponds to an increase of the other, and vice versa); negatively (i.e. an increase of the one corresponds to a decrease of the other, and vice versa); and are non-linearly correlated. The variables chosen for investigation for this study are furnished in Table 2.

Table 2. Description of variables chosen in the study.

Variable	Description
SME-Sustainability (Key Goal)	An accumulator /stock defined as function of productivity, work force and finance towards business sustainability.
Finance	A stock of finance after transactions.
Productivity	Key measure of company performance which contribution to key goal.
Worker	Skilled: Resource to impact positively to productivity
	Unskilled: Resource to impact negatively to productivity
Labour Productivity factor	Denotes fraction of skilled and unskilled worker.
Marketing Cost	Money spent on marketing and promotion of product
Sales	Positive in-flow to finance.
Digitalisation cost	Cost on digital technology (internet, IT, technology in production, e-commerce, social networking platform etc.)
Business Strategy	Stock with contributions from process and activities towards sustainability.
Business performance	A flow variable governed by productivity, sales and digitalisation
Expenditure	Inbound finance flow to business strategy (allocation)

The objective relates to business practices implemented through proper management and enablers to arrive at a strong foundation, namely "Business Strategy" (BS). The strength, quality and compatibility of strategy evolves sustainability. An approach integrating the strategies and SD allows the entrepreneur to perform 'what-if' analyses, ascertain the dynamics of system, and enable planning. A simple, quick and elegant stock and flow diagram depicting the business support plan employing variables from Table 2 is shown in Figure 1. The BS provides the relationship of process and activities in the firm and is the key element towards sustainability. The value indicators productivity and sales, which carry quality and customer satisfaction as the value proposition of the model. A budget with allowance for digitalization, marketing, sales and talented resources with waste reduction justify the basics of best practice. Skilled labor and digitalization are the key enablers. Being central to the core theme, the BS integrates the production cycle, marketing and sales cycle with the defined finance for a sustainable SME support. The productivity cycle aims to address the impact of skills of the workforce towards performance and is expected to be influenced greatly by digitalization. Digital literacy of resources (including other skills) and digitalization of process and systems will be the holistic idea in moving towards 4IR. A market sensible sales through good marketing management houses

voluminous customer base promising ample growth. Waste management not only improves the productivity but gains prominence in chemical industry from a disposal and environmental perspective.

4. Results

4.1. SD modelling

An approach integrating the strategies and SD allows the entrepreneur to perform 'what-if' analyses, ascertain the dynamics of system, and enable planning. A simple, quick and elegant stock and flow diagram depicting the business support plan is shown in Figure 1. The BS provides the relationship of process and activities in the firm and is the key element towards sustainability. The value indicators productivity and sales, which carry quality and customer satisfaction as the value proposition of the model. A budget with allowance for digitalization, marketing, sales and talented resources with waste reduction justify the basics of best practice. Skilled labor and digitalization are the key enablers. Being central to the core theme the BS integrates the production cycle, marketing and sales cycle with the defined finance for a sustainable SME support. The productivity cycle aims to address the impact of skills of the workforce towards performance and is expected to be influenced greatly by digitalization. Digital literacy of resources (including other skills) and digitalization of process and systems will be the holistic idea in moving towards 4IR.A market sensible sales through good marketing management houses voluminous customer base promising ample growth. As the sales enhances, the productivity level improves and need for skilled workforce with suitable digital support becomes critical for sustainability. Waste management not only improves the productivity but gains prominence in chemical industry from a disposal and environmental perspective. The impact of productivity based on the skills of labour, sales, digitalization and waste contingency are manipulated using factors or indices namely labour productivity factor, sales index, digitalisation index and waste index respectively. The estimated operation cost is the current budget which varies according to business climate. A steady business performance leads to sustainability helps in combating any business uncertainties. The business strategy is a stock represented by business performance/expenditure, while the performance is a product of productivity, strategy and estimated cost over the waste contingency. Sustainability is described to directly vary with performance (Appendix).

The time frame for the study is 100 months with all the cost parameters assigned constants *Sales Index*, *Digital Index* being 0.05 and *Waste Index* kept at 0.1. The simulation is conducted with 10 workers in both skilled and unskilled categories with a *Labour Productivity Factor* of 0.7 implying 70% of the work force is skilled and is the base case of our simulation. Extreme condition runs are conducted to test the reliability of the model in the real situation, impact of digitalization and influence of waste producing activities on business performance and subsequently sustainability are depicted in Figure 1 and 2. Sales has a direct impact on production which influences performance and sustainability. Initiatives like e-commerce and e-marketing need digital literacy and digital infrastructure which raises the estimated operational cost but with a huge advantage.

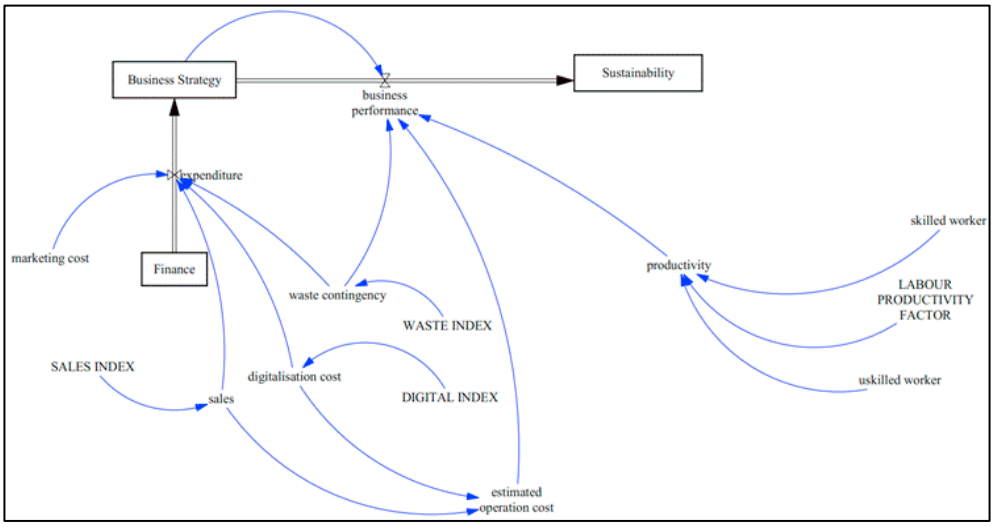

Fig. 1. Stock and flow diagram for SME sustainability.

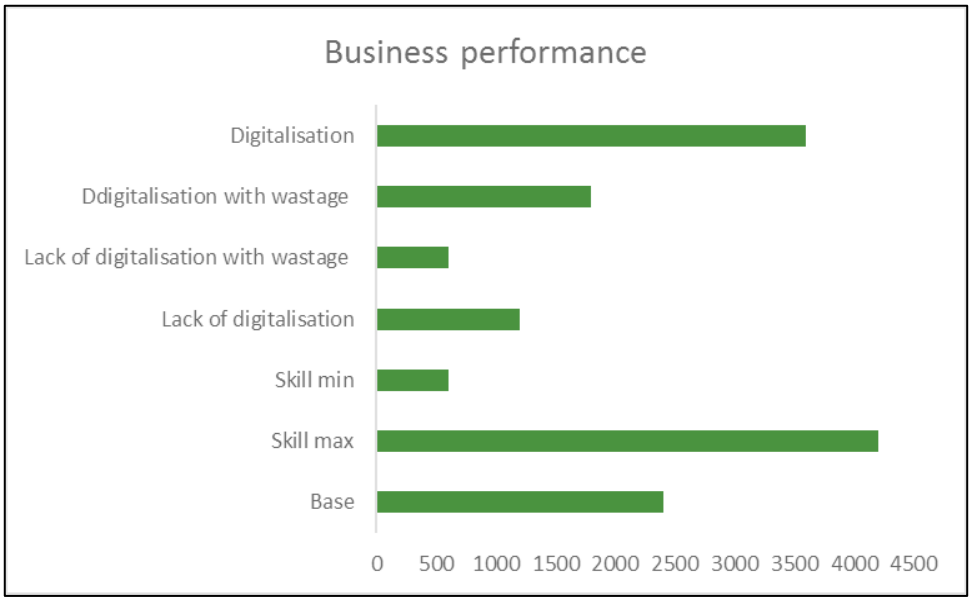

Fig. 2. Business performance over the time period

5. Discussion

5.1. Extreme condition test

The extreme condition test is performed to ascertain the credibility of the model in addressing the practical real world scenario. Hence, SyntheSim experiments conducted in Vensim by maintaining zero unskilled workers for “Skill max” and zero skilled workers for “Skill min” condition. Figure 2 which reflects the business growth pattern reveals the performance is at 600 units and 4200 units for case with exclusively unskilled or skilled workforce in contrast to the base case (2400 units) with equal numbers from the representative worker class. The sustainability profile is in agreement with this extreme observation which is practically a non-existent case hence the model is reliable. The base

case is taken as reference point with allowance to accommodate experienced, unskilled worker like trainees and skills across the firm with varying capacity.

5.2. Impact of Digitalisation

The impact of digitalisation on the sustainability model as depicted in Figure 1 and 2 are phenomenal leading to improvement in the performance compared to base case due to digitalisation. This effect is observed by doubling the *Digital Index* and conversely a firm with no digitalization (*Digital Index* =0) falls below the base case in performance and sustainability. A threefold enhancement in the business performance corroborates the need for digital enablement. The extant literature does stand in accordance with this simulation behavior.

5.3. Impact of Digitalisation and wastage

Improper management practices, improper time management, wastage of vital resources like energy, water, material and poor human resource management accounts for loss in sustainability. Efficient process control with right technology especially when the scale of operation is appreciable calls for automation to avoid these undesirable effects. Doubling of the waste index in case of an enterprise with and without digital adoption are attempted to understand the magnitude of impact. The impact pushes the performance below the base case and hence sustainability outcome.

6. Conclusion

The study aims to understand the status of SMEs in South African context. The literature scan reveals the series of factors that contribute to the failure of SMEs. Despite rigorous attempts to promote SMEs through various initiatives, further interventions are required. Reference [29] indicates a higher import participation by digitally connected SME's than non-digitally-connected SME's and the impact is pronounced compared to large firms in developing countries. The need for ICT as an enabler to achieve SDG's are laid by United Nation's Broadband Commission for Sustainable Development including "Industry, innovation and Infrastructure". Digitalisation brings about productivity, cost reduction and scope for innovation through new business models. The current study is based on enabling SMEs digitally with focus on productivity, finance and skills of workforce as the determinant factor. The impact of these factors on the business sustainability of SMEs are addressed. A generic approach adopted to realise the cause and effect relationship between variables. The study is in infancy and attempts to provide business solution to enhance business performance through best practices incorporated in its strategy to ensure sustainability. The simulation outcome indicates digitalization and skills of future are the key drivers to unlock the economy through business support to SMEs. The observation has been the central theme in many research reports. The model needs expansion to incorporate other elements which significantly contribute. The simulation lacks support from real data from SME to validate. This model serves to provide business support to SME's with key inputs from them to design a practical framework for sustainability

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Appendix

Table A1: SD model equations

(01) business performance=	(02) Business Strategy= INTEG (
0.2*Business Strategy*0.4*productivity*estimated operation cost/waste contingency	-business performance/expenditure,
Units: Year/(cost*cost)	10000)

(03) DIGITAL INDEX=	Units: Year/(cost*cost)
0.05	(04) digitalisation cost=
Units: Dmnl	10000*DIGITAL INDEX
(05) estimated operation cost=	Units: cost
sales+digitalisation cost	(06) expenditure=
Units: cost	digitalisation cost+sales+marketing cost+waste contingency
(07) FINAL TIME = 100	Units: cost
Units: Year	(08) Finance= INTEG (
The final time for the simulation.	-expenditure,
(09) INITIAL TIME = 0	1e+06)
Units: Year	Units: cost*Year
The initial time for the simulation.	(10) LABOUR PRODUCTIVITY FACTOR= 0.7
(11) marketing cost=10000	Units: Dmnl
Units: cost	(12) productivity= (skilledworker*LABOUR PRODUCTIVITY FACTOR*0.75+uskilledworker*(1-LABOUR PRODUCTIVITY FACTOR) *0.25)/ (skilled worker+uskilled worker)
(13) sales= 10000*SALES INDEX	Units: Dmnl
Units: cost	(14) SALES INDEX=
(15) SAVEPER =	0.05
TIME STEP	Units: Dmnl
Units: Year [0,?]	(16) skilled worker=10
The frequency with which output is stored.	Units: labour
(17) Sustainability= INTEG ((business performance) *0.2, 100)	(18) TIME STEP = 1
Units: Year/(cost*cost)	Units: Year [0,?]
(19) unskilled worker= 10	The time step for the simulation
Units: labour	(21) WASTE INDEX=0.1
(20) waste contingency= 1000*WASTE INDEX	Units: Dmnl
Units: cost	

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