AN EVALUATION OF THE EFFECTS OF THE FOURTH INDUSTRIAL REVOLUTION ON SALES GROWTH OF AQUACULTURE MSMEs IN LUSAKA PROVINCE OF ZAMBIA

BY

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EXAMINER

DEDICATION

I dedicate this thesis to my husband, Austin Muhyila, and children, Towera, Miyanda and Namusenga for their support and patience and to my entire family, friends and everyone who played a role towards making this work a success.

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LIST OF ABBREVIATIONS

7NDP	Seventh National Development Plan
8NDP	Eighth National Development Plan
AfDB	African Development Bank
BOZ	Bank of Zambia
CSO	Central Statistics Office
EBZ	Export Board of Zambia
ERP	Economic Recovery Programme
EU	European Union
FNDP	Fifth National Development Plan
FNDP	First National Development Plan
FNDP	Fourth National Development Plan
IFAD	International Fund for Agricultural Development
JICA	Japanese International Corporation Agency
M & E	Monitoring and Evaluation
MCTI	Ministry of Commerce, Trade and Industry
MCTI	Ministry of Commerce, Trade and Industry
MMD	Movement for Multiparty Democracy
MSME	Micro, Small and Medium Enterprises
NAP	National Agriculture Policy
NDP	National Development Plan
PACRA	Patents and Companies Registration Agency
PF	Patriotic Front
R-SNDP	Revised Sixth National Development Plan
SADC	Southern African Development Community

SDGs	Sustainable Development Goals
SED	Small Enterprise Development
SEDB	Small Enterprises Development Board
SID	Small Industries Development
SIDO	Small Industrial Development Organisation
SNDP	Second National Development Plan
SNDP	Sixth National Development Plan
SOE	State Owned Enterprise
SPSS	Statistical Package for Social Sciences
TNDP	Third National Development Plan
USAID	United States Agency for International Development
VDC	Village Development Committee
VIS	Village Industry Service
WDC	Ward Development Committee
ZDA	Zambia Development Agency
ZEPZA	Zambia Export Processing Zones Authority
ZIC	Zambia Investment Centre
ZPA	Zambia Privatization Agency

ABSTRACT

The purpose of the study was to investigate the utilisation of some 4IR technologies, namely, big data (BD), the internet of things (IoT), artificial intelligence (AI) and cloud computing (CC), among aquaculture micro, small and medium enterprises (MSMEs) and evaluate the effect of the 4IR technologies on sales growth with a view to developing a strategy that could be used to enhance growth in sales.

A mono method quantitative study employing a survey questionnaire of 142 MSMEs in aquaculture in Lusaka was conducted. SPSS statistical package version 21 was employed in data analysis. Ordinal regression was used to model the study and it showed that the four models do not show an excellent fit. The Model Fitting Information and Goodness-of-Fit, was below the acceptable *p* value.

The McFadden Pseudo value of R-Square of use showed improvements that were far lower than the acceptable value of 20% and the Parameter Estimates Pseudo R-Square values were less that the acceptable value, except for internet use which was greater than the acceptable value. Though the sales growth had increased, none of the independent variables were worth noting to be significant predictors of sales growth.

The conclusion is that there are other determinants of increase in sales such as age, levels of education, etc and not solely new technology. However, if the new technologies were employed, MSMEs would accelerate their sales more than observed. Aquaculture MSMEs ought to embark on a cultural change of using traditional methods to adoption of new technologies if they are to exploit the market more than they are currently doing.

This is the first kind of study looking at the utilisation of new technologies, big data, cloud computing, the internet of things and artificial intelligence among aquaculture MSMEs in Lusaka with a view to developing a strategy that could be used to enhance growth in sales.

Key words: Aquaculture, Micro, Small and Medium Enterprise, Sales Growth, Fourth Industrial Revolution.

CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.1 Introduction

At independence in 1965, Zambia inherited a highly dualistic economy characterised by a foreign-owned modern sector, dominated by the copper industry, manufacturing and large-scale commercial agriculture. The rest of the economy was made up of mainly rural small peasants practising traditional agriculture. The three industries, i.e., mining, manufacturing and agriculture, were concentrated along the line of rail which ran through the Southern, Central and Copperbelt provinces. The line of rail became 'an island of comparative plenty in the vast sea of rural poverty.' Africans who got employed in either the mining or agriculture sector were earning on average K291 per capita income annually, whereas their colleagues who were engaged in traditional agriculture in the rural areas were earning, on average, a meagre K23 per capita income annually (Roberts, 1976).

Consequently, the disparity in earning between those who got employed in the urban areas and those who remained to work as subsistence farmers in the rural areas resulted in a drift or people migrating away from the rural areas into the urban areas. The total urban population increased from 715,000 between 1969 and 1980 to 2, 440, 419 (Zambia Central Statistics Office, 1980). In as much as the urban areas benefited from this drift by the availability of labour, the rural areas where negatively affected in the sense that the drift *inter alia* robbed them of able-bodied men, reduced food production and increased malnutrition (Fair, 1983).

Owing to very little direct control over economic decision making in the mostly foreign-owned copper, manufacturing and commercial agriculture industries, the Zambian government took over majority control in some of these industries. This takeover or economic reform was coined as 'Zambianisation' or nationalisation. (Kaunda, 1968; 1969; 1970). Despite the government taking over control of the industries, it was not possible to create employment at the rate sufficient enough to absorb the rapidly expanding workforce. Therefore, a lot of people remained unemployed.

A few years later, a decline in international copper prices caused a prolonged recession to the entire Zambian economy. The recession, coupled with weakness of managerial resources resulted in failure of the nationalised industries. Zambia suffered another economic downturn in the early 1990's leading to the introduction of, yet another type of economic reforms dubbed 'privatisation' or 'liberalisation.' These were economic reforms during which about 262 out of the targeted 284 state-owned enterprises (SOE's) were liquidated thereby putting a lot of people out of formal employment (Silungwe & Silungwe, 2019).

Over the years, the lack of employment, coupled with the call for diversification away from the mining sector resulted in the establishment of micro, small and medium enterprises (MSMEs) as a means of sustainability. The Zambian government has been supportive of the MSME sector from the late 1970's when the country experienced the rural to urban migration which saw major foreign-owned industries not being able to absorb the increasing labour force, resulting in unemployment. As a result of this development, MSMEs began to mushroom. Chisala (2008) asserts that "the formation of MSMEs was inevitable since most Zambians were out of formal employment and therefore, they had to find alternative means of surviving."

1.1.1 First, Second and Third National Development Plans

The Zambian government embarked on the creation of five-year development plans aimed at addressing various national issues, *inter alia*, economic development. For instance, Zambia's First National Development Plan (FNDP) which was launched in 1966 had a number of objectives. The objectives were diversification of the copper-based economy, reduction of inherent disparities between urban and rural areas, expansion of education and training, with the aim of maximum zambianisation, expansion of housing, health and social welfare services and the extension of the transport and communications network (Ministry of Development, Planning and National Guidance, 1971).

There was substantial achievement in the anticipated and desired economic and social development in the sense that the plan resulted in the establishment of Village Development Committees (VDCs) and Ward Development Committees (WDCs) which strengthened communication between the government and communities. The FNDP fell

short in other areas because of lack of legal backing. Further, the FNDP did not outline a deliberate strategy and implementation plan aimed at promoting the agriculture sector, despite the promotion of rural agriculture being one of its objectives.

When it comes to government support towards the fisheries subsector, the FNDP provided infrastructural support such as improving landing, handling, recording and processing of fish by building fish markets, fish stores, access roads, jetties and cutting channels to fisheries but the FNDP did not provide any support towards aquaculture. Fisheries comprises of catching, processing and selling naturally occurring fish from natural water bodies such as dams and earthen fishponds, whereas aquaculture involves cultivating or breeding, raising and harvesting fish using both natural and constructed water bodies (Indaba Agricultural Policy Research Institute, 2021). Aquaculture has been defined as "the cultivation, propagation or farming of fish, aquatic vegetation, or other living aquatic resources whether from eggs, spawn, spat or seed or by rearing fish lawfully taken from the wild or lawfully imported into the country, or by other similar processes" (Ministry of Commerce, Trade and Industry, 2020).

Aquaculture fish production in Zambia started around 1958 to 1960 but it came to a standstill in 1967 due to "an insufficient appreciation of the basic requirements of an effective aquaculture development programme and a consequent inadequacy of governmental support activities such as extension services, training, etc. (Food and Agriculture Organisation, 1978). The concept has however grown in the last two decades.

The successes and failures, discrepancies and deficiencies encountered during the implementation of the FNDP laid a valuable background for better formulation of targets and strategies of the subsequent NDP, i.e., the Second National Development Plan (SNDP) of 1972 to 1976. The SNDP aimed at continuing building up the on the FNDP for the country's economic and social infrastructure while laying a foundation for more balanced national economic development.

The objectives of the SNDP were to expand agricultural productivity, increase agricultural output and efficiency of production in the traditional farming sector, expand and diversify industry and mining, develop tourism, construction of transportation routes, energy, education and health infrastructure, initiate comprehensive regional development and promote rural development. Just like the

FNDP, the SNDP only addressed support to fisheries and not aquaculture (Ministry of Development, Planning and National Guidance, 1971).

Successful implementation of the SNDP was hampered due to several factors, among them, a failing economy as a result of the drop in copper prices in the world market, the effect of weather conditions on crop harvests, the impact of stagflation in the industrial world, the fuel crisis and disruption of supply routes caused by the Rhodesian border closure and the Angolan civil war (Ministry of Development, Planning and National Guidance, 1971).

The first government support initiative for MSMEs came during the implementation of the SNDP in 1978 through the creation of the Village Industry Service (VIS) whose objective was to encourage and provide support to rural communities to develop and use their industrial artisan skills and not agricultural skills, to produce crafts which could then be sold and in turn improve their standards of life (Mate, 1999). This initiative was aimed at promoting rural economic growth so as to discourage the rural to urban migration. The VIS initiative failed due to the inability to recover 50 % of the disbursed loans, thereby rendering the onward disbursement to other beneficiaries impossible (Mate, 1999).

It is worth stating that one of the FNDPs objectives which was to develop agriculture in order to increase rural incomes and reduce dependence on copper, was not fully satisfactory. Similarly, among the objectives of the SNDP which were to improve rural standards of living, creating employment opportunities in rural areas in order to counteract the drift of populations to urban areas and the positive contribution of agriculture to GDP were not realised. Instead of bridging the income gap between those employed in urban areas and the rural subsistence earners, the FNDP and SNDP only served to further broaden the gap (National Commission for Development Planning, 1979).

The subsequent national development plan was the Third National Development Plan (TNDP). It had to be deferred for two years, from 1977 to 1979 because some of the projects under the SNDP took more time to be completed. The delay in completion of some projects under the SNDP was attributed to lack of funding due to the failing economy which was triggered by the drop in copper prices in the world market, the negative effect of weather conditions on crop harvests, the impact of stagflation in the

industrial world, the fuel crisis and disruption of supply routes caused by the Rhodesian border closure and the Angolan civil war (Ministry of Development, Planning and National Guidance, 1971).

The objectives of the TNDP were to use planning as an instrument for attaining socialism, generate more employment through the adoption of labour intensive technology, diversify the economy from copper dependence and promote prospecting and exploitation of non-copper minerals, promote rural development and reduce the disparities in the levels of income between rural and urban sector, promote industrial production based on local raw materials, promote a regional pattern of development, speed up the process of Zambianisation and expand education and training facilities (National Commission for Development Planning, 1979; Simson, 1985).

During the implementation of the TNDP in 1981, the Zambian government established the Small Industries Development Organisation (SIDO) to provide more support to people who were engaged in MSMEs. However, the SIDO failed to achieve the anticipated results *inter alia* because it was only applicable to small businesses in the manufacturing formal sector and it excluded others such as those in the aquaculture subsector (Mauzu, 1997).

The shortcomings of the SIDO led to its replacement in 1996 by the Small Enterprises Board (SEDB) whose functions were to formulate, co-ordinate and implement policies and programmes for promoting and developing micro and small enterprises; to develop industrial estates and common facilities for use by micro and small enterprises; to establish a training and processing centre to provide machinery and equipment to micro and small enterprises on a lease-out basis and to make recommendations on any legislative reform which could be required for the development of micro and small enterprises (Mauzu, 1997).

It is worth noting that SEDB provided support to those people who were already venturing into small businesses and not start-ups (Munalula et al., 2017). The functions of SEDB were incorporated into the Zambia Development Agency (ZDA). Among the ZDA's functions were to facilitate and promote trade, investment and enterprise development, to build and enhance Zambia's investment profile for increased capital inflows, capital formation, employment creation and growth of the MSME sector in Zambia. More details of the ZDA are provided in Section 1.1.5 of this Chapter.

1.1.2 Fourth National Development Plan

Further national planning was provided by the launch of the Fourth National Development Plan (FNDP). The launch was delayed for about five years in order to implement the newly developed Economic Recovery Programme (ERP). The FNDP was launched in 1989 but it was abandoned a few years later in 1991 when it was replaced by an open market system, dubbed 'privatisation' or 'liberalisation' alluded to in the Introduction (Section 1.1). The consequences of the disruption in implementation of the NDP were that there was no medium-term plan for the country to follow to guide public investment priorities for implementation by government and no planning framework to serve as a basis for cooperation with donors (Ministry of Finance and National Planning, 2006).

Other consequences of the disruption in implementation of the NDP were weakened capacity of the country to coordinate national development programmes, since there was no organ at national level to oversee, initiate and coordinate cross-cutting national programmes among ministries, absence of an organ to oversee plans, coordinate and monitor at the provincial and district level and serve as a link with development priorities at the national level, and the inability of the private sector to undertake some of the market-related functions (Ministry of Finance and National Planning, 2006).

1.1.3 Fifth, Sixth, Revised Sixth and Seventh National Development Plans

The Fifth, Six, Revised Sixth and Seventh National Development Plans were developed in alignment with the National Long-Term Vision 2030. Vision 2030 is the long-term national plan aimed at attaining a prosperous middle-income status by creating an enabling environment for sustainable socio-economic development by the year 2030. It is founded on seven key basic principles. These principles are sustainable development, upholding democratic principles, respect for human rights, fostering family values, a positive attitude to work, peaceful coexistence, and upholding good traditional values (Office of the President of the Republic of Zambia, 2006).

The Fifth National Development Plan (FNDP) was launched in 2006 with a theme 'broad based wealth and job creation through citizenry participation and technological advancement.' Its strategic focus was on economic infrastructure and human resources

development. It outlined five areas of policy direction, namely, macroeconomic, social, rural, urban and structural policies (Ministry of Finance and National Planning, 2006).

Firstly, it outlined a number of macroeconomic policies aimed at reducing inflation and interest rates, transparent debt contraction and management, effective public expenditure and revenue management, sound economic governance and transparency, a stable and competitive exchange rate; and financial sector policies, including microfinance (Ministry of Finance and National Planning, 2006).

Secondly, it had social policies which covered poverty reduction, public investment in effective HIV and AIDS interventions, housing, water and sanitation improvement, public investment in education and health, social safety nets and pro-employment economic growth and sound labour administration. Thirdly, rural sector policies were also outlined with the following focus areas; irrigation development, attainment of food security, provision of microfinance, development and/or rehabilitation of infrastructure, especially feeder and all-weather roads and livestock development (Ministry of Finance and National Planning, 2006).

Fourthly, the FNDP listed urban sector policies aimed at housing improvement including revamping urban planning such as upgrading of unplanned settlements, safe water and sanitation, waste management, improved land management and manufacturing and services sectors growth. Lastly, the FNDP outlined structural policies aimed at private sector development, especially relating to improving the business and investment climate and strengthening the financial sector. The plan also undertook to address a number of cross-cutting issues such as mainstreaming HIV and AIDS, gender mainstreaming, ensuring environmental sustainability, improved land management and promoting good governance (Ministry of Finance and National Planning, 2006).

The FNDP laid the foundation for improving economic infrastructure and investing in human development. During its implementation, the country achieved positive gains in infrastructure development, a reduction in the maternal and infant mortality rates and increase in education enrolment rates. However, despite these gains, the reductions in unemployment and poverty levels were not significant because MSMEs were not adequately catered for (Ministry of Finance and National Development, 2011). For instance, despite the establishment of microfinance institutions, MSMEs could not

access the funds due to various reasons, such as high interest rates, lack of security, etc. The plan seemed to support commercial farmers instead of MSMEs.

The FNDP recognized the potential which the fisheries sector had in supporting livelihoods although the production trends had not grown consistently despite the demand for fish outstripping supply. The FNDP did not however, identify aquaculture as a solution to increasing production. Aquaculture fish production would have countered low production attributed to declining yields in capture fisheries. The decline in production was brought about by an increase in human population in fishing areas thereby putting more demand on the limited fish stocks and also unsustainable fishing practices such as fishing in breeding sanctuaries and the harvesting of immature fish also adding to the reduction of fish production (Ministry of Finance and National Planning, 2006).

At the expiry of the FNDP, the Sixth National Development Plan (SNDP) was launched in 2011 with only three objectives, namely, to accelerate infrastructure development, economic growth and diversification, to promote rural investment and accelerate poverty reduction, and to enhance human development. The SNDP, which was launched during the Movement for Multiparty Democracy (MMD) regime, and which should have lasted from 2011 to 2015, was revised in 2013 in order to incorporate the priorities of the Patriotic Front (PF) Government's policies and manifesto (Japan International Cooperation Agency, 2007) resulting in the revised SNPD (R-SNDP). Both the SNDP and the R-SNDP undertook to support MSME aquaculture development (Ministry of Finance and National Development, 2011; Ministry of Finance and National Planning, 2014).

The theme of the revised SNDP (R-SNDP) was 'people centred economic growth and development' and it had the following objectives: to promote employment and job creation through targeted and strategic investments in selected sectors, promote rural development by promoting agricultural development, rural enterprises and providing support infrastructure in rural areas, enhance human development by investing in the social sectors and accelerate infrastructure development to enhance the growth potential of the economy (Ministry of National Development Planning, 2017).

The SNDP and the R-SNDP did not yield the desired results due to many challenges. Firstly, the irregular release of money made the implementation of programmes

impossible thereby not achieving the desired results. Secondly, there was a notable inconsistency between the programmes and the Development Plans and due to this lack of correlation, when resources were released for implementation of the various programmes, there were variations that led to resources being expended on non-core activities of the Plans. There were too many priority areas resulting in thinly spreading of resources which in turn resulted in minimal impact. Thirdly, budgetary allocation meant for sectors targeting human development was insufficient, resulting in non-implementation of the programmes. Fourthly, there was lack of adequate implementation of the Decentralisation Policy, poor monitoring and evaluation (M & E) (Ministry of National Development Planning, 2017).

The subsequent undertaking was the Seventh National Development Plan (7NDP) of 2017 who's theme was 'accelerating development efforts towards Vision 2030 without leaving anyone behind.' The theme of the 7NDP was coined in that manner in order to align its objectives towards the attainment of Vision 2030 because the two preceding NDPs, i.e., the FNDP and the SNDP provided contrasting development scenarios from what is espoused in the Vision 2030. The main goal of the 7NDP was to create a diversified and resilient economy for sustained growth and socio-economic transformation driven by agriculture, mining and tourism and it had a number of objectives including diversifying and making economic growth inclusive, reducing poverty and vulnerability, reducing developmental inequalities, enhancing human development and creating a conducive governance environment (Ministry of National Development Planning, 2017).

In an attempt to align with Vision 2030, the 7NDP aimed at diversifying and making economic growth inclusive through improved production of technology and innovation by the use of research and development, improved priority socio-economic physical infrastructure, restructured, diversified and export-oriented economic sectors, increased private sector engagement across sectors, increased employment opportunities in both urban and rural areas and enforced sustainable development principles (Ministry of National Development Planning, 2017).

Attaining the Vision 2030 also required that the poor and vulnerable be safeguarded through reduction of all forms of inequality, promoting a well-nourished population free of all forms of malnutrition, capable of contributing to economic growth and

diversification, improved general welfare of poor and vulnerable households and promoting livelihoods and empowerment. Realising the Vision 2030 would require an improvement in human development through promoting a highly skilled workforce that contributes effectively to economic growth and diversification, promoting livelihoods and empowerment in rural areas, enhancing the effectiveness of economic empowerment programmes, achieving universal health care through improved health-related services and improving the education system that produces individuals with numeracy, ICT and literacy skills beyond a basic level (Ministry of National Development Planning, 2017).

Finally, to realise the Vision 2030, Zambia would also strengthen governance mechanisms. In order to achieve the above objectives, the 7NDP would focus on certain key areas, namely, improving the policy environment, improving transparency and accountability, establishing an inclusive democratic system of governance, improving service delivery, accelerating decentralisation and devolution to local authorities and improving the rule of law, human rights and constitutionalism (Ministry of National Development Planning, 2017).

Aquaculture offers great potential for diversification, gainful employment and poverty reduction because capture fisheries have depleted production for various reasons, such as natural water bodies being overfished, inadequate supportive legislation, inadequate control, lack of surveillance and the unavoidable adverse effects of climate change, i.e., reduction in water availability. Successful aquaculture demands increased investment in fish farming technologies.

According to the 7NDP, "aquaculture fish production significantly grew in the preceding two decades from a total production of only 5,000 MT in 2006 to about 22,700 MT of fish per annum in 2015, representing a 340 percent increase. This was as a result of the Government's commitment to promoting aquaculture in the country and an increase in the number of production companies, among other reasons. Despite an average total annual production of 95,000 MT of fish, the actual annual demand has been 140,000 MT, representing a deficit of 45,000 MT. This deficit provides room for a flourishing fish farming industry in Zambia as there is a guaranteed market in the country and the sub-region for fish and fish products. It also has the potential to create

employment and contribute to increased incomes for households as well as to overall GDP" (Ministry of National Development Planning, 2017).

1.1.4 Eighth National Development Plan

These national development plans were ideally designed to serve as five-year roadmaps to the nation's development goals with the current one being the 8NDP whose theme is 'socio-economic transformation for improved livelihoods.' It has four strategic development areas, namely, economic transformation and job creation, human and social development, environmental sustainability and creation of a good governance environment (Ministry of Finance and National Development, 2022).

Economic transformation and job creation are to be achieved through an industrialised and diversified economy, enhanced citizenry participation in the economy and a competitive private sector. Human and social development are to be achieved through improved education and skills development, improved health, food and nutrition, improved water supply and sanitation and reduced poverty, vulnerability and inequalities. Environmental sustainability is to be achieved through enhanced mitigation and adaptation to climate change, sustainable environment and natural resources management and the creation of a good governance environment will be achieved through an improved policy and governance environment, improved rule of law, human rights and constitutionalism (Ministry of Finance and National Development, 2022).

Owing to shortcomings with the previous NDPs, the 8NDP has provided an overview of some valuable lessons which must be taken into consideration when formulating NDPs in order to avoid and reduce the undesirable outputs and outcomes which have been exhibited since 1966.

The 8NDP states that actualisation of the decentralisation reform agenda is a necessary precondition for attainment of people-centred sustainable development as weak alignment of annual budgets to outputs in the NDPs makes it difficult to achieve the objectives and targets of the Plan and to improve performance of the Plan, it is important at the inception of the Plan, to set realistic targets, given that it takes time for limiting factors, such as legislation, required financing, human resources and capacity enhancements to be actualised, incorporating key stakeholders in time throughout the

Plan formulation process ensures ownership and contributes to successful implementation of the Plan (Ministry of Finance and National Development, 2022).

The 8NDP further states that prudent fiscal management is critical for economic development as delay in undertaking of legal reforms, including the processing of legislation negatively affects the achievement of some Plan objectives. Production of quality and timely statistical data as well as its use is important for effective monitoring and evaluation as well as informed policy decision-making. In addition, a strong M&E system is essential for timely tracking of progress as well for informing policy decision-making, rigorous project appraisal processes are critical to ensure value for money, targeting of programmes and projects to geographical locations and beneficiaries should be guided by demographic analysis and levels of deprivation and lack of risk management frameworks in the public sector undermines the capacity to respond in a timely manner when risks emerge, thereby negatively impacting the attainment of development results (Ministry of Finance and National Development, 2022).

The Zambian government recently launched the 8NDP and one of the strategic area's places emphasis on the use of technologies to drive economic transformation and job creation. According to the 8NDP, government will provide interventions in fisheries aimed at promoting aquaculture investments as a measure to bridge the domestic fish deficit and expand into the regional market, create employment and ultimately reduce poverty levels in the country.

1.1.5 Zambia Development Agency and Citizens Economic Empowerment Commission

Apart from the foregoing, there are various other efforts that have been made in growing MSMEs in Zambia over the years. Currently the Zambia Development Agency (ZDA) has the mandate of facilitating and promoting trade, investment and enterprise development, building and enhancing the country's investment profile for increased capital inflows, capital formation, employment creation and growth of the MSME sector in Zambia. ZDA was created in 2006 and was an amalgamation of a number of institutions all dealing with investment (Zambia Development Agency, 2022).

These five institutions were the Export Board of Zambia (EBZ), Zambia Privatization Agency (ZPA), Zambia Investment Centre (ZIC), Small Enterprises Development

Board (SEDB) and Zambia Export Processing Zones Authority (ZEPZA). The amalgamation was done in order "to foster synergies that would accelerate economic development and achieve sustained exponential growth and also to improve efficiency in the delivery of business development services under a one stop shop concept aimed at reducing the cost of doing business. The one stop shop concept would also make it easy to do business thereby enhancing business competitiveness" (Zambia Development Agency, 2022).

Part of the ZDA's mandate is "to promote and facilitate the development and growth of local enterprises especially the Micro, Small and Medium Enterprises (MSMEs) in the country, in order to create wealth, employment and to accelerate industrialisation and economic diversification. It has the duty to facilitate MSME competitiveness and business development services through business clinics and product development; training, coaching and mentoring through incubation and business acceleration; access to markets through joint ventures, partnerships and chain store market linkages and access to Finance through bankable business plans, grants and proposal preparation." (Zambia Development Agency, 2022).

In 2006, the Zambian government also established a state-owned credit institution, the Citizens Economic Empowerment Commission (CEEC), to foster the growth of locally owned SMEs. CEEC's mandate is "to promote broad based and equitable economic empowerment of citizens that are or have been marginalized or disadvantaged and whose access to economic resources and development capacity has been constrained due to various factors such as race, sex, educational background, status and disability" (Citizens Economic Empowerment Commission, 2022).

Both the ZDA and CEEC are supervised by the Ministry of Commerce Trade and Industry (MCTI) and the Ministry of Small and Medium Enterprises. The MCTI "is responsible for formulating and administering policies as well as regulating activities in the trade and industrial sectors in order to enhance the sectors' contribution to sustainable social economic growth and development for the benefit of the people of Zambia" (Ministry of Commerce, Trade and Industry, 2022). The MCTI had the mandate to actualise Zambia's National Industrial Policy (2018 – 2027). The Policy envisions an industrialised and competitive nation with a diversified, innovative and

globally competitive industrial base, which can contribute to sustainable growth and employment creation (Ministry of Commerce, Trade and Industry, 2018).

The Zambian government created a new ministry in September 2021; the Ministry of Small and Medium Enterprises whose mandate is to enhance MSMEs development in Zambia. According to the Minister of Small and Medium Enterprises Mr Elias Mubanga, "the Ministry was created to lay out a conducive environment for existing SMEs to grow and further incubate the start-ups resulting in economic development." Mr Mubanga further stated that "the Zambian government is keen to ensure the growth of small medium enterprises across the country and empowering small and medium sized enterprises across all economic sectors was the core business of his ministry. Small and medium enterprises have the potential to translate economic growth into actual improvement in people's livelihoods if well nurtured" (Jere, 2022). Therefore, the main focus of the Ministry is to create jobs and enhance economic development.

1.2 Background of the Study

Globally, MSMEs, have been identified as the backbone of economic development because they promote economic growth by contributing on average, 55% towards national gross domestic product (GDP), 65% towards creation of employment and increasing the tax base which ultimately results in poverty reduction (Liyanda, 2017; Nuwagaba, 2015; OECD, 2004).

The MSME sector in Zambia contributes approximately 88% of employment and is estimated to account for 97% of all businesses and it is undeniable that MSMEs contribute to the country's GDP by increasing chances of forthcoming and diverse economic growth (Ministry of Commerce, Trade and Industry, 2008). MSMEs in Zambia cut across all sectors of the nation's economy, ranging from manufacturing, mining, services and trading. Manufacturing represents 41%, trading 49%, while mining and services represents 10% of MSME sector categorisation (Munalula et al., 2017).

Activities under MSME manufacturing include *inter alia* textile products, carpentry and other wood-based business, light engineering and metal fabrication, food processing, leather products, handicrafts, processing of semi-precious stones, essential oils and ceramics. Mining consists of small-scale mining and small-scale quarrying. The

services sector comprises of restaurants and food production, hair salons and barbershops, passenger and goods transport, telecommunication services, financial services, business centres, cleaning services, guest houses and building and construction and the trading sector comprises of consumable products, industrial products, agricultural inputs, agricultural produce and printing (Munalula et al., 2017). The focus of the research was the agricultural sector and in particular, the aquaculture sub-sector because it has potential for diversification, gainful employment and reduction in poverty.

Zambia is endowed with vast water resources thereby making fishing a common activity which has since been adversely affected by the negative effects of climate change, specifically the reduction in naturally occurring water bodies. However, the country has favourable conditions which can support aquaculture such as good soil formation, availability of water and climate (Mushili & Musuka, 2015). Aquaculture is not new in Zambia as it started in Chilanga around 1958 to 1960 with the construction of six earthen ponds. Earthen ponds require lower construction costs unlike concrete ponds which are more costly.

The government encouraged the establishment of aquaculture MSMEs in areas that had abundant water resources but which did not have major capture fisheries facilities (Mainza & Musuka, 2016) resulting in the construction of more ponds by MSMEs which later spread to other areas of the country. This had to be done in order to bridge the widening gap between fish supply and demand. However, although aquaculture has been going on for many years and has been promoted as a means of enabling MSMEs to create employment and reduce poverty thereby improving their economic security, this has not been achieved as there is still a deficit in the anticipated output. A 2018 aquaculture survey revealed a national productivity of 4.1 tonnes per hectare which was way below the recommended productivity rate of between 6 to 8 tonnes per hectare (National Assembly of Zambia, 2019). There has also been a high level of mortality rate among MSMEs that had ventured into the aquaculture sub-sector (Maguswi, 1986).

Aquaculture MSMEs had dominated the sector in the past, but today, the sector is dominated by large scale commercial businesses that are overtaking the MSME sector which suffered a 27% reduction. The large-scale commercial businesses contribute 71% to the overall production whereas the MSMEs only contributed 29%. Less than 10

years ago however, MSMEs contributed 75% towards overall production (Genschick et al., 2017).

The government has endeavoured to provide support for the establishment and growth of aquaculture MSMEs in Zambia as evident in the preceding NDPs and other efforts. However, notwithstanding the governments initiatives towards supporting the development and growth of aquaculture MSMEs in Zambia over the years, the sector has not contributed positively to the much-needed national economic growth or economic development and closing up the broadening deficit gap between supply and demand. Statistics indicate that three out of every five such businesses fail within the first few months or years of commencement of operations (Zambia Statistics Office, 2011).

Owing to this high mortality rate of 75 %, aquaculture MSMEs fail to meet the demand and they fail to make the much-needed greater contribution towards national economic growth. This coupled with the effect of Covid 19, a global pandemic, in the past two years, which limited mobility and access to the marketplace, saw even more aquaculture MSMEs fail. Manda et al., (2021) in their survey on how MSMEs leveraged during the COVID-19 pandemic in Zambia, revealed that 72% of the 560 respondent MSMEs suffered a decline in revenue and closed down, 18% of them considered closing down and only 12% who had adopted digital technology, reported an increase in revenue and continued in business.

Studies worldwide have revealed that MSMEs that have harnessed new technologies have been able to enhance their performance and continue to exist (Garcia, 2014; Westerberg, 2008). The United Kingdom for instance, saw 51% of SMEs adopting digital technology as a measure to ensure future business continuity. Similarly, a world survey on SMEs revealed that 70% intensified their use of digital technology due to the pandemic and were subsequently able to continue in operations (Abed, 2021; OECD, 2022).

This study focused on aquaculture MSMEs in Lusaka. The study was aimed at determining how technologies impact on these MSME's financial performance. The researcher was driven by Saha et al.'s assertion (2021) in their research on entrepreneurial orientation which referred to Lumpkin and Dess (1996)

conceptualisation of entrepreneurial orientation as “one that requires competitive aggressiveness in order to survive.”

If aquaculture MSMEs are to survive in the current competitive environment, they have to be aggressive. They have to move away from using traditional business methods that impede high productivity and instead begin to adopt new technology in their operations thereby improving business efficiency and effectiveness (Toko, 2021). Aquaculture appears to be technically too complex for rapid adoption by people with little technical experience and expertise. There is need to identify the systems that are most suitable for integration with aquaculture MSMEs for their successful implementation. It is envisioned that with the implementation of new technologies, their production levels can triple. The world is currently experiencing the Fourth Industrial Revolution (4IR) which comprises of a number of new technologies which are changing the way we live and conduct business.

1.2.1 Fourth Industrial Revolution Technologies

Tremendous market competition and dramatically changing business environment have forced enterprises to adopt various state-of-the-art information technologies (IT) such as social networks, semantic web, embedded systems, the internet of things, virtualization technologies, cloud computing and artificial intelligence, among others. These technological innovations have received more attention in both private and public sectors due to the growing reputation of the shared networks connecting people from all over the world. They offer an innovative business model for the pervasive, convenient, and on-demand access to the virtualized and distributed resources (Marston et al., 2011).

It has been argued that the use of 4IR technologies which include cloud computing, internet of things, artificial intelligence and big data have become a necessity and a major strategy and driving force for businesses that yearn for survival and growth in today’s competitive business environment (Kulemeka et al., 2015; Kusi et al., 2015; Quartey et al., 2017). The researcher asserts that if new technologies are adopted by aquaculture MSMEs, they would become more efficient, thereby more productive and competitive and their much-needed contribution to economic development would then

be realized. 4IR technologies have the potential to positively impact on the productivity and profitability of the aquaculture MSMEs in Zambia.

For instance, agricultural SMEs and farmers in India and China have adopted various 4IR innovative technologies resulting in them being ranked among the largest food producers worldwide (Food and Agriculture Organisation, 2021). In India, the agricultural sector contributed 17.8% towards GDP in 2019 and 19.9% in 2021 and the increase was attributed to the governments supportive policies to the sector and proven use of modern or new business and 4IR farming technologies (Food and Agriculture Organisation, 2022). In 2021, the Indian government embarked on a digital agriculture mission aimed at ensuring that agricultural SMEs and farmers used new technologies such as artificial intelligence, block chain, remote sensing and geographic information systems (GIS) technology, drones and robots, etc in their operations.

In China, the 14th Five-Year Plan provides policy support to the agriculture sector because they believe that the sector can only thrive and flourish with modernisation and the only mode of achieving this is by the use of technology. According to Juul (2021), China is using drones to spray pesticide, unmanned transplanters to seed, block chain to follow chickens, the internet of things devices to monitor land and data to understand demand for produce more precisely.

The 4IR has come with the introduction of internet technologies in industry and it has disrupted every industry worldwide (Trento et al., 2018). The 4IR represents the advancement from simple digitisation to innovation based on combinations of technologies which enable businesses to innovate. The technologies range from big data (BD), i.e., storage and analysis; to artificial intelligence (AI), which is value creation by prediction and customization; to the internet of things (IoT) which involves data collection and optimization. The research will not evaluate all the nine pillars of the 4IR technologies, but will concentrate on big data, cloud computing (CC), the internet of things and artificial intelligence and how they can be used to enhance the financial performance of aquaculture MSMEs in Lusaka. as financial performance can be investigated using various parameter, the study used the parameter sales growth.

1.3 Statement of the Problem

Literature indicates that globally, aquaculture MSMEs contribute towards employment creation, wealth generation and poverty reduction. However, despite the significance of aquaculture MSMEs contribution towards national per capita income in Zambia, statistics indicate that three out of every five such businesses fail within the first few months or years of commencement of operations (Zambia Statistics Office, 2011) and they fail to make the much-needed greater contribution towards national economic growth. Chisala (2008) further posits that aquaculture MSMEs in Zambia do not grow. They start small and barely grow above the start-up size and remain stagnant and fail to escalate from emerging or micro businesses to large businesses. The failure and stagnation of aquaculture MSMEs can be attributed to various factors, *inter alia*, excessive competition, lack of access to finance, insufficient use of technology, etc.

There is a paucity of evidence in Zambia that points to aquaculture MSMEs in Zambia having innovated. Silimina (2020) has suggested the need for smart agriculture, that is, the adoption of new technologies as a way to enhance sustainability of aquaculture MSMEs. The Zambian government recently launched the 8th National Development Plan (8NDP) and one of its strategic areas' places emphasis on the use of four technologies (big data, cloud computing, the Internet of things and artificial intelligence) as predictors of sales growth or volumes among MSMEs.

Literature further reveals that the use of new technologies in innovation is the most fundamental source for aquaculture MSME success and survival in today's competitive business environment (Abdollahi et al., 2021; Chen et al., 2012; Delmar, 2006; Hu et al., 2018; Wiener et al., 2020). Evidence is yet to show that poor growth in sales among aquaculture MSMEs is due to not investing and utilizing new technologies and these include big data, cloud computing, the internet of things and artificial intelligence. Eventually, such businesses exhibit growth stagnation and a high mortality rate. At the time of developing this study, the researcher was advancing the assumption that lack of innovation characterized by non-use of big data, cloud computing, the internet of things and artificial intelligence by aquaculture MSMEs in Lusaka, could be the reason for their poor growth in sales.

1.4 General Objective

The aim of this study was to investigate the utilisation of new technologies (big data, cloud computing, the internet of things and artificial intelligence among aquaculture based MSMEs with a view to developing a strategy that could be used to enhance growth in sales.

1.5 Specific Objectives

i. To explore the state of usage of new technologies in innovation efforts among MSMEs in the aquaculture sub-sector.
ii. To describe the rate of growth in sales of aquaculture MSMEs over the past five years.
iii. To assess the effect of new technologies in innovation on the growth in sales of MSMEs in the aquaculture sub-sector.
iv. To generate a strategy that can be used by MSMEs in the aquaculture sub-sector to harness some 4IR technologies in innovation in order to enhance their growth in sales.

1.6 Research Questions

i. What is the state of usage of new technologies by aquaculture MSMEs?
ii. What has the rate of growth in sales of aquaculture MSMEs been over the past five years?
iii. What new technologies are predictors of increase in the sales volumes among aqua culture MSMEs?
iv. How can growth in sales among MSMEs in the aquaculture sub-sector be enhanced?

1.7 Hypotheses

The study aimed at evaluating the effect of new technology on sales growth and the main hypothesis of the study was depicted as follows:

H0: Use of innovative Technologies have no significant impact on aquaculture MSME sales growth.

H1: Use of innovative Technologies have a significant impact on aquaculture MSME sales growth.

The study was opined on the fact that the use of new technology (independent variables) can enhance sales growth (dependent variable) hence the main hypothesis was operationalised as:

Hypothesis I

H0 The use of big data has no significant impact on aquaculture MSME sales growth.

H1 The use of big data has a significant impact on aquaculture MSME sales growth.

Hypothesis II

H0 The use of the internet has no significant impact on aquaculture MSME sales growth.

H1 The use of the internet has a significant impact on aquaculture MSME sales growth.

Hypothesis III

H0 The use of artificial intelligence has no significant impact on aquaculture MSME sales growth.

H1 The use of artificial intelligence has a significant impact on aquaculture MSME sales growth.

Hypothesis IV

H0 The use of cloud computing has no significant impact on aquaculture MSME sales growth.

H1 The use of cloud computing has a significant impact on aquaculture MSME sales growth.

1.8 Theoretical Framework

A theory is an established representation of how variables interact with each other and the study utilised four notable theories, i.e., Schumpeter's Innovation Theory, Mckinsey's Three Horizons Model, the Diffusion of Innovations Theory and the Technology Acceptance Model.

Schumpeter's innovation theory talks about 'creative destruction, that is, the need to continue using new technologies in innovating as the market changes in order for an entity to survive. By so doing, aquaculture MSMEs stand a better chance of improving their growth in sales over time. The theory is founded against the background of inevitable profit diminishing over time and the need to counter the reduction. The solution is to innovate (Freel, 2000; Porter & Kramer, 2019).

Schumpeter's theory was supplemented by Mckinsey's Three Horizons Model (McKinsey & Company, 2009), a tool for thinking and planning about transformation and how to bring it about. The model provides insight into possible alternative futures and the need to continue innovating because the introduction of an innovation allows an MSME to enjoy relatively high profits. Over time however, these high profits are eroded due to imitation and competition, but MSMEs that continue innovating will be able to achieve high profitability for a sustained period attributed to increased sales growth.

The diffusion of innovation relates to the process where the use of an innovation spreads over time throughout a marketplace and via multiple categories of adopters. It explains technology adoption whereas the Technology Acceptance Model (TAM) is used to predict the use and acceptance of information systems and technology by individual users based on perceived usefulness (PU) and perceived ease of use (PEOU) (McCormack et al., 2022).

1.9 Conceptual Framework

Schumpeter's Innovation theory has been used to develop the conceptual framework. The conceptual framework shows the effects of the relationship between some 4IR technologies in innovation and growth in sales as illustrated in Figure 1.1 below.

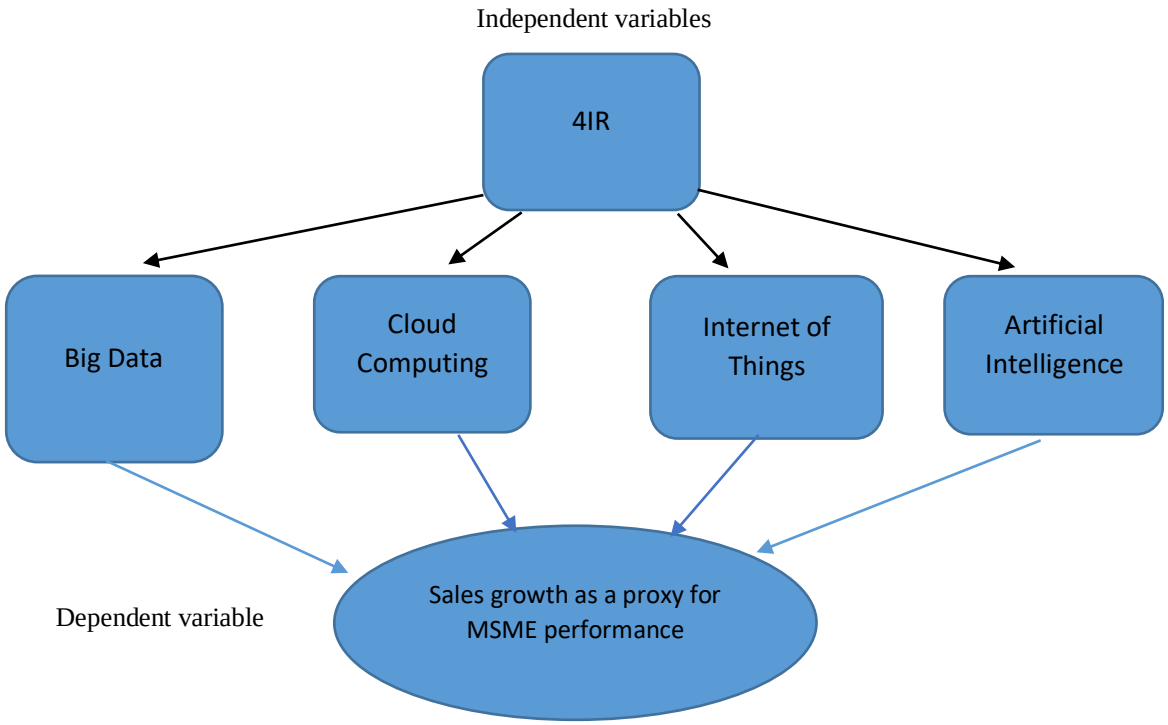

Figure 1. 1: Conceptual Framework

Source: Inductively developed by the Researcher

The independent variables (IV) wholistically are the 4IR technologies broken down as big data, cloud computing, the internet of things and artificial intelligence. The IV's can have a positive effect on the dependent variable (DV) which is growth in sales over a period of five years (Joseph et al., 2014). The null hypothesis posits that the use of big data, cloud computing, the internet of things and artificial intelligence technologies in innovation do not affect MSME growth in sales and the alternative hypothesis posits that the use of the big data, cloud computing, the internet of things and artificial intelligence technologies in innovation will affect MSME growth in sales. From the foregoing, the hypothetical representation therefore is:

Ho: Use of innovative technologies has no significant impact on aquaculture MSME sales growth.

Ha: Use of innovative technologies has a significant impact on aquaculture MSME sales growth.

1.10 Scope/Delimitation of the Study

The agricultural sector can be classified into three categories, namely, crops, aquaculture and livestock. The target sample for the study was drawn from MSMEs in the aquaculture sub-sector in Lusaka because the area lacks natural water bodies, thereby making it fertile for alternative fishing methods such as aquaculture. It would have been ideal to conduct the research across the country but owing to the prevalence of capture fisheries in other provinces, it would have been a challenge to locate the appropriate target sample. Notwithstanding using a target sample from Lusaka, however, the conclusions of the research can and will be generalised to the other regions countrywide which do not have an abundance of natural water bodies as they have potential to venture into aquaculture as an alternative to traditional capture fisheries.

1.11 Rationale of the Study

Enhancing the aquaculture subsector using new technology in Zambia is a critical solution to address the significant 87 tonne fish deficit the country currently faces (National Assembly of Zambia, 2021). With the increasing demand for fish as a vital protein source, aquaculture presents an opportunity to boost domestic fish production, reduce reliance on imports, and enhance food security. By promoting the use of new technology for sustainable fish farming practices, Zambia can harness its abundant underground water resources to feed into fishponds so as to efficiently and effectively cultivate fish thereby alleviating the current strain on overfished and depleting naturally occurring water bodies. Additionally, aquaculture offers job opportunities and income generation for local communities, thereby fostering national economic growth and ultimately, poverty reduction. Embracing aquaculture will not only bridge the fish deficit gap but also pave the way for a resilient and self-sufficient fisheries industry in Zambia.

1.12 Definition of Operational Terms

In order to provide an in-depth understanding and appreciation of the subject which the researcher was trying to explore and to convey to the readers, a number of operational definitions had to be given. The following are the key words used in the research:

Aquaculture: It has been defined as "the cultivation, propagation or farming of fish, aquatic vegetation, or other living aquatic resources whether from eggs, spawn, spat or seed or by rearing fish lawfully taken from the wild or lawfully imported into the country, or by other similar process" (Ministry of Commerce, Trade and Industry, 2020).

Micro, Small and Medium Enterprise: In Zambia MSMEs are defined based on the legal status, total fixed investments, sales turnover, number of employees and registration status. Legal status means registration with the Registrar of Companies. Total fixed investments ranges from K50,000 (rebased) to K500,000 (rebased); sales turnover ranges from K150,000 (rebased) to K300,000 (rebased) and the number of employees ranges from 1 to 10, 49 to 50 and 51 to 100 for micro, small and medium enterprises, respectively.

4IR: They have been defined as a fusion of technologies that is blurring the lines between the physical, digital and biological spheres and they involve technological integration of cyber-physical systems in the process of production (Min et al., 2018). Components of the 4IR technologies include big data, cloud computing, the internet of things, 3D, artificial intelligence and robotics (Markowitz, 2019).

Innovation: It could mean the introduction of a new good, the introduction of a new production method, the opening of a new market, or the opening of a new source of supply (Schumpeter, 1934). Kuratko and Hodgetts (2004) defined innovation as the creation of new wealth or the alteration and enhancement of existing resources to create new wealth whereas the OECD (2005) defines innovation as an activity that produces new or significantly improved goods (products or services), processes, marketing methods or business organization.

Measuring performance: As noted by Forsaith and Hall (2000) and Rogoff et al., (2004), performance is a multi-faceted concept, which includes indicators such as

survival, profitability, sales growth, number of employees, firm reputation, production, finance or marketing. Gerba & Viswanadham (2016) opined that performance can be in terms of both financial and non-growth in sales comprising of return on investment (ROI), sales volume and value, profitability, total assets, employment size, capital employed, market share, customer satisfaction, productivity, turnover, delivery time and employee's turnover, etc.

Sales growth: Sales growth is either an increase or decrease in sales over a specific period of time. It is subtracting the sales in the previous period from sales of the current period then then dividing by sales in the previous and multiplying by 100 (Ghozali, 2018). It is a measure of the company's overall sales performance, taking into account both the quantity (volume) of products or services sold and the price at which they are sold. It provides a broad view of how well a company is performing in terms of generating sales and increasing its top line.

1.13 Thesis Outline

The study is divided into five Chapters. Chapter One consists of the introduction, the background of the study, statement of the problem, the general and specific objectives of the study, the research questions, the hypotheses of the study, the study's theoretical and conceptual frameworks, scope, delimitation as well as rationale of the study and definitions of key works used in the study.

Chapter Two contains literature reviewed by the researcher starting with classification of MSMEs in Zambia to an in-depth discussion of study's independent variable, big data, cloud computing, the internet of things and artificial intelligence and the various measures of entrepreneurial performance before narrowing the discussion down to the study's dependent variable, sales growth. What follows next is a discussion of the four new technologies under study by aquaculture MSMEs in innovation and the effects of adopting these new technologies on their growth in sales. The subsequent topic is a discussion of the theories used to design the study's conceptual framework. The Chapter further synthesises the literature and identifies the gaps therein. The literature reviewed emanated from work done by other researchers, scholars and experts in the subject.

Chapter Three focuses on the research methodology, clearly outlining the design and methods. Since the study was mono quantitative, positivism, being the most ideal philosophy for quantitative studies, was used. The study approach was deductive as the study was testing a theory relating to the positive relationship between new technology and sales growth. The deductive approach demands the use of a survey as a data collection strategy, hence the study used the survey method to collect data using a self-administered questionnaire from 171 randomly selected respondents in Lusaka after seeking ethical clearance to do so. As the study was one-off and academic in nature, it was cross-sectional but incorporated a minor element of a horizontal approach by soliciting for information about the respondents' experiences in the preceding five (5) years. The data was statistically analysed using SPSS Version 21 through correlation and ordinal regression.

Chapter Four begins with presentation of results for the three cardinal tests that precede data analysis, i.e., missing data, data reliability and normality tests before presenting the findings obtained after using the data collection methods highlighted in Chapter Three and discusses the findings. This was done based on the data and other information obtained and analysed in order to answer the research questions of the study. The chapter starts with results of the analysis of classificatory and general aquaculture MSME information and proceeds present results relating to the use the some 4IR and their effect of sales growth in line with the research questions.

The last chapter, Chapter Five, begins with a discussion of the overall research findings before summarising the study. Every research faces challenges and as such, the chapter then proceeds to identify the limitations encountered by the researcher. The chapter also highlights the theoretical and practical significance of the study before proceeding to discuss various recommendations and areas of possible future research are presented.

1.14 Summary of Chapter One

The Chapter begins by tracing through the historical background of MSMEs in Zambia since it attained political independence in 1964. The Chapter then highlights various government efforts aimed at developing and growing aquaculture MSMEs over the years. This is followed by the statement of the problem, the research questions, general and specific objectives, the study hypothesis, theoretical and conceptual frameworks of

the study. What follows is the scope, delimitations and rationale of the study, definition of key words and the outline of the thesis. The subsequent chapter contains the literature review.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This segment of the thesis attempts to outline literature reviewed by the researcher related to the use of some 4IR technologies by aquaculture MSMEs in innovation and the effects of adopting some of these new technologies on the growth in sales of these business entities. The literature reviewed provided the researcher with an in-depth understanding of the how the use some 4IR technologies has improved the growth in sales of SMEs in other countries, such as the USA, China and India.

A review of literature is considered a very important activity in every research. Randolph (2009) asserts that "conducting a literature review is a means of demonstrating an author's knowledge about a particular field of study, including theories, key variables, phenomena and its history. Conducting a literature review is also an avenue which can be used to inform the student of the influential researchers in the field."

In addition, a review of literature is a tool which helps the student to distinguish what has been done in the particular subject area or field of inquiry from what needs to be done and enables the researcher to identify the research gap. In view of the foregoing, the researcher consulted various sources of information. The literature review conducted by the researcher emanated from empirical studies and information obtained from various sources, ranging from books, journals, reports, research publications and the internet sources.

The chapter begins with an overview of the 4IR and the selected four new technologies. The identified technologies are big data, cloud computing, the internet of things and artificial intelligence. These four technologies make up the independent variables of the study. Big data entails generation of information from various activities. Cloud computing involves the storage and analysis of information whereas artificial intelligence is value creation by prediction and customization and the internet of things involves data collection and optimization. The four technologies are discussed in detail later in the chapter. A detailed review of the four technologies follows after the general overview of the 4IR and MSMEs in Zambia.

According to Nyagadza et al., (2022), the 4IR represents an entanglement of physical, digital and biological technologies and the notable technologies which are driving the 4IR are artificial intelligence, the internet of things, big data, blockchains, cloud computing, robotics, 5G network and 3D printing. Among these technologies, the most common technologies being used in Zambia currently are big data, cloud computing, the internet of things and artificial intelligence, and as such, the four were the focus of the study.

The researcher further goes on to show how the four technologies can and have been used to enhance the growth in sales of aquaculture MSMEs in Lusaka and in other countries respectively. The chapter proceeds to explain the other important key concepts of the study which are innovation and measuring performance and goes on to show how the selected 4IR technologies have been used in innovation efforts among aquaculture farmers in other parts of the world.

The chapter goes on to discuss the impact of the identified new technologies in innovation on the growth in sales of MSMEs in the aquaculture sub-sector. This segment of the literature review discusses the link or relationship between the use of new technology in innovation and growth in sales of MSMEs. The subsequent segment of the literature review shows how the identified 4IR technologies can be used by MSMEs in the aquaculture sub-sector in innovating to enhance their growth in sales. Growth in sales is the dependent variable of the study and it will be measured based on a five-point agreement scale: 1 for Very low volumes of sales, 2 for Low volumes of sales, 3 for Moderate volumes of sales, 4 for High volumes of sales and 5 for Very high volumes of sales recorded by the aquaculture MSMEs over a period of five (5) years.

2.2 Overview of the 4IR

Industrial revolutions have been characterised by a totality of the changes in economic and social organization. The 1st Industrial Revolution presented a shift from manual production to the use of machines, and it began in 1790. The 1st Industrial Revolution was characterized by steam power and mechanization of production. Industries started using coal powered steam for mechanical production (Ralph et al., 2018).

The 2nd Industrial Revolution began in 1870 and it resulted in mass production and technology revolution. The 2nd Industrial Revolution was characterised by new

innovations in steel production, petroleum and electricity. 1969 saw the 3rd Industrial Revolution whose focus was automation of production. The 3rd Industrial Revolution, also referred to as the 'Digital Revolution' introduced electronics which were driven by semi-conductor industries resulting in automation, digitisation of industries through the use of electronics, the invention of the Internet and nuclear energy (Sam Tambani Research Institute, 2021).

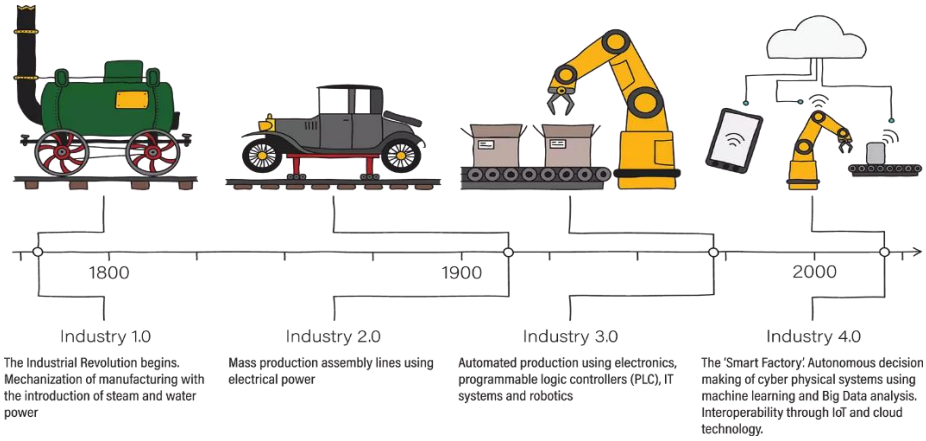

Figure 2. 1: Characteristics of the Industrial Revolutions

Source: Simio (2022)

Klaus Schwab, the founder and executive chairman of the World Economic Forum announced the Fourth Industrial Revolution (4IR) in 2016 and described is as "a fusion of technologies that is blurring the lines between the physical, digital and biological spheres." It involves technological integration of cyber-physical systems in the process of production (Min et al., 2018). Refer to Figure 2.1 for an illustration of the characteristics of the industrial revolutions.

According to Markowitz (2019) the technologies associated with the 4IR include, among others, big data, cloud computing, the internet of things, 3D printing and artificial intelligence. All these technologies have the potential to enable large amounts of data to be stored, processed and distributed instantly. The large amounts of data or the huge amount of data is that which is generated from conversations, comments, messages, commercial transactions, documents, etc. and it can be classified into various categories, such as, professional, personal or social big data. This big data can then be

converted to provide valuable insights into business where it can assist in effectively managing smart operations (Weber, 2019).

The other 4IR technology is cloud computing. Cloud computing entails storing and accessing data over the internet and not on computer hard drives. Because it does not require investment in complicated infrastructure, cloud computing makes processing of large amounts of big data more efficient and cost effective as it does away with direct active human management (Annosi et al., 2019). Cloud computing allows the transfer of computing services such as servers, storage, databased, software, etc., over the internet or the 'cloud' in order to deliver more efficient, effective, or quicker resources. Cloud computing facilitates access to information remotely as long as a user has access to the Internet. It has also been referred to as 'on-demand availability of computer system information' (Knorr, 2018).

The internet of things is yet another 4IR technology. The internet of things is a type of 4IR technology which uses sensors that connect everyday products to the Internet. Examples of sensors are remote controls of home appliances. Kim (2016) has defined the internet of things as "a pervasive network in which a thing, or a smart object, is equipped with embedded sensors and internet connectivity, and serves as a primary building block that facilitates interactions, communication and integration with the surrounding environment to provide intelligent, useful services to achieve common goals." The internet of things involves combining technologies that can also interact with the human environment. The aim of the internet of things is to develop an integrated and intelligent environment where time, energy and money can be saved. Another technology is 3D printing whereby computational design is used to complete processes of manufacturing, materials engineering and synthetic biology by 'printing' parts. The process eliminates the need for mass production and is both faster and cheaper. 3D printing utilises computer-aided design to create three dimensional solid objects by layering (Kim, 2016).

Artificial intelligence is another technology characterised by software and robotics that are able to undertake processes which are traditionally done by humans. Artificial intelligence technologies facilitate data collection, storage and cleaning in order to provide business insights. Artificial intelligence technologies can assist in creating insights providing visibility, predictability and automation operations (Man et al.,

2002). Another technology is blockchain. blockchain enables decentralised, public ledger storing digital information that allows for payment transactions to be public to anyone with access to the network.

Big data and cloud computing are important supplements to the internet of things and artificial intelligence. Together, these four technologies can enable a business to evolve into a so called 'system of systems' that is agile, smart and has competitive advantage. Businesses can use big data which is generated through the internet of things and stored in cloud computing in order to drive artificial intelligence that can guarantee businesses success. In other words, the four technologies, when used as a whole, can build a highway to opportunities for exploring, understanding and analysing processes with large volumes of data (Wolfert et al., 2017).

2.3 Innovation

Innovation is an increasingly important element of competitiveness (Castro et al., 2013) and the extent of innovativeness of aquaculture MSMEs may be affected by both internal and external factors. Research has shown that the use of new technologies in innovation plays an essential role in the survival of MSMEs in any competitive business environment. Innovation can be viewed as a multidimensional concept (Bakar & Ahmad, 2010).

A notable economist, Schumpeter, defined innovation in the literal sense as the introduction of a new good, the introduction of a new production method, opening of a new market, or opening of a new source of supply. The process of innovation was termed 'constructive destruction' in which businesses that did not adapt new methods were ousted by those who had adapted new methods of operations. (Schumpeter, 1934 in Nieuwenhuis, 2002).

Similarly, Lundvall (1992), described innovation as an ongoing process of exclusion, search, and exploration resulting in new products, new techniques, new organizational forms, and new markets. He gave a few examples of actions which can amount to innovation, that is, actions such as changing one's product properties, changing one's modes of delivery of goods, introducing new packaging for goods and changing the way the workplace is organised (Bayacelik et al., 2013).

Innovation has been associated with business success, performance and survival. It requires adaptive behaviour that results in changes in a business. Baregheh et al., (2012) observed that innovation can sometimes be driven by external factors and the notable factors are competition, scarcity of resources and customer demands. These external factors would require a business to adapt new methods of operation or risk becoming obsolete. Innovation was therefore defined as "a multistage process whereby organisations transform ideas into new/improved/services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace" (Baregheh et al., 2012).

Kuratko and Hodgetts (2004) defined innovation as the creation of new wealth or the alteration and enhancement of existing resources to create new wealth. The OECD Oslo Manual (2005) defined innovation as an activity that produces new or significantly improved goods (products or services), processes, marketing methods or business organization. Innovation also refers to the process of creating ideas, developing an invention and also introducing a new product, process or service to the market (Thornhill, 2006). All the foregoing definitions imply the use of technology in innovation.

2.4 Classification of MSMEs in Zambia

Despite the MSME sector being very well researched and documented with their importance very well established globally, they lack a universally accepted definition. It is notable that the definition of MSMEs is nebulous as it varies from one country to another and even within the same country, it may vary from sector to sector depending on the purpose for which the definition is sought. The definitions may use similar parameters, but the parameters differ from one jurisdiction to another. For instance, a small enterprise in the United Kingdom must satisfy at least two or more of the following requirements: it must have a turnover of not more than £5.6 million; it must have not more than 50 employees or a balance sheet total of not more than £2.8 million (UK Companies Act, 2006).

Table 2. 1: Classification of MSMEs in Zambia

	Micro	Small	Medium
Total Fixed Investment	K80,000	K80,000 - K200,000	K200,000 - K500,000
Annual Sales Turnover	K150,000	K150,000 - K250,000	K300,000 - K800,000
Number of Employees	< 10	11 – 49	51 – 100
Legal Status	Registered with PACRA	Registered with PACRA	Registered with PACRA

Source: Adapted from Ministry of Commerce, Trade and Industry (2008)

In Zambia, MSMEs are also defined based on the legal status, total fixed investments, sales turnover, number of employees and registration status but the parameters are different. Table 2.1 shows the specific parameters, and the parameters are further outlined in the subsequent paragraphs. The Zambian government rebased the currency effective 1st January 2013 following a Bank of Zambia recommendation. In view of the rebasing, the total fixed investments and sales turnover amounts indicated below have been rebased in accordance with the rebasing of the currency in order to reflect the current values.

Below is the detailed explanation of the MSMEs as per the categories outlined in the table above.

2.4.1 Micro Enterprises

According to the Ministry of Commerce, Trade and Industry (2008), a micro enterprise is any business enterprise registered with the Registrar of Companies whose total investment excluding land and buildings, is up to Eighty Thousand Kwacha (K80, 000). Further, a micro enterprise is one whose annual turnover is up to One hundred and Fifty Thousand Kwacha (K150,000) and employing between one to ten (1 - 10) persons.

2.4.2 Small Enterprises

A small enterprise is any business enterprise registered with the Registrar of Companies whose total investment, excluding land and building; in the case of manufacturing and processing enterprises, is between Eighty Thousand and Two Hundred Thousand Kwacha (K80,000 – K200, 000) in plant and machinery and in the case of trading and service providing enterprises it is up to One Hundred and Fifty Thousand Kwacha (K150,000). A small enterprise is one whose annual turnover is between One Hundred and fifty Thousand and Two Hundred and Fifty Thousand (K150,000 – K250,000) Kwacha and employs between eleven and forty-nine (11- 49) persons.

2.4.3 Medium Enterprises

A medium enterprise is any business enterprise larger than a small enterprise and is registered with the Registrar of companies whose total investment, excluding land and buildings; in the case of manufacturing and processing enterprises, is between Two Hundred Thousand and Five Hundred Thousand (K200,000 – K500, 000) Kwacha in plant and machinery and in the case of trading and service provision is between One Hundred and Fifty-One Thousand and Three Hundred Thousand (K151, 000 – K300,000) Kwacha. A medium enterprise is one whose annual turnover is between Three Hundred Thousand and Eight Hundred Thousand) (K300,000 - K800,000) and the business employs between Fifty-One and One Hundred (51 -100) persons.

2.5 Overview of MSMEs

MSMEs in Zambia account for 97% of all businesses in the country. They contribute 70% towards GDP and make up 88% of job creation or employment (International Trade Centre, 2019). MSMEs, as they are increasingly recognized as central contributors to innovations, play a pivotal role in the national economies of countries all around the world. The activities of SMEs affect any country's economic growth and prosperity because they have the potential to employ large numbers of people and thereby have the potential to reduce poverty (Halabi & Lussier, 2014).

In Nigeria, Italy, Japan and France for instance, the number of SMEs accounts for 99% of the total number of enterprises. In the United States there were more than 2000 million SMEs, accounting for 98% of the total number of enterprises (Liu et al., 2012).

In Turkey SMEs constitute 99.9% of the total number of enterprises (Karpak & Topcu, 2010). Similarly, MSMEs account for 97% of all businesses in Zambia (International Trade Centre, 2019; Ministry of Commerce Trade and Industry, 2008;).

It is undeniable that MSMEs contribute to the country's GDP by increasing chances of forthcoming and diverse economic growth (Ministry of Commerce, Trade and Industry, 2008). MSMEs in Zambia cut across all sectors of the nation's economy, ranging from manufacturing and mining to, services and trading. Manufacturing represents 41%, trading 49%, while mining and services represent 10% of the MSME sector categorisation (Munalula et al., 2017). The focus of the research was the agricultural sector, which falls under the trading category, and in particular, the aquaculture sub-sector. The aquaculture sub sector has great potential for diversification, gainful employment and reduction in poverty. 29% of total fish production in Zambia comes from aquaculture and the rest from capture fish production (Kakwasha, 2020).

Since independence, Zambia has been endeavouring to diversify away from the economically predominant copper industry, the first effort being a call in the FNDP to diversify away from copper and venture into other sectors like agriculture and manufacturing. Agricultural diversification is defined in the National Agriculture Policy (Ministry of Agriculture, 2016) as a shift away from dominance by one crop to include livestock and fisheries production. Crop diversification is referred to as a shift to the production of a number of crops.

However, the call for diversification resulted in support towards the agricultural sector which concentrated on maize production at the expense of other crops, livestock and fisheries. The 7NDP attempted to remedy the problem of agricultural diversification which mainly focused on manly maize production by first and foremost identifying agriculture as being one of the sectors into which the economy must diversify. The 7NDP went further to provide a deliberate strategy which was aimed at promoting agricultural diversification in crops, fisheries, livestock and forestry products (Ministry of National Planning Development, 2017).

Several studies have demonstrated that crop diversification is strongly associated with increased agricultural income (Food and Agriculture Organisation, 2018; Pellegrini & Tasciotti, 2014). The aquaculture subsector has been recognized as having potential to contribute towards the economy because it provides an opportunity for improved

nutrition, income generation and job creation which can result in general wealth creation and food security at national and household levels. At national level, the aquaculture sub-sector can contribute towards national GDP (Ministry of Agriculture, 2016). The sub sector can contribute towards enhancing household income and providing additional protein thereby reducing poverty levels.

This is evidenced by the tremendous positive trajectory of aquaculture production from 12,988Mt in 2012 to 32,888Mt in 2017 (Department of Fisheries, 2017; 2018). Despite this increase in production, Zambia continues to face a huge deficit in meeting the growing demand for fish. The deficit is estimated at 185,000Mt per annum against the current production rate of 100,000Mt per annum. The huge deficit in meeting the growing fish demand has driven the country into becoming an importer of fish. For instance, in 2015 Zambia's fish imports volume was 77,199 metric tonnes which increased to 126,345 metric tonnes in 2016 (Department of Fisheries, 2017).

2.6 Use of 4IR Technologies by Aquaculture MSMEs

MSMEs are looking for ways that can help them to remain competitive, innovative, and profitable. 4IR incorporates technologies which can help MSMEs to access and analyze data that will lead them to prosperity. This means that 4IR technologies can be adopted as a strategy of business growth. However, 4IR technologies are not sufficiently used by SMEs (Maroufkhani et al., 2020), even though technology and innovation have the potential to grow them as they improve their performance and create new knowledge that can be used to grow the businesses (Shah et al., 2017). Loon and Chik (2019) argue that when SMEs are innovative, when they acquire and use appropriate technology that is efficient and innovative, they will have a better chance of becoming efficient at what they do. However, a relatively low number of MSMEs in developing countries are using 4IR technologies (Potter, 2015).

4IR technologies can be used by aquaculture MSMEs for monitoring of their operations, control and surveillance. 4IR adoption can bring efficiencies in terms of cost, productivity and innovation and can improve access to searchable knowledge that compensates for limited expert staffing and achieving accuracy as well as helping personnel find what they are looking for more quickly. Given the shortage of experts, the time saved in accessing and loading data is important. Aquaculture MSMEs can leverage on 4IR technologies to enhance operations, improve efficiency, risk

management, personalised marketing and customer service, financial management and competitive intelligence (Lin et al., 2020)

It was demonstrated in Norway how big data for example, allowed for a faster production rate by accelerated time-to-production through minimising data bottlenecks that can reduce asset team productivity. In addition, 4IR technologies capacitated for faster decision-making by aquaculture MSMEs because they were able to undertake risk profiling and forecasting effectively and efficiently. 4IR technology was also very helpful in asset development by improving asset uptime and predicting the need for assets related to operational demands (Akerkar & Hong, 2021). The main innovation 4IR instruments are discussed below.

2.6.1 Big Data

Big data refers to enormous data sets that would be impossible for any single human to handle thereby demanding the help of specific technology and analytical methods using automated systems. Ahmadi et al., (2016) argue that there is no universal definition for the term "big data". From the different definitions that are available, the three key words that surface are: volume (high volume – quantity of data), velocity (high velocity – the speed of data), and variety (variety – different data generated). This means that big data can be summed up as data that is generated in high volume, at a very fast speed and that varies.

Companies need to mine and analyze data and they need the tools and skills to do this. However, they must have the relevant resources for it. The world is currently data driven. It is stated that organizations must use big data so that they can remain competitive at all times (Kobayashi et al., 2018). This includes SMEs among the organizations that should gain leverage from big data. Ahmadi et al., (2016) state that SMEs need training and the transfer of skills to be able to make sense of the data they mine and analyze. This will help them to gain a clear picture of what their customers or clients want and need.

Figure 2. 2: Benefits of big data

Source: Ahmadi, M., Dileepan, P., and Wheatley, K. K. (2016)

Ahmadi et al., (2016) find that big data can play a critical role in the following three areas:

a) Business efficiency – big data can improve the efficiency of the business by understanding customer intelligence by predicting buying behaviour using augmented social media profiles. This can also be improved by detecting fraud and improving the supply chain.
b) Business innovation – big data can lead the organization into innovative products or services or even to introducing new products into the organization and
c) Business creation – big data decreases the entry barriers to business, and it also helps in identifying signals and areas that are profitable in the market.

Figure 2.2 illustrates the three benefits of using big data outlined above.

The main characteristics of big data, are called the 5 V's, representing high volume, high variety, high velocity, veracity and high value. These are information assets that demand cost-effective and innovative forms of information processing which enable enhanced insight, decision making and process automation for its transformation into high value (Gartner, 2017)

This is extremely important to organizations, as they have to remain competitive, relevant, and responsive to the wants and needs of their customers (Maroufkhani et al.,

2020; Shah et al., 2017). Additionally, data that is of high quality must be used so that the organizations can improve their strategies and subsequently improve their performance (Santoro et al., 2017).

Aquaculture MSMEs in China are increasingly utilizing big data to enhance their operations and achieve sustainable growth as they are able to collect, analyse, and interpret vast amounts of information, enabling them to make informed decisions and improve various aspects of their businesses thereby optimizing feed management, monitoring water quality parameters, enhancing disease detection and prevention, streamlining supply chain logistics, and making data-driven marketing decisions (Lin et al., 2021; Wang et al., 2020).

2.6.2 Cloud Computing

Aquaculture MSMEs in Lusaka generate a lot of data relating to *inter alia,* stocking, feeding regimes, growth rates, mortalities, water samples, production estimates and incomes. Notable however, is the fact that most of this information is written, correlated and retained in paper records and paper records have the potential of being misplaced, destroyed, etc. Cloud computing provides a solution to better managing data generated by aquaculture businesses. The cloud refers to software and services that run on the Internet instead of one's computer such as Apple iCloud, Dropbox, Netflix, Amazon Cloud Drive, Flickr, Google Drive, Microsoft Office 365, Yahoo Mail, etc.

One major advantage of using cloud computing is that all information, ranging from videos, photos, documents, etc, can be accessed by using any device provided it can be connected to the Internet (Luening, 2015). With the increased availability of internet enabled devices in Lusaka, MSMEs can utilise cloud computing and be able to bring data management into their hands. This will cut down on the one-way stream of data flow which restricts access to information by the workers. Instead, the workers collect information which they escalate to their administrators and managers and there is no flow back down to the workers. Cloud platforms facilitate easy access to data from anywhere thereby enabling collaboration and real-time decision making (Lin et al., 2021).

2.6.3 The Internet of Things

With the introduction of the 4IR comes the Internet of Things (IoT) which calls for the development of a 'smart aquaculture management system.' In India, the IoT has enabled aquaculture MSMEs to be able to continuously monitor and collect real-time data on parameters such as water temperature, quality, dissolved oxygen levels, salinity fish health, and feeding behaviour which has ultimately resulted in an improvement in production yield and profitability (Yadav et al., 2022). Aquaculture entails growing fish in earthen ponds or confined artificial water bodies such as concrete ponds or tanks and this calls for constant monitoring of the water quality to ensure maximum productivity. The water quality in these ponds and tanks is prone to declining quickly and this can adversely affect the health and growth of the fish hence the need to maintain the correct temperature, pH level, quality supply of oxygen, and dissolved ammonia level (Wang, et al., 2021).

The IoT can be used to create an appropriate fish monitoring system for aquaculture in which the aquaculture MSME can measure the water quality factors and monitor the health of fish in real time. By measuring the most important water parameters, the cost of monitoring the water quality will reduce and ultimately there will be an increase in the production level. The IoT enabled devices can be used by aquaculture MSMEs to monitor their operations and enable them to maintain a satisfactory environment for maximum production, profitability and sustainability (Tamim et al., 2021).

2.6.4 Artificial Intelligence

Aquaculture has developed in tandem with the era of advanced technology requiring a shift from the traditional practices to adopting smart technology that uses artificial intelligence (AI) to predict and provide insights into a wide range of operations aimed at improving the ability of aquaculture MSMEs to monitor, control and document key factors affecting their undertakings. This enables them to fine tune operational decisions, improve fish health and achieve higher efficiencies and profit (Korus, 2021).

AI technology can be used to improve the production process by monitoring the growth of underwater parameters, judge, discuss and analyse problems, and then perform feeding, disease treatment, and breeding (Daoliang & Changd, 2020). AI has the potential to improve aquaculture by making MSME aquaculture farmers understand the

analytics of how their inputs affect fish growth under various conditions. In addition, Wang et al., (2021) posit that AI models can assist in early detection of diseases, optimising feeding regimes, predicting growth rates and improving overall production and efficiency.

2.7 Measures of Entrepreneurial Performance

Performance measurement and performance management practices have become common place in all businesses. The knowledge of the association between technology in innovation and performance offers practical insights for proper management of aquaculture MSMEs. As noted by Forsaith and Hall (2000) and Rogoff et al., (2004), firm performance is a multi-faceted concept, which includes indicators such as survival, profitability, sales growth, number of employees, firm reputation, production, finance or marketing (Wolff & Pett, 2006).

Studies have described firm performance in terms of how organizational objectives are well achieved (Jarvis et al., 2000). Therefore, MSME performance can be assessed by examining how successful an organization is in achieving its goals (Gerba and Viswanadham, 2016). Scholars have argued that performance of SMEs can be described as the firms' ability to produce suitable outcome and actions (Chittithaworn et al., 2011). However, Gerba & Viswanadham (2016) opined that performance can be in terms of both financial and non-financial performance. This would include return on investment (ROI), sales volume and value, profitability, total assets, employment size, capital employed, market share, customer satisfaction, productivity, turnover, delivery time and employee's turnover, etc.

A significant problem in the measurement of performance outcomes of entrepreneurship is to reach consensus on suitable measures of performance. Research points to the fact that rigorous construct measurements are critical for the advance of science, particularly when the variables of interest are complex or not observable. Paradoxically, strategic business management has been criticized for not giving this topic a high priority (Boyd et al., 2013). The lack of measurement accuracy affects quantitative research quality and masks true relationships (Venkatraman & Grant, 1986). This is particularly critical in the case of firm performance, one of the most relevant constructs in the field and a construct commonly used as the final dependent

variable (Richard et al., 2009) in various fields (Cho & Pucik, 2005; Sila & Ebrahimpuor, 2005; Wiklund & Shepherd, 2003).

Despite its relevance, research into firm performance suffers from problems such as lack of consensus, selection of indicators based on convenience and little consideration of its dimensionality (Richard et al., 2009). Many studies measure firm performance with a single indicator and represent this concept as unidimensional, even while admitting its multidimensionality (Glick et al., 2005). If several dimensions exist, a researcher should choose the dimensions most relevant to his or her research and judge the outcomes of this choice (Richard et al., 2009).

In this thesis, the researcher confines the attention of the study to performance at the level of the MSME. While a range of financial and non-financial indicators have been suggested as measures of performance, prior research has tended to focus on variables for which information has been easy to gather (Cooper, 1994). Reviews of the literature by Ardishvili (1998), and Delmar (1997) found possible indicators of performance which include assets, employment, market share, physical output, profits and sales. Several researchers suggest growth as the most important performance measure in small firms, with growth being a more accurate and easily accessible performance indicator than accounting measures, and therefore superior to indicators of financial performance (Wiklund, 1999).

Lumpkin and Dess (1996) suggested that performance is multidimensional in nature and as such multiple measures of performance should be considered. The relationship between the different measures of performance can be complex in nature with growing firms not necessarily performing better when financial performance is taken into account. Firms may also trade off performance along different dimensions, choosing, for instance, to trade-off long term growth for short term profitability (Zahra, 1991). As such, the relationship between these measures warrants further research if a better understanding of firm performance is to be gained.

Delmar et al., (2003) discussed the various performance measures and suggested that if only one indicator had to be chosen as a measure of firm growth, then the preferred measure of growth should be sales. Sales figures are relatively easy to obtain and reflect both short term and long-term changes in the firm. In addition, as Barkham et al., (1996) points out, it is also the indicator favoured by entrepreneurs themselves. Other

arguments for using sales growth are based on the growth process being driven by demand for the firm's products and services. Increasing sales will allow growth along other dimensions such as employees and assets. Sales though, may not always the best measure of performance.

Delmar et al., (2003) note that start-up and high technology firms may grow significantly in employment and assets before any significant sales are made. As a result, growth in employment and assets should also be considered as performance measures. Employment has been considered an alternative measure for performance and with the public interest in new employment there are arguments that employment growth is an important dimension to capture (Wiklund, 1999).

Measuring performance by employment growth can be problematic though, since this measure can be affected by productivity changes, replacement of employees with capital investments and outsourcing of activities. As a result, a firm can grow significantly in output without any increase in employment (Delmar et al., 2003). Growth in assets is another useful performance measure that has been considered. However, measuring growth in terms of assets can be difficult from an accounting perspective. Service firms for example may have considerable intangible assets which may not be reflected in the firms' balance sheet (Wiklund, 1999). Other problems include differences in capital intensity ratios across industries (Delmar et al., 2003).

However, when measuring performance of SMEs, previous studies have used either a subjective or objective approach to measuring performance (Hakimpoor et al., 2012). This is due to problematic operations of the SMEs. For instance, Hakimpoor et al., (2012) posit that most small firms are privately held, thus it is unlikely that their CEOs will be willing to provide detailed data on the firm's performance. Such situations make the researchers use either objective or subjective approaches. Generally, the choice of the approach used depends on the availability of data.

The literature provides various performance indicator variables such as profit figures (EBIT), growth of employment or turnover, employee morale, survival, market share, return on sales, return on assets which have been used to measure performance in SMEs. However, Haghighinasab et al., (2013), argue that performance can be measured based on sales growth, market share and profitability. In this regard, since there is no agreement on what constitute the variables to be used on performance of the SMEs, this

study will adopt the Haghighinasab et al., (2013) way of measuring performance where growth, market share and profitability were used. These performance variables used in MSME studies are discussed in the paragraphs that follow.

2.7.1 Sales Growth

The use of sales growth as a measure of firm performance is generally based on the belief that sales growth is a precursor to the attainment of sustainable competitive advantage and profitability (Daniel, 2018). The growth rate of sales plays an important role in an innovative company performance. (Daniel, 2018; Feng et al., 2017; Gaur and Kesavan, 2015; Haghighinasab et al., 2013; Herri, 2011; Kim et al, 2016). This is the increase in firm's sales over a particular period, usually given as a percentage. The company's sales growth is basically influenced by internal and external factors.

Internal factors come from within the company and can affect the performance of the company. They can be regulated and controlled by the company and may include the decision to increase company's capital, the addition of labor, the determination of proportion of retained earnings, mergers, acquisitions, determination of debt for investment, managerial structure etc. External factors come from outside the company and cannot be controlled by the company. These are raw material prices, competitors' behavior, macroeconomic and political conditions, lending rates, business climate and market structure. If these factors indicate a positive value, they will increase the company's sales growth.

While sales growth has been considered the most important measure in small firms, it has also been argued that financial performance is multidimensional in nature and that measures such as financial performance and sales growth are different aspects of performance that need to be considered (Wiklund, 1999). It has also been argued that firms grow in many ways and that a firm's growth pattern is related to age, size and industry (Delmar et al., 2003). Delmar et al., (2003) also point out that firm growth is not static in nature and there may be considerable variation in firm growth over time. As such, the dynamic nature of growth is an area worthy of investigation (Lechner, et al., 2016; Parida, et al., 2016). In general, the results of previous research allow us to draw the conclusion that sales growth plays an important role in improving firm performance.

2.7.2 Market Share

This is the portion of the market controlled by an MSME operator in a particular industry (Haghighinasab et al., 2013). Market share is calculated by taking the company's sales over a period and dividing it by total sales of the industry over the same period. It can also be described as a percentage of total sales volume in a market captured by a brand, product or company. Market share is said to be a key indicator of market competitiveness, that is, how well a firm is doing against its competitors.

Research has shown that marketing generates gains in market share in contexts of economic growth when the company has been financially reinforced. The economic context (Lyons, 2013), which works as a discriminatory stimulus, is fundamental for clarifying the effects of marketing for the firm. In a situation of economic growth combined with prior reinforcement, the effect of marketing is maximized. This enhancement is due to the greater number of pecuniary exchanges between companies and consumers as a whole in times of prosperity (Jackson, 2017), and because of the obtainment of prior financial reinforcers (Vella & Foxall, 2011; 2013) the company tends to have more effective marketing in subsequent situations. Companies that achieve a large market share and are therefore more competitive (Dhakecha, 2013), tend to maintain or increase it in subsequent situations and end up becoming profitable.

As such, market share or relative market share has been used in research as an independent variable and as a measure of competitive strength. Among studies that used market share, Bert and Guariglia (2015) found a positive relationship between market share and profitability. This relationship was significantly greater when the industry was highly concentrated, or industry growth was medium but there was no significant effect in cases of rapid industry growth. Rostamkalaei and Freel (2016) also found a significant positive relationship between market share and profitability.

The most common explanation as to why market share leads to higher profitability are higher economies of scale, experience and market power (Chen & Mintz, 2017; Cingano et al., 2016). Economies of scale provide larger firms with cost advantages (Lechner et al., 2016; Parida et al., 2016). However, most studies indicate that economies of scale dissipate at a small percentage of the market. Powell and Eddleston (2017) postulated the efficiency hypothesis as a possible explanation of the market share effect.

According to the efficiency hypothesis, market share is the consequence of efficiency rather than its cause. Differences in profitability among firms are due to higher efficiency. Efficient firms obtain a large market share and earn high profits which induce a causal association between size and profitability. Firms offering products that offer customers greater value enjoy gains in market share. Better managed firms that have a competitive advantage grow faster than rival firms. Firms with superior skill and foresight gain market share through lower prices or through better products. Tripathi and Kirti (2015) and Ali (2016) provide evidence that smaller-share competitors are equally or even more profitable than larger rivals.

In general, the results of previous research allow us to draw the conclusion that market share plays an important role in improving firm performance in terms of profit. Based on this result, it is not possible to use this variable in this study because first, it is a dependent variable and acts as a predictor of profit. The second reason is that it is not possible to get the logs of total revenue of an MSME ***i*** in time ***t*** divided by total revenue of the industry in time ***t.***

2.7.3 Profitability

Profitability is another important measure of performance that must be considered as it is unlikely that firm growth can be sustained without profits being available for reinvestment in the firm. Growth along this dimension can be considered in terms of net profit margins or return on assets. If we take the definition of entrepreneurship as the creation of rents through innovation (Stewart, 1991) where rents are defined as above average earnings relative to competitors (Norton, 2002), then profitability measures are particularly appealing. This also implies that economic success is required by high performance firms. Alternative views are given by Delmar et al., (2003), who point out that while profits are an important indicator of success, the relationship of profits to size is only evident in an aggregate of firms or over long periods for individual firms.

Profitability is reported on the income and expense statement. Basically, the accrued net income is the profit a firm has generated for the fiscal period being reported. It is very important to use the accrued income and expense statement to calculate profit and not a cash statement. Profitability measures the size of the profit relative to the gross and net capital invested in the business. Profitability ratios are used to compare the

performance or efficiency of a business to a set of established standards (or benchmarks) for the industry or sector, or by comparing one business against others. The gross capital of a business is the total assets, and the net capital in a business is the total equity the firm owner has in his business.

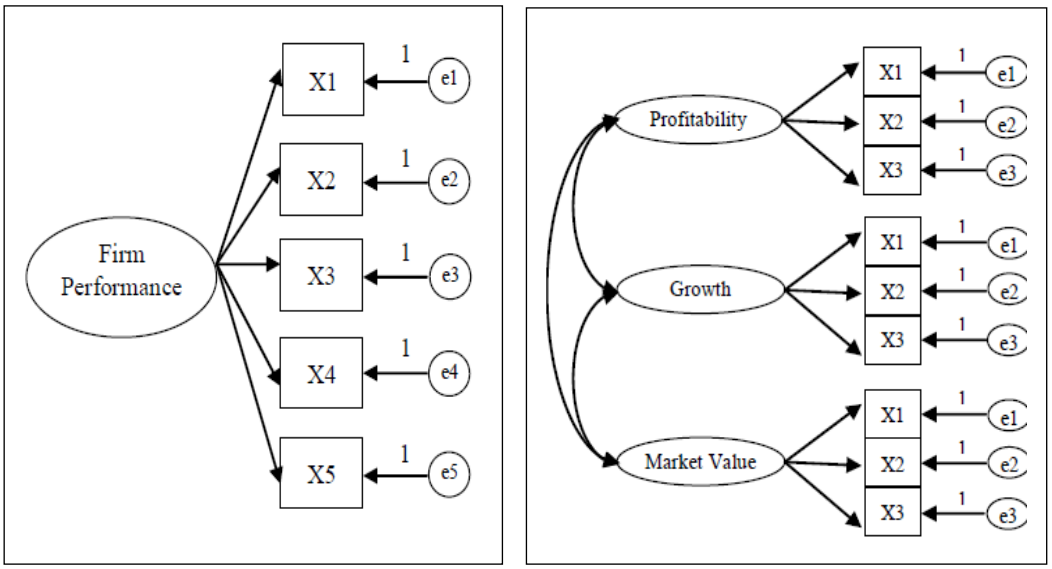

Figure 2. 3: Unidimensional and Multidimensional Representation

Source: Santos, J.B., & Brito, L.A. (2012)

The constructs of profitability can be unidimensional or multidimensional (Santos & Brito, 2012). Figure 2.3 presents two models to elucidate these possible representations of firm performance (only a few dimensions were used for simplicity purposes). Although there are widely used measurements of firm performance which are related to many fields, the researcher has tried to execute the various forms of measurement regarding those that may be appropriate for MSMEs.

Unidimensionality, the left-side model, implies that all the indicators illustrate the performance of the firm in an almost interchangeable way. Indicators in this case should be highly correlated. Multidimensionality suggests that each dimension symbolizes one facet of the overall result of the company, and is represented by a particular group of indicators. Observed indicators of the same domain should cluster

together in one dimension, having higher correlations among themselves than with indicators of different dimensions. Theoretical perspectives and empirical studies point toward multidimensionality, with multiple dimensions that make up the complex and complete notion of performance. Below there is a unidimensional and multidimensional representation of performance.

Based on the stakeholder theory, unidimensionality would mean that all the stakeholders have similar demands and needs, but this is unlikely (Simerly & Li, 2000). Unidimensionality would be a simplistic representation for such a complex construct (Abdullah et al., 2008; Cameron, 1986; Steers, 1975). Additionally, indicators used to measure different aspects of performance have already been submitted to factor analysis by several authors who found multidimensional structures (Baum & Wally, 2003; Bozec et al., 2010; Chari et al., 2012; Cho & Pucik, 2005; Combs et al., 2005;).

A complete analysis of multidimensional constructs needs to explore the existence of second-order structures that can group first-order dimensions. Glick et al., (2005) suggest that firm performance could be conceptually represented by one second-order construct reflecting itself on its first-order dimensions (Figure 2.3, model on the left). These first-order dimensions, although different from each other, would be symptoms of a more general, higher order: performance (Glick et al., 2005). This would require all dimensions to have positive and strong correlations.

The Venkatraman and Ramanujam (1986) conceptual model suggests an alternative representation, in which performance would have two second-order dimensions: the financial one, represented by profitability, growth and market value; and the operational domain, that includes non-financial competitive aspects, like customer satisfaction, quality, innovation, employee satisfaction and reputation (Figure 2.3, model on the right). The researcher, however, prefers the name strategic performance to operational performance on the right which could form the dependent variables for this study.

2.8 4IR in Innovation and Growth in Sales

The relationship between the use of new technologies in innovation and firm growth in sales has been confirmed in both empirical and theoretical studies. Several studies have established a positive relationship between the two variables. For instance, Hajar's (2015) research regarding the relationship between the use of technology in innovation

and growth in wooden furniture sales SMEs in Indonesia found that the use of technology in innovation had a positive effect on growth in sales of SMEs. Other studies which were conducted on the automotive industry in Turkey revealed that the use of technology in product and process innovation had a positive and significant impact of MSME performance (Kuswantoro, 2012; Sattari, 2013).

Some scholars such as Calantone et al., (2002) also posit that innovation using new technologies enhances MSME growth in sales. Calantone et al., (2002) examined the relationship between MSME use of technology in innovation and growth in sales in US based SMEs and found that the use of technology in innovation improved MSME growth in sales. In Kenya and Tanzania, research established that SMEs which adopted new technology in their various operations were able to grow. The studies established a positive relationship between the variables (Isaga, 2012; Mbizi, 2013; Ngungi, 2013).

Carol and Marvis (2007) examined and established the relationship between technology in innovation and organizational performance of Taiwanese SMEs in the manufacturing and service sectors. Their study revealed that the adoption of new technology in innovation resulted in an increase in terms of sales. Van Auken et al., (2008) assessed the relationship between the degree and type of technology used in innovation and performance among a sample of 1,901 Spanish manufacturing SMEs and their study revealed evidence of a positive relationship between technological innovation of the product, process and managerial/systems and enhanced growth in sales.

Similarly, Garrido and Camarero (2009) investigated the relationship between new technology in innovativeness and performance and the findings of their study reveal that such an undertaking significantly improves growth in sales. Also, Terziovski (2010) studied the use of technology in innovation practice and its effects on growth in sales of Australian SMEs. The study revealed that new technology in innovation is a key driver to enhanced growth in sales of SMEs.

The researcher posits that there is a positive link or relationship between the use of 4IR in innovation and enhanced growth in sales and that MSMEs which have adopted new technologies in innovation have been able to improve their growth in sales and have been able to continue in business. The lack of technological innovation by MSMEs is the reason for their poor growth in sales and high mortality rate. The study will

concentrate on the effects of using big data, AI and the IoT in innovation in business operations.

2.9 Theoretical Framework

The study is founded on four notable theories, i. e. Schumpeter's Innovation Theory, Mckinsey's Three Horizons Model, the Diffusion of Innovations Theory and the Technology Acceptance Model. The theories are discussed in detail in the paragraphs that follow.

2.9.1 Schumpeter's Innovation Theory

An investigation of the use of new technologies in innovation by aquaculture MSMEs and its impact on their growth in sales was the objective of the study. The traditional explanation of the positive relationship between firm level innovation and firm performance rested on Schumpeter's innovation theory of 1942. This theory explains the need to continue using new technologies in innovating as the market changes. By so doing, aquaculture MSMEs stand a better chance of improving their growth in sales.

Schumpeter, a German economist and political scientist was the first to define innovation and established its relationship to firm performance. He propounded the theory of economic development and linked economic development to entrepreneurship and innovation as major drivers of economic progress (Schumpeter, 1934 in Russell et al., 2020). This entrepreneurial process he coined as 'creative destruction', i.e., creating something new while destroying something old.

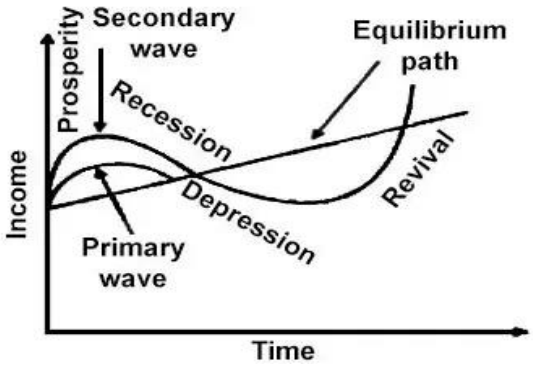

Figure 2. 4: Schumpeter's Innovation Theory

Source: Zaman (2020)

Creative destruction is likened to a cycle of death and rebirth whereby an innovation is introduced by an entrepreneur, which renders a contemporary idea obsolete and it dies. The death creates room for the new idea (Figure 2.4). But with the passage of time, the new idea also becomes old, hence the need to continuously innovate. Creative destruction therefore asserts that the market and the economy will remain dynamic and keep changing (Schumpeter, 1934 in Russell et al., 2020) and in order for aquaculture MSMEs to continue to exsist, they have to continue innovating.

Schumpeter's innovation theory was used to investigate the use of new technologies in innovation among aquaculture MSMEs. The theory has been used in the past to ascertain the link between innovation and firm performance. Schumpeter's theory assumes that there is a set of purposive innovation strategies aimed at enhancing firm performance. It is premised against the background of inevitable diminishing of profit over time and the need to counter the reduction. The solution of which is to innovate (Freel S. M., 2000; Porter & Kramer, 2019). According to Schumpeter, the market system is a process that is never stationary, it is instead continuously ongoing or perennial. As such there is a need to provide a conducive environment which allows the process of creative destruction to unfold and not environments which protect the *status quo*.

2.9.2 Mckinsey's Three Horizons Model

Schumpeter's theory was supplemented in the study by Mckinsey's Three Horizons Model (McKinsey & Company, 2009).

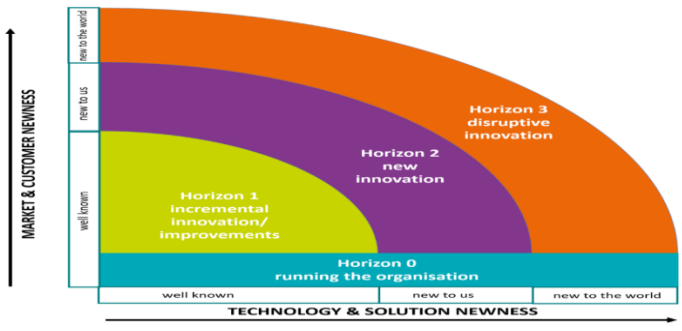

Figure 2. 5: Mckinsey's Three Horizons Model

Source: Oomen (2019)

Mckinsey's Three Horizons Model is a tool for thinking and planning about transformation and how to bring it about. The model provides insight into possible alternative futures. Arising from Schumpeter's and Mckinsey's theories, it can be stated that innovative new products, when first introduced to the market face limited direct competition and, as a result, allow firms to enjoy relatively high profits. Over time however, these high profits are likely to erode due to imitation and competition by other firms, but firms that continue introducing innovative new products and processes are most likely to be able to achieve high profitability for sustained periods of time. Mckinsey's Three Horizons Model is illustrated in Figure 2.5 above.

Mckinsey's Three Horizons Model was utilised in determining the best combination of new technologies in developing innovation strategies by MSMEs in the aquaculture agricultural sub-sector. The four new technologies are big data, cloud computing, the IoT and AI.

2.9.3 Diffusion of Innovation Theory

This idea was first discussed by Gabriel Tarde in 1903 and the theory was improved upon by Everett Rogers who introduced the five adopter categories (Rogers, 2003).

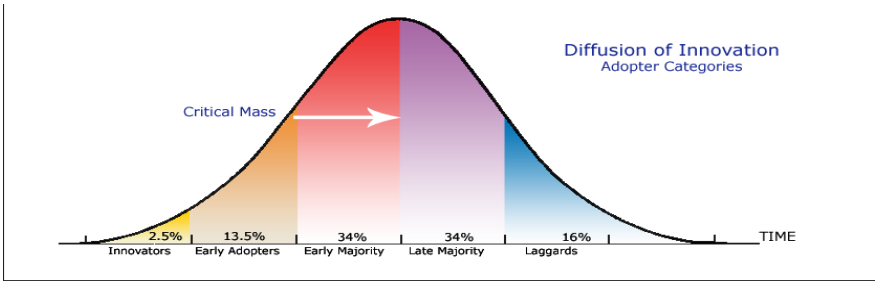

Figure 2. 6: Diffusion of Innovations Theory

Source: Rogers (2003)

The diffusion of innovation relates to the process where the use of an innovation spreads over time throughout a marketplace and via multiple categories of adopters. It explains technology adoption. The theory identifies five categories of adopters as illustrated in Figure 2.6 above.

The theory is useful in identifying the target group and who the first adopters will be. It also helps in determining at what point in time the others should be brought on board.

The theory identifies five cohorts: innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and the laggards (16%) (Kaminski, 2011).

The 2.5 % innovators are the technology enthusiasts. They accept technology without hesitance and they are moved by the idea of being the first to adopt change. They quickly understand and begin to apply technology to cope with uncertainty. The next category are the early adopters, making 13.5%. These are visionaries who believe in high returns from risky undertakings. They are interested in utilising new technology in order to survive in a competitive environment. The early majority yearn for proven applications because they want to avoid risk. They only adopt new technology upon assurance from another person who would have used the technology and proven it worthwhile (Rogers, 2003).

The next category is that of the late majority. These are people who are very cautious and skeptical and very slow to adopt new technology. They are not risk takers and would only adopt new technology if it is prescribed by a trusted advisor. The early and late majority each make up 34%. The last category is that of the laggards, who take up 16%. These are very suspicious of any new technology. They would rather remain in their status quo unless all other alternatives are worse off. They believe that technology is a hindrance to progress and they would rather 'do things as they have always done' (Rogers, 2003).

2.9.4 Technology Acceptance Model

The Technology Acceptance Model (TAM) was developed by Davis (1989). It is used to predict the use and acceptance of information systems and technology by individual users by the determination of two key attitudinal components: perceived usefulness (PU) and perceived ease of use (PEOU). TAM proposes that "perceived ease of use and perceived usefulness of technology are predictors of user attitude towards using the technology, subsequent behavioral intentions and actual usage. Perceived ease of use was also considered to influence perceived usefulness of technology" (Masrom, 2007).

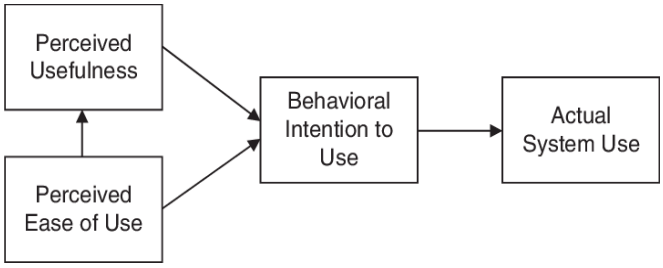

Figure 2. 7: Technology Acceptance Model

Source: Akhlaq & Ahmed (2015)

Perceived usefulness is defined as the prospective user's subjective probability that using a specific application system will enhance their job or life performance. Perceived ease of use can be defined as the degree to which the prospective user expects the target system to be free of effort. These two factors can be influenced by various external variables (McCormack et al., 2022). Masrom (2007) asserts that "both PU and PEOU are considered as distinct factors influencing the user's attitude towards using the technology, though perceived ease of use is also hypothesized to influence perceived usefulness and attitude towards using the technology. Finally, such attitude towards using the technology determines the behavioral intention to use that technology." An illustration of the TAM is given in Figure 2.7 above.

2.9.5 Application of the Theories to the Study

The study was founded on a synergy of the above-mentioned theories. On one hand and in accordance with Schumpeter's theory, the study asserted that there was a need for aquaculture MSMEs to constantly explore and utilise new technologies in innovation if they are to survive in the current competitive environment (Porter & Kramer, 2019). The Diffusion of Innovation Theory further assisted the researcher to classify technology adoption based on the five (5) cohorts and the type of intervention requited for aquaculture MSMEs to become profitable and sustainable. On the other hand, the Technology Acceptance Model and Mckinsey's Three Horizons Model provided tools enabled the researcher to identify the factors that influence the acceptance of new technology and to develop an acceptable strategy comprising of possible innovative strategies which would ensure aquaculture MSME profitability and survival (McKinsey & Company, 2009).

Authors such as Atalay (2013) support the use of the two theories in improving firm growth in sales. In his article entitled "The Relationship between Technology, Innovation and Firm Performance, Atalay (2013) posits that "technological innovation is widely regarded as one of the most important sources of sustainable competitive advantage in an increasingly changing environment because it leads to product and process improvements, makes continuous advances that helps firms to survive, allows firms to grow more quickly, be more efficient and ultimately be more profitable than non-innovators."

Other researchers have established that firms and countries that continuously use technology to innovate contribute significantly to economic growth and it is not a coincidence therefore that countries like China, India, USA, Japan and some European countries, which demonstrate the highest intensive adoption of new technologies in MSME innovative activity, are the leaders of the ladder of economic development worldwide (Bach, 2019; Chen, 2018).

2.10 Conceptual Framework

Schumpeter's Innovation theory has been used to develop the conceptual framework requiring aquaculture MSMEs to 'disrupt'.

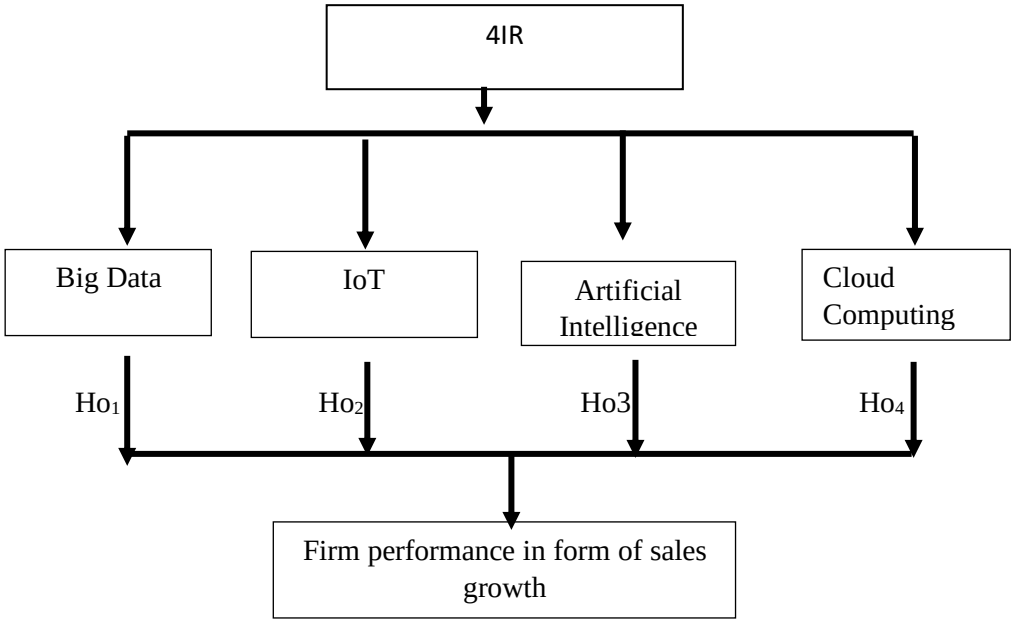

Figure 2. 8: Conceptual Framework

Source: Researcher

The conceptual framework was developed to examine the impact of 4IR on the performance of the aquaculture SMEs. Therefore, the conceptual foundation of this study is anchored on what the reviewed literature points out regarding factors that influence MSME performance as depicted in Figure 2.8. The conceptual framework is appropriate for this study because it has the necessary variables. The study assessed four independent variables and one dependent variable. The conceptual framework shows the probable impacts between 4IR technologies in innovation and firm performance. The independent variables (IV) are big data, cloud computing, the IoT and AI. The IV's can have a positive effect on the dependent variable (DV) which is growth in sales (Joseph et al., 2014). The second order null hypothesis posits that the use of the big data, cloud computing, the IoT and AI technologies in innovation have no impact on sales growth.

2.11 Gaps in the Literature

Several studies have been conducted regarding the effects of using new technologies in innovation on the performance of SMEs. However, it is notable that there is less focus in the literature on the use of new technology among the aquaculture MSME sector especially in Zambia. (Ar & Baki, 2011; Carol & Marvis, 2007; Halabi & Lussier, 2014; Harrigan et al., 2011). For instance, an empirical study was conducted by Atalaya and Sarvan (2013) on the relationship between the use of technology in innovation and firm performance and another research on determining innovation factors for SMEs which were both conducted in Istanbul, Tukey in the motor industry (Bayarçelika et al., 2014).

Another example is a review of empirical evidence on the impact of the use of new technology in innovation on the performance of small and medium enterprises which was carried out in Tanzania by Ndesaulwa and Kikula (2016). This was a worldwide empirical study on the relationship between use of new technologies in innovation and MSME performance but the said study only concentrated on the Western, Middle Eastern and the Far Eastern countries and very little empirical evidence is noticeable on Africa. The study focused on cross sector SMEs and was not limited to only those in the agriculture sector.

In Zambia, literature abounds on agricultural production methods covering areas such conservation agricultural technology and technology embodied in inputs such as seed, pest control, fertiliser, etc, but there is not as much literature addressing the use and effects of improved technologies among aquaculture MSMEs in processing and distribution of their products and services. One example of studies covering aspects other than the use of new technologies in the Agro sector was the one conducted by Abdulai et al., (2021) on the adoption and diffusion of conservation agriculture technology in Zambia whose data was collected from smallholder farmers in selected provinces in Zambia to examine the role of social and institutional networks as well as other farm and household factors in the adoption and diffusion of conservation agriculture technology.

Another example is the study which was carried out by Botha (2020) among farmers in Malawi, Mozambique and Zambia. The focus of the study was to identify and develop technologies in relation to identification of crop varieties that are highly productive, resistance or tolerant to various pests and diseases and improved nutrition crops such as rice, maize hybrids, beans. Most of the research has been concentrating on conservation,

input and seed variety management and not utilisation of new technology in agricultural practices. As a result, aquaculture MSMEs have continued using traditional modes of production which have not yielded positive results in as far as profitability is concerned.

Unfortunately, despite the emphasis by the government on economic diversification away from mining into the aquaculture sub-sector in Zambia, the sector has continued to receive relatively little attention. Most of the support was provided by other development partners, such as the International Fund for Agricultural Development (IFAD) United States Agency for International Development (USAID), SIDA, Southern African Development Community (SADC), European Union (EU) and Japanese International Corporation Agency (JICA) and the African Development Bank (AfDB) (Ministry of Commerce, Trade and Industry, 2020). The research has provided a strategy which the government policy makers and aquaculture MSME managers can use in order to develop adoption of technologies, supportive policies and strategic plans in order to prosper their businesses.

The other gaps arising from the reviewed literature is that studies in the use of new technologies in innovation and financial and performance that have been conducted globally are from developed countries and contextually, this limits generalizability of prior research conclusions to Zambia, a developing country (Bakar & Ahmad, 2010; Gu & Shao, 2015; Li, 2003; Lin & Chen, 2007; Liu et al., 2012;). This research aimed at filling up these research gaps and developing a customised strategy that could be used to enhance aquaculture MSME use of new technologies in innovation in the sub sector in Lusaka with the aim of improving their growth in sales.

Chisala (2008), carried out a study to unlock the potential of Zambian MSMEs while learning from the international best practices borrowed from Southeast Asia. The study was on MSMEs in all sectors and not focused on those in the agricultural sector, let alone the aquaculture sub-sector. Further, Choongo et al., (2016) carried out an empirical study of the factors influencing the identification of sustainable opportunities by MSMEs in Zambia. The study was also a cross sectoral one.

Additional cross sector research was conducted by Matakala (2018) and Fungwe and Kabuba (2019) who studied the constraints of small firm and medium's contribution to economic growth in Zambia and an exploration of the operational challenges faced by small and medium-sized enterprises in the Lusaka Central Business District. Another

study conducted by Kalyongwe (2019) examined business sustainability challenges facing SMEs in selected districts in Zambia. The study assessed whether the challenges lead to lack of operational and financial sustainability and developed a broad-based holistic framework for managing MSME sustainability in Zambia.

It is evident from the foregoing that the focus has been research on MSMEs in general and there is need to bridge the knowledge gap regarding the aquaculture sub-sector in particular. This research aimed at filling up this knowledge gap. It aimed at generating information about the use on new technology in innovating the otherwise traditional modes of aquaculture practices in Lusaka.

2.12 Summary of Chapter Two

The chapter reviewed the literature which relates to the use of some 4IR technologies by aquaculture MSMEs innovative efforts aimed at increasing growth in sales. The chapter began with an overview of the 4IR and the selected four new technologies and MSMEs. The identified technologies are big data, cloud computing, the IoT and Ai. These four technologies make up the independent variables of the study.

The chapter proceeded to explain key concepts of the study, namely innovation and measuring performance and went on to show how the selected 4IR technologies are used in innovation efforts among aquaculture MSMEs. The chapter then went on to discuss the impact of the identified new technologies in innovation the growth in sales of MSMEs in the aquaculture sub-sector. This segment of the literature review discussed basically the relationship between the use of new technology in innovation and growth in sales of MSMEs. Growth in sales being the dependent variable of the study.

The chapter also discussed four theories under the sub-heading ‘theoretical framework’ of the study. The theories were Schumpeter’s Innovation Theory, Mckinsey’s Three Horizons Model, the Diffusion of Innovation Theory and the Technology Acceptance Model. An outline was then given showing how the four theories were used by the researcher in the study. This was done through the conceptual framework whose independent variables were big data, cloud computing, the IoT and AI. The dependent variable was increase in growth in sales which was determined by profitability, growth and reduced mortality of aquaculture MSMEs. The chapter ends with the identification of gaps in the existing literature. Some of these gaps were filled up by the study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The aim of this chapter it to provide an outline of the methods that were used in the study. The research used Saunders' research onion as a guide in developing the methodology. Saunders is a renowned author of research methodology and he developed the 'research onion' in 2007 to explain the various stages that must be covered when a researcher is developing a research strategy (Bryman & Bell, 2011). An onion is made up of several layers from the outside up to the center or the core and Saunders' research onion is founded on the metaphor of an onion. It lays out the different stages and methodological choices that a researcher must follow and make, respectively, from the beginning to the end of one's study.

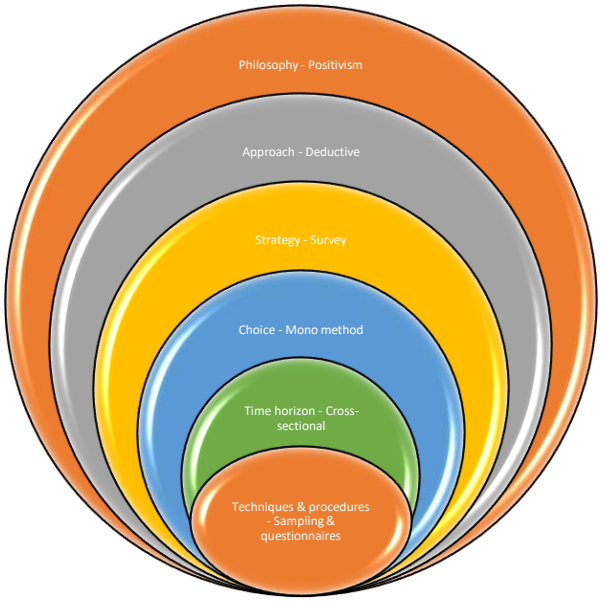

Figure 3. 1: Research Design

Source: Adapted from Saunders et al., (2009)

The metaphor of Saunders research onion, was used by the researcher to design a research method aimed at deriving an understanding of the phenomena under investigation: 'evaluating the effect of innovative technologies on growth in sales of aquaculture MSMEs in Lusaka.' In accordance with the research onion, the researcher selected the appropriate methods, starting from the outer layer to the innermost layer in

Figure 3.1. From Saunders' various study designs, the researcher selected the ones which best suited the topic and the chapter explains the research design and methods in detail. The researcher's design of the study is reflected in Figure 3.2. The chapter discusses the different research philosophies, approaches, strategies, choices, time horizons, data collection and analysis techniques and procedures and the researcher indicates and justifies which ones of the foregoing were used in the study.

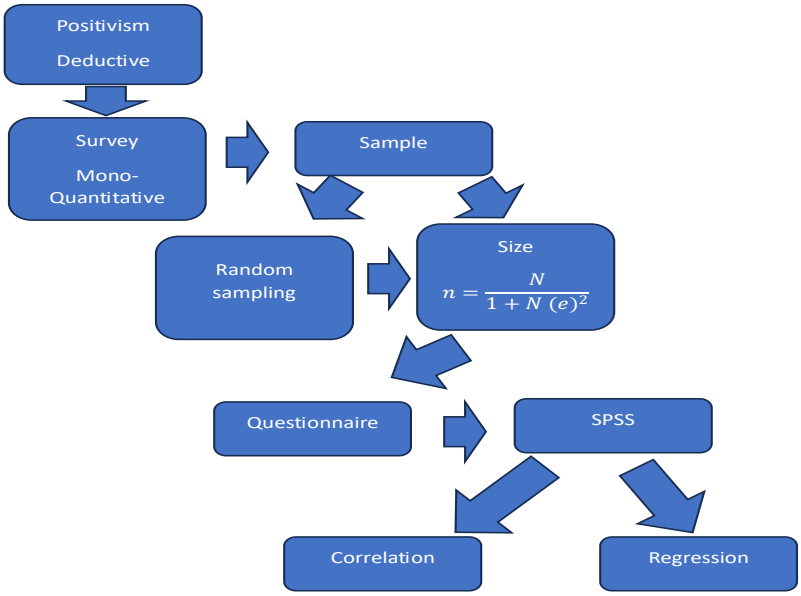

Figure 3. 2: Research Process

Source: Researcher

3.2 Research Philosophy

There are different world views associated with research philosophy. World views have been defined by Guba (1990) as "the basic beliefs that guide action." Some authors refer to research philosophies as "paradigms' (Lincoln et al., 2011). Saunders et al., (2009) define research philosophy as "the development of knowledge and the nature of that knowledge in relation to research." There are other scholars who refer to research philosophies as epistemologies and ontologies (Crotty, 1998).

Epistemology is the theory of knowledge and is concerned with type of knowledge that is possible to be accepted as true or valid or reliable and the means by which this knowledge can be communicated (Blaikie, 2010; Moser, 2002; Schwandt, 2001). Epistemology implies "how we receive information"; how we know things; how we

think we know things and what standards are required to justify the selected beliefs about reality or knowledge whereas ontology is concerned with knowledge, i.e., what reality is.

The word ontology is derived from the Greek word *ontos* and *logos* which mean "being" and "theory" respectively. Ontology is concerned with studying the nature of human beings' existence as individuals, as members of the society and the universe. It deals with the experiential conditions which are related to material, social, cultural and political contexts (Neuman, 2009). Ontology is concerned with knowledge, i.e., what is reality; it is how we come to know whereas epistemology is how we know.

Research philosophy refers to the set of beliefs concerning the nature of the reality being investigated (Bryman, 2012), i.e., the nature of the knowledge and justification for how the research will be undertaken. It depends on the type of knowledge being investigated (May, 2011). Research philosophy therefore provides the justification for the research methodology. According to Saunders' research onion, research philosophies can be classified into four broad categories, namely, positivism, realism, interpretivism and pragmatism. These can be broken down further into objectivism, subjectivism, functionalist, radical humanist and radical structuralist.

Positivism assumes that there is one reality which can be measured using established designs and tools, implying that it is aligned with quantitative studies (Creswell, 2014). Positivism therefore is founded on an assumption that an objective reality exists which is independent of human behaviour and is not a creation of the human mind but instead, it is about directly perceivable entities or processes (Poole & Jones, 1996). Positivist inquiry is achieved through the verification and replication of observable findings. Post-positivism evolved from positivism and it is concerned with the subjectivity of reality. Post-positivism moves away from the purely objective stance adopted by the logical positivists (Ryan, 2006).

Realism is founded on the belief that there is an external reality which is independent of what human beings may think or understand a phenomenon to be. Realism is founded on the principle that what the senses show to human beings as reality is the truth. Realists believe that objects have an existence which is independent of the human mind. Realism is associated with scientific enquiry in the sense that it assumes a scientific approach towards the development of knowledge. The assumption serves as the basis for determining what type of data to collect (Bryman & Bell, 2011).

Constructivism is founded on the existence of one or more realities which are subject to interpretation. This theory is also referred to as interpretivism. (Flick, 2011; Saunders et al., 2012). Qualitative studies are anchored on the interpretivism philosophy which rests on the belief that the social world is a product of human consciousness; that the social world is mentally constructed (Lane, 1999; Sekaran & Bougie, 2013). This philosophy is better used by researchers who chose to ground qualitative expressions or views based on the experiences of the respondents to study phenomena.

Pragmatists argue that sometimes a researcher may not be certain as to which philosophy to adopt between positivism and interpretivism. Saunders et al., (2009) state that the most important issue when determining ontology and epistemology is the research question itself. From the research question, a researcher can select the most appropriate philosophy, but if the research question is ambiguous and it does not suggest the use of either a positivist or interpretivist philosophy, then a researcher can adopt pragmatism.

Pragmatism enables a researcher to adopt variations in their philosophy, i.e., to adopt mixed methods whereby both quantitative and qualitative methods are being used in a single study. Pragmatism combines the strengths of both positivism and constructivism philosophies simultaneously to evaluate independent and dependent variables of a study, some of which are numerical and others categorical requiring quantitative and qualitative data analysis respectively.

Objectivism emphasises that social entities exist in reality external to social actors and require the researcher or observer to be independent of what is being observed whereas subjectivism holds that social phenomena are created from the perceptions and consequent actions of those social actors who are concerned with their existence and a researcher or observer in this case interacts with the subjects being observed (Saunders et al., 2009). As the name suggests, functionalists focus on the functions performed in various social structures. The radical humanists focus on consciousness and take human nature into account, whereas radical structuralists focus is on realism, positivism, i.e., the structural relationships which exist within a realist social world (Callaghan, 2016).

The study adopted positivism philosophy because the philosophy enabled the researcher to study the effects of using 4IR technologies in innovation and the effect on growth in sales of aquaculture MSMEs in Lusaka statistically and drawing inferences therefrom. The researcher identified four independent variables, namely, big data, cloud computing,

the IoT and AI. The dependent variable was growth in sales. The independent and dependent variables enabled the researcher to check statistically the relationship between the two sets of variables using ordinal regression.

Positivism allows a researcher to embrace facts which exist in the world and are tangible thereby making it possible for the facts to be measured and studied independently with prediction (Grix, 2004). This required the researcher to identify facts that could be measured and quantified. The researcher identified a dependent variable, growth in sales which was measured based on levels of growth ranging from very low, low, moderate, high and very high, in the preceding five years.

Growth in sales was evaluated against four independent variables which were big data, cloud computing, the IoT and AI. This means that the researcher did not embrace qualitative research which examines feelings and thoughts but instead used the quantitative research method to carry out an empirical analysis of the relationship between the independent and dependent variables of the study and ultimately arrive at conclusions.

3.3 Research Approach

Research approach refers to the overall or general plan addressing how the research questions are to be answered. The research approach demonstrates how all the major parts of the research study work together in an attempt to address the research questions. The research approach serves to "plan, structure and execute" the research to maximize the "validity of the findings". It gives the pathway or research direction from the underlying philosophical assumptions to data collection and analysis (Mouton, 1996). There are four notable research approaches, namely, deduction, induction, abduction and retroduction (Meyer & Lunnay, 2013).

Deductive theory demands for a researcher to identify a particular theory and to draw or ‘deduce’ either research questions or hypotheses from the identified theory. The researcher must then proceed to determine the variables from the research questions or hypotheses and thereafter, the data collection method. The research variables are then tested empirically because the deductive approach is used in quantitative studies.

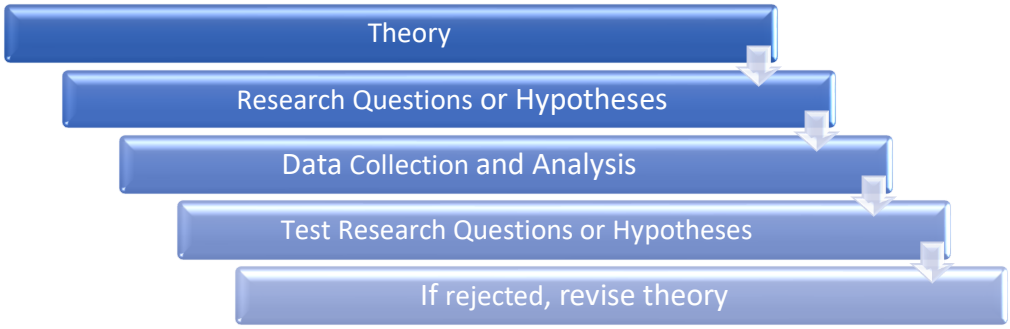

Figure 3. 3: The Deductive Theory Process

Source: Adapted from Bryman & Bell (2011)

The deductive theory therefore is used in quantitative studies to empirically test causal relationships between variables. The result is either confirming or rejecting the research theory, answering the questions or hypotheses. If the research results of the empirical analysis fail to confirm the theory, then the theory may require revision (Creswell, 2014). The deductive theory process is illustrated in Figure 3.3 above.

The opposite of the deductive theory is the inductive theory. The inductive approach entails exploring data, then developing a theory and relating the theory to literature.

Figure 3. 4: The Inductive Theory Process

Source: Adapted from Creswell (2014)

Unlike the deductive approach, the inductive researcher will have research questions and objectives, but will not have a theory or conceptual framework from which to draw a hypothesis. The researcher begins by collecting data from respondents using open-ended questions and classifies that data into either categories or themes. The categories or themes are then developed into theories that are in turn evaluated against personal experiences or existing literature. The inductive approach is associated with qualitative studies (Creswell, 2014). The inductive theory, the approach whereby the researcher

develops a theory as a result of the observation of empirical data is illustrated in Figure 3.4 above.

The abductive approach was developed by Charles Sanders Peirce in 1960 as a third mode of reasoning or inference (Asvoll, 2014). Abduction is also referred to as retroduction and it developed following the shortcomings of the deductive and inductive approaches. The criticisms of the deductive and inductive approaches were that there is a lack of clarity regarding how to select theory to be tested through the formulation of hypotheses and that no amount of empirical data could facilitate theory building, respectively (Dudovskiy, 2011). Abduction is concerned with the discovery of new concepts, ideas and explanations by finding surprising phenomena, data or events that cannot be explained by pre-existing knowledge.

Figure 3. 5: The Abduction Theory Process

Source: Adapted from Bryman & Bell (2011)

The abductive approach requires constantly moving backwards and forward between data and theories and making comparisons and interpretations in searching for patterns and the best possible explanations (Bianna & Thornberg, 2018). A researcher using abduction explores data, finds a pattern, and then suggests a plausible hypothesis. The theory of abduction is founded on the researcher determining the most likely inference which can be made from a set of observations (Figure 3.5). It is the process of making probable conclusions from what is known, and this approach is associated with exploratory qualitative studies. The last approach is retroduction which requires speculation and the study of deep underlying phenomenon.

The study used the deductive research approach. The deductive research approach is founded on the principle of testing a theory from which a researcher then develops either

research questions or hypotheses. In other words, the deductive approach involves the statistical testing of expected results to an accepted level of probability. It involves theory verification (Joseph et al., 2014) in the sense that the researcher places the theory at the beginning of the study, develops research questions or hypotheses, with the purpose of testing or verifying the theory, rather than developing the theory, as is the case with the inductive approach. The deductive approach enables a researcher to collect data in order to test the theory (Creswell, 2014).

The deductive method is based on a positive perspective that since there is an objective reality that can be measured, it becomes possible to predict the outcome of an intervention by establishing research questions or a hypothesis to be tested. This results in generation of knowledge about the phenomena under investigation. The research aim and objectives will lead to data collection and ultimately to either the confirmation or rejection of the theory (Blaikie, 2010; Layder, 2011).

The researcher identified and used two notable theories: Schumpeter's creative destruction innovation theory and Mckinsey's Three Horizons Model. Due to market dynamism, Schumpeter's innovation theory emphasis the need for businesses to continue using new technologies in innovating if they are to survive. Mckinsey's Three Horizons Model supports Schumpeter's theory as it is a tool for thinking and planning about transformation and how to bring transformation about. The model provides an insight into possible alternative futures and the need to continue innovating if a business is to make profit in a competitive environment.

In accordance with the foregoing, the researcher had identified four independent variables (IV's) which were considered as the key technologies in innovation efforts. The four independent variables were big data, cloud computing, the IoT and AI. The dependent variable (DV) was growth in sales which was determined based on profitability, sales growth and business entity growth. Literature reviewed revealed that there was a cause-and-effect relationship between the IV's and the DV. The assumption was that the use of some 4IR in innovation would result in enhanced growth in sales of aquaculture MSMEs (Joseph et al., 2014).

The deductive approach enabled the researcher to test the relationship between the use of 4IR technologies in innovation growth in sales of aquaculture MSMEs through empirical data. From the empirical analysis of data, the researcher was able to test the relationship. Empirical details of the study are given in Chapter Four of the thesis.

3.4 Research Strategy

There are different types of research strategies that guide the specific direction a researcher must take. The research strategy is mostly determined by the research design itself, i.e., whether the study is quantitative, qualitative or uses mixed methods, whether the study is to be used for exploratory and explanatory research. Exploratory research aims at seeking insight or trying to clarify the researcher's unclear conception of a phenomenon whereas explanatory research on the other hand is used to explain causal relationships between variables (Bryman & Bell, 2011).

Research strategies are also referred to as strategies of inquiry. The research strategy is also guided *inter alia* by the object of a specific inquiry or research questions, research objectives, time and resource restrictions (Saunders et al., 2009). Quantitative research places emphasis on numerical data or quantification in data collection and analysis whereas qualitative research is concerned with non-numerical data such as people's views or opinion on a particular phenomenon. Mixed methods, as the phrase suggests, involves the use of both numerical or quantitative methods and non-numerical, qualitative methods (Bryman & Bell, 2011).

Scholars such as Creswell (2014) align strategies of inquiry with specific research designs whereas Saunders et al., (2009) assert that strategies of inquiry are not mutually exclusive. For instance, Saunders et al., (2009) cite examples of using a survey strategy in a case study. However, despite the fact that strategies of inquiry are not mutually exclusive, quantitative research studies are characterised by survey and experimental research. Qualitative studies utilise strategies of inquiry such as grounded theory and ethnography. Mixed methods of inquiry combine quantitative and qualitative research and the three common models used are convergent parallel, explanatory sequential and exploratory sequential mixed methods (Creswell, 2014).

Survey research enables a researcher to collect data from sample of the study population using questionnaires. The data is analysed empirically and the results can be generalized to the study population. Experimental research can be used by a researcher who desires to establish a link between variables to check whether a specific treatment can have any influence on a particular outcome (Creswell, 2014).
Grounded theory involves collecting data based on an abstract theory, refining the data and establishing interrelationships in order to predict and explain behavior and ultimately build or develop a theory. Ethnography tries to 'describe and explain the social world which the respondents inhabit, in the way in which the respondents would describe and explain it' in a natural setting and over a prolonged period of time (Saunders et al., 2009).

Convergent parallel, explanatory sequential and exploratory sequential are aligned towards mixed methods studies. When using convergent parallel research, a researcher collects and analyses quantitative and qualitative data concurrently. In explanatory sequential research, the researcher collects and initially analyses data quantitatively, then proceeds to explain the data qualitatively. In exploratory sequential research, a researcher collects qualitative data then proceeds to analyse the data quantitatively.

Another type of strategy of inquiry are case studies. These require the researcher to study in depth *inter alia*, a process, an activity, etc. while action research requires the researcher and the client to collaborate in order to identify, find a diagnosis and solve a problem (Bryman & Bell, 2011). Archival research involves collecting and analysing data from day-to-day administrative documents and records (Saunders et al., 2009).

In line with the positivism philosophy and the deductive approach, the study used a survey as the research strategy. The survey method was actualized through the use of a self-administered questionnaire as a data collection tool to understand and know more about the effect of using some 4IR in innovation, on the growth in sales of aquaculture MSMEs in Lusaka. The theory underpinning the study was that there is a positive effect on growth in sales of aquaculture MSMEs owing to the use of some 4IR technologies. This assumption was the phenomena under investigation.

The survey research strategy enabled the researcher to collect data which answered questions such as ‘what’, and ‘how’ of the research. The first research question related to identifying the state of usage of new technologies by aquaculture MSMEs in Lusaka. The second research question aimed at establishing how aquaculture MSMEs used new technologies. This question was followed by an inquiry into the growth in sales of aquaculture MSMEs over the past five years. Lastly, the researcher wanted to establish a strategy to enhance the growth in sales of MSMEs in the aquaculture sub-sector.

A survey entails sampling a representative proportion of the entire population. Bryman and Bell (2011) describe a survey design as ‘one which provides a plan for a quantitative or numeric description of trends, attitudes or opinions of a population by studying a sample of that population.’ The study sampled 142 respondent aquaculture MSMEs from a sampling frame of 300 (Department of Fisheries, 2022). The researcher then analysed the data to establish the causal effects of the independent variables: big data, cloud computing, the IoT and AI on the dependent variable, growth in sales. The survey method enabled the researcher to collect data that was analysed statistically to facilitate descriptive and inferential analysis.

3.5 Research Choice

Bryman and Bell (2011) posit that there are three research choices: mono, mixed and multi methods. The mono method, as the word suggests, entails the use of one data collection and analysis technique. The research uses either quantitative or qualitative data collection and analysis but does not use both methods. The mixed method research choice entails the use of both quantitative and qualitative data collection and analysis techniques at the same time. This can be done parallel or one after the other, i.e., sequential but without combining the two techniques. In this case both quantitative and qualitative methods are used but one of the two techniques must dominate. The multi method research choice does not mix the methods but instead uses each of the techniques, one after the other, independently of each other. A researcher uses more than one data collection technique and corresponding analysis procedure or procedures (Saunders et al., 2009).

The researcher adopted the mono method as the research choice and used a questionnaire to collect data. The relationship between the variables was tested by ordinal regression using SPSS Version 21. The study had identified four independent variables, big data, cloud computing, the IoT and AI, whose outcome was increased growth in sales. A synopsis of the variables called for a quantitative approach because the researcher was of the view that an empirical analysis was the best approach to use when testing the phenomenon.

3.6 Time Horizon

Research can be conducted as either a once-off or a series of events and the concept is referred to as time horizons. Once-off research is associated with cross-sectional research or studies whereas a series is longitudinal research. Saunders et al., (2009) have defined a cross-sectional study as research that is done at a particular time and a longitudinal study as one that is used to study a phenomenon over time. Cross-sectional and longitudinal studies can overlap; they are not exclusive of each other. For instance, a researcher can conduct a cross-sectional study and collect data in retrospect, say, data from five years prior. By so doing, such a researcher incorporates the longitudinal factor and is thereby able to conduct both a cross-sectional and longitudinal study at the same time.

The time horizon which was used in the study is cross sectional because the intended period for completion of the research was determined. The study had to be completed within a calendar year and the study was undertaken for academic purposes. It was a once-off activity. The study was a short-term study intended to fulfil the requirements of a study programme. Using the cross-sectional time horizon, the researcher was able to use quantitative methods to evaluate the independent and dependent variables of the study empirically.

However, if a longer period of time had been allocated, the study would have instead opted for a longitudinal time horizon because it allows for observation of variables over an extended period of time (Bryman & Bell, 2011). However, notwithstanding the time limit, the researcher endeavored to obtain data from the respondents regarding their growth in sales over the past five to ten years. In essence therefore, the researcher was able to use both cross-sectional and longitudinal time horizons in the study.

Prompting respondents to provide information regarding their experiences over the past five years was done in order to investigate the effect of using some 4IR technologies, namely, big data, cloud computing, the IoT and AI and whether the use of these new technologies had either a positive or negative impact on aquaculture MSMEs growth in sales.

3.7 Research Techniques and Procedures

Research techniques and procedures comprises of discussions regarding the selection of the specific study area, the target population, the sampling strategy and sample size. The section also highlights the data collection methods and analysis which the researcher used.

3.7.1 Study Area

The study was country specific and industry specific as it addressed the use of selected 4IR technologies by aquaculture MSMEs in Lusaka, Zambia. Hence, the unit of analysis was MSMEs in the aquaculture sub sector in Lusaka. The unit of analysis is the entity described by the data collected and about which the analysis is conducted (Casteel and Bridier, 2021).

It would have been ideal to conduct the research across the country but owing to time, geographical and financial constraints, the study was limited to the jurisdiction of Lusaka. However, the results of the study can be applied to aquaculture MSMEs outside Lusaka as they make up the broader population of the same units of analysis countrywide. The conclusions of the research can be generalised, by inference, to the other regions countrywide because aquaculture MSMEs are present across the country and they face similar challenges of underperforming as those in Lusaka.

3.7.2 Target Population

The population is the group about which the researcher will draw inferences to and select the target population. The target population, however, is the group identified after following a suitable sampling method, and with whom one conducts their study (Collis and Hussey, 2013). From the foregoing, the population of interest were therefore aquaculture MSMEs in Lusaka. The study was limited to Lusaka because of

geographical, time and financial constraints. The researcher used Yamane's equation to determine the number of respondents from the target population of 300. The target population was determined from the database of aquaculture MSMEs provided by the Department of Fisheries Provincial Administration.

3.7.3 Sampling Strategy

Sampling designs can be either probability or non-probability. Probability sampling entails that each unit in the population has an equal chance of being selected and non-probability sampling does not use random selection, as such, some units in the population are more likely to be selected than others. Examples of probability sampling methods are simple random sampling, systematic sampling, stratified random sampling, cluster sampling and multi-stage cluster sampling. Non-probability methods include convenience sampling, snowball sampling and quota sampling (Bryman & Bell, 2011).

Probability sampling enables the researcher to 'answer research questions that require the researcher to estimate statistically the characteristics of the population from the sample' and non-probability sampling 'the researcher is unable to answer the research questions that require to make statistical inferences about the characteristics of the population' (Saunders et al., 2009). The researcher will provide an overview of probability and non-probability sampling methods and since the study was quantitative, the researcher will provide a detailed discussion of the specific sampling strategy which was used in the study.

Random sampling is ideal for a researcher whose population is not very large and it requires a researcher to select a sample randomly from the sampling frame. There are different ways of carrying out random sampling; manually, random number tables or computer random generation software such as Microsoft Excel. Systematic sampling is used when the population size is large and the researcher determines a fraction, for example, 1 out of every 20. In stratified random sampling, a researcher groups or places respondents into desirable strata and then uses either simple random sampling or systematic sampling to select respondents from each group or strata. Cluster sampling is similar with stratified random sampling. The difference however is that the population is divided into groups called clusters whose attributes occur naturally. Then the researcher

selects clusters randomly and collects data from every unit in the cluster. Multi-stage cluster sampling arises when a researcher utilises cluster sampling in a series.

Among the non-probability sampling methods is convenience sampling in which the researcher selects respondents based on convenience and availability. Snowball sampling requires the researcher making initial contact with an individual or small audience and then uses them to establish contact with others. For quota sampling, a researcher must divide the population into groups and take samples from each group in proportions representative of the population.

The researcher used simple random sampling to select respondents for the study. Simple random sampling exposes the entire study population to the same probability of being chosen as respondents (Joseph et al., 2014) thereby giving aquacuture MSMEs an equal chance of being selected. The target population of 300 was provided by the Ministry of Fisheries and Livestock, Lusaka Provincial Administration Office and using the Taro Yamane equation of calculating sample size, the study then required 171 respondents out of the total of 300. The researcher then used Microsoft Excel to randomly select the 171 respondents from the sampling frame of 300, i.e., the database of aquaculture MSMEs obtained from the Department of Fisheries.

The ideal sample size for quantitative research is dependent on various factors, including population size but there is also a rule of thumb which requires a minimum of 40 respondents (Budiu & Moran, 2021). Cochran's Formula for sample size calculation however suggested a sample size of 385 which was beyond the target population of 300, hence the use of Taro Yamane's equation which yielded 171 respondents.

The researcher used simple random sampling because of the availability of an accurate and accessible database of the population provided by the Department of Fisheries Provincial Administration for Lusaka. The database served as the researchers sampling frame. By using simple random sampling, the respondents were representative of the whole population thereby allowing for generalisation of the study conclusions to the entire population of aquaculture MSMEs in Zambia. According to Casteel and Bridier (2021) probability sampling such as simple random sampling allows one to make inferences about the population of interest after analysis of data. Because the sample is

developed at random, the nature of the sample is such that it has a probabilistic representation of the population of interest in which each member of the population has an equal chance of selection.

3.7.4 Sample Size

The sample size was calculated using the Taro Yamane (Yamane, 1967) equation with a standard degree of accuracy expressed as a proportion (0.05) because the population is finite. The formula is given below:

$$n = \frac{N}{1 + N\,(e)^2}$$

Where : n = sample size required;

N = number of people in the population of the study;

1 = Constant and

e = allowable sampling margin of error.

Therefore:

$$n = \frac{300}{1 + 300\,(0.05)^2}$$

$$n = \frac{300}{1 + 300\,(0.0025)}$$

$$n = \frac{300}{1 + 0.75}$$

$$n = \frac{300}{1.75}$$

n = 171.43

Sample size = **171**

3.8 Operationalization of Main Variables

Generally, the main hypotheses are depicted as follows.

MH_O: Use of innovative Technologies have no significant impact on MSME sales growth (Performance).

From this hypothesis, two main variables will be studied and these are use of innovative Technologies and sales growth. Below is the operationalisation of the two variables.

A. Use of innovative technology is operationalised based on the application of the 4IRs to increase growth of sales:

Big Data

- The firm using Features of big data.
- The firm using Utility factors of big data.
- The firm using Processing factors of big data.
- The firm using Knowledge of big data.

Internet of Things

- The firm using Features of internet.
- The firm using Utility factors of internet.
- The firm using Processing factors of internet.
- The firm using Knowledge of internet.
- The firm using complex techniques of internet.

Artificial Intelligence

- The firm using Features of artificial intelligence.
- The firm using Utility factors of artificial intelligence.
- The firm using Processing factors of artificial intelligence.
- The firm using Knowledge of artificial intelligence.
- The firm using complex techniques of artificial intelligence.

Cloud Computing

- The firm using Features of cloud computing.
- The firm using Utility factors of cloud computing.
- The firm using Processing factors of cloud computing.

- The firm using Knowledge of cloud computing.
- The firm using complex techniques of cloud computing.

B. Each of these technologies were measured on a five-point agreement scale by the respondents indicating as follows: 1 for Completely disagree, 2 for Disagree, 3 for Somewhat agree, 4 for Agree and 5 for Completely agree.

Sales growth as a measure of MSME performance is operationalised as volumes of sales and it was measured on a five-point agreement scale by the respondent indicating as follows: 1 for Very low volumes of sales, 2 for Low volumes of sales, 3 for Moderate volumes of sales, 4 for High volumes of sales and 5 for Very high volumes of sales.

Apart from the main variables, the researcher desired to measure the extent of use of the 4IRs.

The dimensions for use where as follows:

Big Data Use

a) I use big data to improve operations.
b) I use big data to provide better customer service.
c) I use big data to create personalized marketing campaigns.

Use was measured on a five-point scale as follows: 1 for never, 2 for Rarely, 3 for Occasional, 4 for Frequently and 5 for Always.

The expected score for Big Data use was set as follows:

a) Low degree of big data use 3 to 6
a) Moderate degree of big data use 7 to 11
b) High degree of big data use 12 to 15

Internet of Things Use

a) I use internet to improve operations.
b) I use internet to provide better customer service.
c) I use internet to create personalized marketing campaigns.

Use was measured on a five-point scale as follows: 1 for never, 2 for Rarely, 3 for Occasional, 4 for Frequently and 5 for Always.

The expected score for internet use was set as follows:

a) Low degree of internet use 3 to 6
b) Moderate degree of internet use 7 to 11
c) High degree of internet use 12 to 15

Use of artificial intelligence

a) I use artificial intelligence for spam filters.
b) I use artificial intelligence for smart email categorisation.
c) I use artificial intelligence for voice to text features.
d) I use artificial intelligence for smart personal assistants.
e) I use artificial intelligence for automated responders and online customer support.
f) I use artificial intelligence for process automation.
g) I use artificial intelligence for sales and business forecasting.
h) I use artificial intelligence for security surveillance.

Use was measured on a five-point scale as follows: 1 for never, 2 for Rarely, 3 for Occasional, 4 for Frequently and 5 for Always.

The expected score for artificial intelligence use was set as follows:

a) Low degree of artificial intelligence use 8 to 17
b) Moderate degree of artificial intelligence 18 to 30
c) High degree of artificial intelligence use 31 to 40

Use of Cloud Computing

a) I use Cloud Computing for on line data storage and recovery.
b) I use Cloud Computing for Data Analysis.
c) I use Cloud Computing for business networking.
d) I use Cloud Computing for Testing and Development of products.

Use was measured on a five-point scale as follows: 1 for never, 2 for Rarely, 3 for Occasional, 4 for Frequently and 5 for Always.

The expected score for Cloud Computing use was set as follows:

d) Low degree of Cloud Computing use 4 to 8

e) Moderate degree of Cloud Computing 9 to 15

f) High degree of Cloud Computing use 16 to 20

3.9 Regression Modelling

Since the study had a single dependent variable and four independent variables, regression modelling was used to determine the whether the predictor variables (IV) had a significant effect on the response variable (DV) (Pallant, 2016). The mathematical representation of the regression model to be tested as drawn from the identified variables was represented by the formula below:

$$\mathbf{Y = a + bX1 + cX2 + dX3 + eX4 + \epsilon}$$

Where:

a) Y = Dependent variable (MSME Performance expressed as sales growth, i.e., SG)

b) X1, X2, X3, X4 = Independent (explanatory) variables being the 4IRs, i.e., DB, IoT, AI, CC (see Conceptual Framework in Sections 1.8 and 2.10)

c) a = Intercept or Constant

d) b, c, d, e = beta coefficient of the IV's which explain the variance in Y

e) ϵ – Residual or prediction error

Evaluation items and validation of components of use factors of an innovation technology and MSME performance in the questionnaire were rated on a 5-point Likert scale from 1 (Completely disagree) to 5 (Completely agree).

3.10 Ethical Consideration

Research ethics is of significant value in the sense that it impacts directly on the participants, and it addresses the approach to the participants as they are the subject of the research and they can be affected by the research. In an attempt to contact the respondents and to collect data, an introductory letter (Appendix I) was obtained from ZCAS University and was submitted to the Department of Fisheries. Upon approval, the researcher was given permission to contact the respondents.

During data collection, the self- administered electronic questionnaire had an introduction which was dealing with ethical considerations such as informed consent,

confidentiality, voluntary participation and anonymity. According to Bhandari (2021), ethical considerations work to *inter alia*, protect the rights of research participants.

Consent was sought from the participants prior to them completing the questionnaires and the participants were not to be identified by name, address or location. Identification was anonymous. Further, the participants were informed that the data to be collected would be treated with utmost confidentiality and would be used for academic purposes only. The respondents were also informed that they are at liberty to either participate in the research or not. Following consent, data was collected from respondents who were willing.

3.11 Data Collection Methods

Primary data was derived from firsthand sources, that is, directly from the respondents and primary data collection methods can be divided into two groups: quantitative and qualitative. Since the study was quantitative, primary data for the research was collected through questionnaires and not interviews. Interviews are characteristic of qualitative studies whereby the researcher solicits for the respondent's views using an open-ended tool. The researcher used a self-administered questionnaire (Appendix II) which was completed by the respondents on their own. 90 questionnaires were administered physically while 82 were administered online. The researcher prepared the online questionnaire using Google Forms and sent it to the respondents electronically by email.

Since the sample was dispersed within Lusaka, the researcher administrated some of the questionnaires electronically in order to reach out to the respondents who were in far flung areas. The researcher opted on this method as an alternative to physical administration, in part, because the respondents were abreast with internet technology as evidenced by their participation in a sector WhatsApp group which is hosted by the Department of Fisheries. Further, the researcher used the electronic method of administration to save both time and resources. In addition, it is currently advisable to restrict movements and physical contact with others to curtail the spread of Covid 19. Zambia, as of July 2022 had 1,001 active cases with a cumulative total of 327,102 cases. Therefore, electronic administration of some of the questionnaires was ideal to reduce physical contact with the respondents and restrict the researchers' movements.

The questionnaire was divided into three parts; the first part related to the respondent's demographic information and general business information, while the other part

contained questions relating to the respondent's use of 4IR technologies in their business operations. These were the study's independent variables. The last part was on the study's dependent variable, i.e., growth in sales of aquaculture MSMEs (Crowther & Lancaster, 2009). As the study was quantitative, the researcher used a self-administered questionnaire to capture the attitudes, behaviors, trends and details of the effects of using 4IR technologies in innovation by aquaculture MSMEs and their growth in sales (Ivankova et al., 2006).

3.12 Data Validity, Relaibility and Normality

Firstly, in order to ensure construct validity, the questions in the questionnaire were aligned with the research independent and dependent variable since the relationship was causal thereby calling for an identification of the cause-and-effect behaviors or constructs in the relationships as it is important to ensure that the questions measure exactly what they were intended to measure (Taherdoos, 2018). Construct validity ensures that the research accurately measures the theoretical construct it intends to study, which in this case was, the relationship between some 4IR technologies adoption and sales growth in aquaculture MSMEs. In furtherance of construct validation, the independent variables were operationalized as big data, the internet of things, artificial intelligence and cloud computing and the dependent variable was identified as sales growth. To come up with measurable outcomes, questions were then developed based on a five-point Likert scale to measure the concept under study, i.e., the relationship between 4IR adoption and sales growth.

Secondly, in order to enhance content validity, adequate time was taken in designing the questions for inclusion in the questionnaire so as to avoid using ambiguous words and double-barreled questions but instead to present clear, concise and unbiased questions. Surucu and Maslakci (2020) posit that content validity is important in quantitative research because a well-designed and comprehensive questionnaire in turn enhances the validity of the study. Content validity ensures that the measurement items adequately cover the full range of the constructs being studied, ensuring comprehensive coverage. Collaborative efforts with at least an expert in aquaculture, technology adoption, and an aquaculture MSME manager to review the measurement items resulted in the questionnaire capturing the key dimensions of 4IR technology and sales growth in the aquaculture MSME context.

Lastly, in order to enhance face validity, the researcher administered the draft questionnaire among peers and the three experts mentioned above. Face validity assesses whether the research study, including the measurement items, appear relevant and meaningful to potential respondents and it is done through pilot testing (Elangovan & Sundaravel, 2021). A typical pilot test must be conducted among a small subset of one's target population and the subset should be representative of the larger population to ensure the findings from the pilot test are meaningful. Since the target population of the study was defined and was widely dispersed around the study area, such a pilot study could not be conducted because of the respondent's anticipated availability for second visits, coupled with possible resistance to participate again in the subsequent main study. Hence the use of peers and three experts, who were not part of the main study to gather feedback regarding the clarity, relevance, and comprehensibility of the questions in the draft questionnaire. The feedback was in turn used to refine and rephrase unclear questions and ensure that the questions would be well-understood by the respondents.

Data reliability test was conducted using Cronbach's alpha while normality tests were run using SPSS and the results of both tests are given in sections 4.3 and 4.4 of the subsequent chapter.

3.13 Data Analysis

The collected data was edited, coded, and entered into Statistical Package for Social Sciences (SPSS) version 21 for analysis. Data analysis was determined by the variables to be analysed and the scale of measurement. The independent variables were big data, internet of things, artificial intelligence, and cloud computing (IV) and the dependent variable was sales growth (DV). The scale of measurement was categorical as the data was ordered using a five-point Likert scale (Bbenkele, 1986). The researcher paid particular attention to the credibility of the research findings and conducted univariate analysis of the classificatory data followed by an evaluation of the relationship between the IV's and the DV using correlation and ordinal regression. The statistical findings were generalized to the study sample by drawing inferences.

3.14 Chapter Summary

The chapter has endeavored to explain the research design and methods which were used in the study. The chapter explained the preferred research philosophy which was

positivism whose approach was deductive and therefore uses a survey as a data collection strategy. The study was quantitative, meaning that the data was analysed statistically. The researchers' time horizon was cross-sectional and this was discussed in the chapter. The chapter proceeded to discuss the study area, which was Lusaka, the target population and the sample size. Data collection and analysis techniques and procedures were outlined, together with issues relating to ethical consideration.

CHAPTER FOUR: PRESENTATION OF RESULTS

4.1 Introduction

This chapter focuses on the presentation of results of responses to the questionnaires. This chapter sought to answer the research questions and was aimed at determining what the state of usage of new technologies by aquaculture MSMEs in Lusaka was and how they were using the new technologies. Further, the chapter attempted to establish how growth in sales of aquaculture MSMEs in Lusaka has been over the past five years.

The questionnaire was divided into three parts. The first part related to the respondent's classificatory information and general MSME business information. The second section of the questionnaire contained questions relating to the respondent's use of 4IR technology in their business operations. These were the study's independent variables. The last part of the questionnaire was on the study's dependent variable, i.e., growth in sales of aquaculture MSMEs.

4.2 Missing Data Test

Before one embarks on inter alia data analysis for demographics, descriptives, correlation testing and regression, etc., it is recommended to test the data for missing values to examine if the values are missing completely at random (MCAR) (George & Mallery, 2003). Where values are missing completely at random, the data sample can still be considered to be representative of the population (Cheng, 2013). However, if the missing values are missing systematically, any analysis made against such a data sample is likely to be biased (Cheng, 2013). The researcher identified questions relating to use of 4IR technology and tested for missing values using SPSS. The results of the missing data test are given in Appendix III and they show that there were no missing values among the selected questions, represented by 0 count and corresponding 0%. All the respondents were able to respond to the said questions because they were clear.

4.3 Data Reliability Test

It has been mentioned earlier that the results of quantitative research must be consistent and yield similar results when repeated. The concept is called reliability. The reliability test is concerned with the internal consistency of the innovation constructs. Internal

consistency illustrates the degree to which all the items in the scale measure the same or construct and thus it is related to the inner relatedness of the items within the test (Tavakol & Dennick, 2011). The notable threats to reliability are subject/ participant or observer error or subject/participant or observe bias.

The researcher took into consideration subject/participant error and bias because these are aligned with quantitative research. There is an underlying principle that the respondents may be influenced into giving responses based on several factors. The time or day of the week at which the respondents are answering questions in a questionnaire may not be consistent as when they are asked for responses at a different time or day of the week (Saunders et al., 2009). For example, respondents may give different responses on a Monday morning than what they would on a Friday at knocking off time. The objective of validity is to determine the extent to which a measure produces the same results when applied across different timelines or different target groups. It aims at achieving consistency (VanderStoep and Johnson, 2009).

In addition, in order to enhance reliability, adequate time was taken when designing the questions in the questionnaire so as to avoid using ambiguous words and making errors. Ambiguous words have the potential of yielding inconsistent responses for the same question because the respondents misinterpret the meaning of the question. Further, in order to avoid misinterpretation or misunderstanding of questions, a 5-point Likert scale of responses was provided, requiring the respondents to select among the five responses. Uniformity and clarity in the questions was ensured.

Reliability analysis was done to affirm the dependability of the questionnaire and subsections. Outer loadings were used as indicators for reliability, and values were set to be 0.708 and above (Hair et al., 2017; 2020). All of the items had values between 0.782 and 0.980 and were considered acceptable as they were above 0.708. With regards to the construct reliability, that is, Cronbach's alpha (CA) and composite reliability (CR), values of more than 0.70 (Bryman and Bell, 2011; George and Mallery, 2003; Hair et al., 2017; Kline, 2000) were considered acceptable.

Table 4. 1: Calculated Dependability of Questionnaire

Variable	Number of questions	Cronbach's alpha
Big Data	8	0.866
Internet of Things	9	0.896
Artificial Intelligence	15	0.712
Cloud Computing	8	0.793
The whole questionnaire	40	0.913

In this study, the values ranged from 0.829 to 0.981 and 0.886 to 0.986, respectively, which achieved the threshold. The Average Variance Extracted (AVE) is a common measure of convergent validity where a value higher than 0.50 would be considered as satisfactory. Following the analysis, the results showed that the AVE ranged between 0.660 and 0.947, thus confirming convergent validity ((Bryman and Bell, 2011; George and Mallery, 2003; Hair et al., 2017; Kline, 2000). In Table 4.1, the researcher shows the values of construct reliability or dependability.

Categorical variables are described using absolute/relative frequency distribution and quantitative variables using measures of central tendency/location like mean (standard deviation)/median. The design of Ordinal Logistic Regression is based on the methodology of McCullagh (1980, 1998).

Recognising that the dependent variable is in three categories, an ordinal category logistic regression was performed in addition to the ordinal one (Hosmer & Lemeshow, 2000). It has been determined that it is appropriate to use Ordinal Logistic Regression Method (OLRM) in this study, because this method can be examined in three different groups depending on the nature of the dependent variable In this study the dependent variable sales growth is ordinal in nature and so are the independent variables.

Ordinal Regression allowed the researcher to model the dependence of the polytomous ordinal predictor response. Further than this, the function relating to ordinal regression is highly mathematically flexible, easy to use, and can be interpreted meaningfully in terms of the results (Alpar, 2011). Moreover, it is possible that the independent variables can be used without the need for important assumptions such as multivariate normal distribution and homogeneity of variance and covariance of known groups (Akın & Şentürk, 2012).

It is implausible to assume the normality and homogeneity of variance for ordered categorical outcomes. Thus, the ordinal regression model becomes a preferable modeling tool in this study since it does not assume the normality and constant variance but requires the assumption of parallel lines across all levels of the categorical outcomes.

The major decisions involved in the model building for ordinal regression shall be deciding which explanatory variables should be included in the model and choosing the link function (e.g., logit link, probit link and complementary log-log link) that could demonstrate the model appropriateness. In this way, the study results could lead to a better understanding of the effect of the independent variables, i.e., technology use on the dependent variable which is growth of sales (Hales & Chakavorty, 2006).

The primary focus of the study was the formulation of the ordinal regression model, the application of ordinal regression analysis, and the interpretation of study results. Two study objectives are to be achieved:

a) To identify significant explanatory variables that could influence the overall sales growth;
b) To estimate thresholds (i.e., constants) and regression coefficients.

4.4 Data Normality Test

A normal distribution is characterized by a perfectly symmetrical curve. However, statistics do not always produce perfectly symmetrical curves (Burns & Burns, 2008). The patterns of distribution can be measured by using the normality test to check the values of skewness and kurtosis. If skewness and kurtosis values of variables are between -1 and +1, the data can be assumed normally distributed.

Daone and Seward (2011) posit that, for skewness, if the value is greater than + 1.0, the distribution is right skewed. If the value is less than -1.0, the distribution is left skewed. For kurtosis, if the value is greater than + 1.0, the distribution is leptokurtic (thin-tailed and peaked). If the value is less than -1.0, the distribution is platykurtic (fat-tailed and flat peaked). The descriptives in Appendix 4 indicates skewness and kurtosis values of the 4IR and they fall within the acceptable level of between -1 and +1, except internet use whose value was is 1.085.

Table 4. 2: Test of Normality

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Score for Big Data use	.234	142	.000	.838	142	.000
Score for internet use	.270	142	.000	.818	142	.000
Score of Use of Artificial intelligence	.195	142	.000	.915	142	.000
Score of Cloud Computing	.211	142	.000	.900	142	.000
a. Lilliefors Significance Correction						

The Kolmogorov-Smirnov and Shapiro-Wilk normality statistic examines if variables are normally distributed (Pallant, 2016). According to Pallant (2016), a non-significant result $p > 0.05$ indicates normality. Razali and Wah (2011) state that the null hypothesis that data are normally distributed is rejected if the p value is below 0.05 and the hypothesis is maintained if the p value is above 0.05. Therefore, the results must not be larger than 0.05. From the results in Table 4.2, it is evident that the test of normality for 4IR technology was 0.000, a value less than 0.05 and therefore violates the assumption of normality.

Another output of the SPSS normality test are the histograms and normal probability plots referred to as Q-Q plots. This is a graphical method for checking whether or not a data set is approximately normally distributed. An inspection of the histogram provides information about the distribution of scores, which should follow a normal curve, i.e., one that is each of the variables are normally distributed, i.e., most scores occurring in the centre, tapering out towards the two extremes. For Q-Q plots, the data is plotted against a theoretical normal distribution in such a way that the points should create or form an approximate straight line (Pallant, 2016).

The actual shape of the distribution for each of the innovative technologies appear to lean towards the left and the right for big data and internet use. The scores for artificial intelligence and cloud computing appear to have outliners and are not reasonably normally distributed. This is further supported by the corresponding normal probability plots, the Normal Q–Q plots.

Q-Q plots are used to check the value for each score plotted against the expected score from the normal distribution and a reasonably straight line suggests a normal distribution (Daone & Seward, 2011). A visual inspection of the Q-Q plots for the 4IR indicates that the observed data is approximate to the expected data, that is, the values are statistically equal as they are located close to the straight line thereby suggesting a normal distribution.

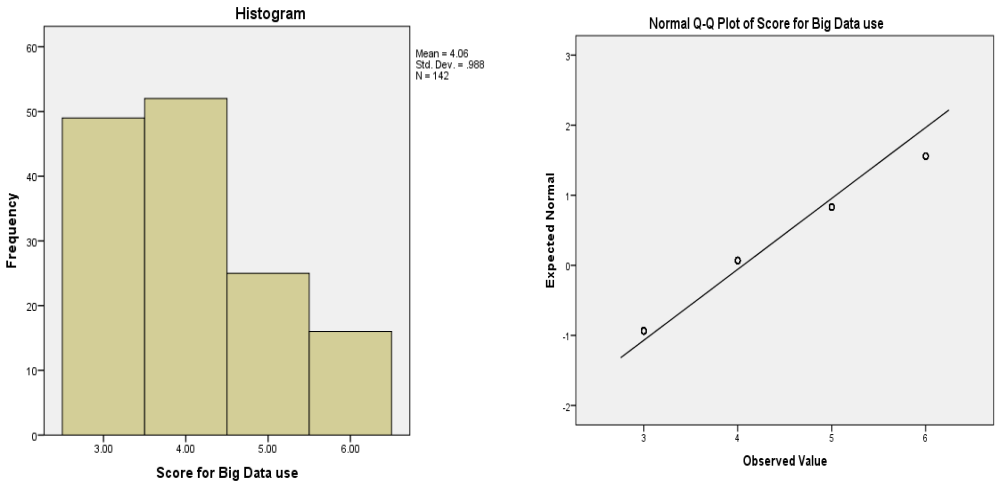

Figure 4. 1: Histogram and Q-Q plot for Big Data

The histogram for big data in Figure 4.1 shows that the scores appear to lean more towards the left and less towards the right, thereby representative of a normal distribution. This implies that the observed values where in two extremes, with outliers in both directions, and not accumulated at the centre and spreading to either side. Bryman and Bell (2011) posit that this kind of distribution, where variables are skewed to the left or right, is common in the Social Sciences. An inspection of the Q-Q plots for big data in Figure 4.1 supports the histogram results as the plots of the observed values are located in an almost straight line.

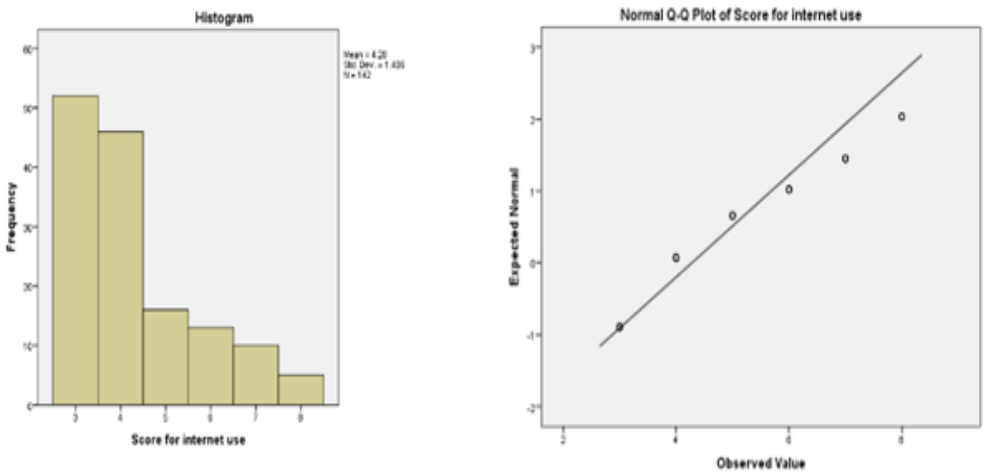

Figure 4. 2: Histogram and Q-Q plot for Internet Use

The histogram and Q-Q plot for internet use in Figure 4.2 shows that the scores appear to lean less towards the left and more towards the right, representing a normal distribution and the Q-Q plots supports the histogram results as the plots of the observed values are located near the straight line.

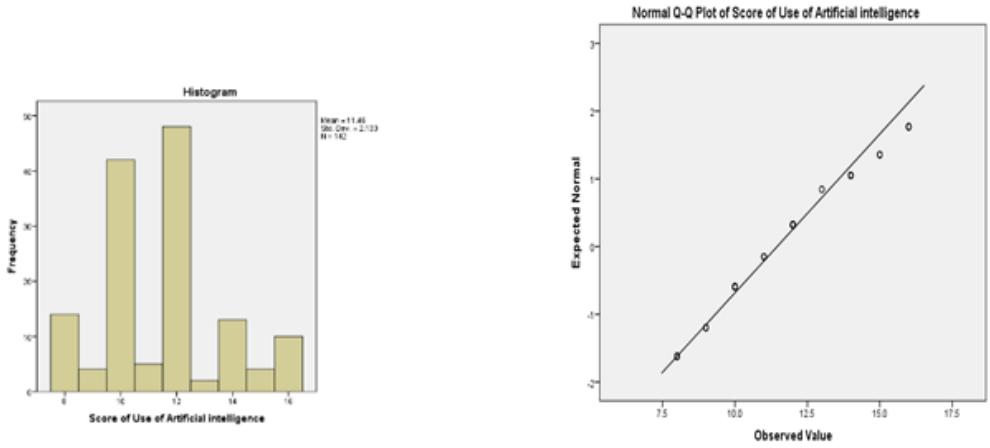

Figure 4. 3: Histogram and Q-Q plot for Artificial Intelligence

The scores for artificial intelligence in Figure 4.3 appear to have outliners and are not reasonably normally distributed. However, the Q-Q plot Q-Q plots of the observed values are located in an almost straight line. Thereby representing a normal distribution.

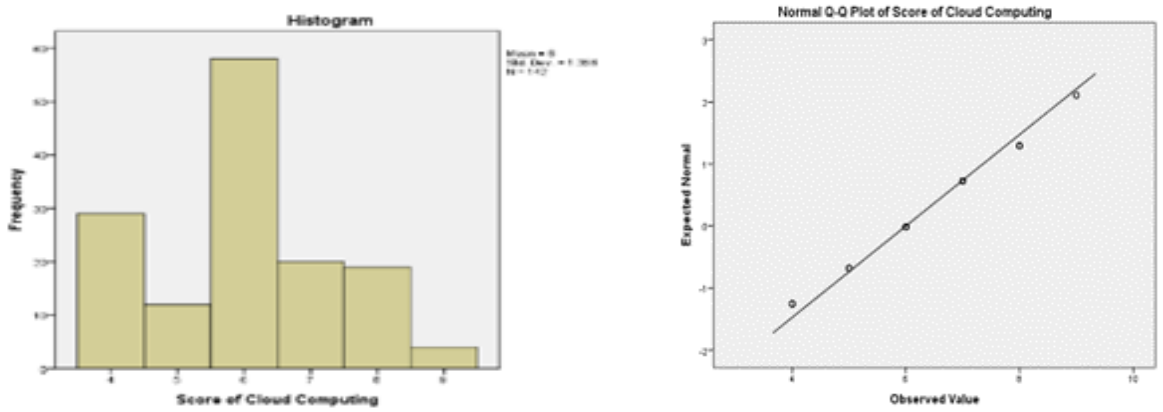

Figure 4. 4: Q-Q plot for Cloud Computing

Just like the scores for artificial intelligence in Figure 4.3, the values for cloud computing in Figure 4.4 appear to have outliners and are not reasonably normally distributed but the Q-Q plot Q-Q plots of the observed values are located in an almost straight line showing a normal distribution.

4.5 Response Rate

The sampling frame had 300 units and the study sample size was 171 out of which 90 questionnaires were administered physically while 82 were administered online.

Table 4. 3: Response Rate

	Administered Questionnaires	Responses	Percentage	Non-responses
Physical	90	86	83	04
Online	81	56	17	25
Total	171	142	100	30

Out of the 171 questionnaires which were administered, the researcher received 142 responses, representing an 83% response rate and 17% non-response rate as illustrated in Table 4.3 above. According to Sue and Ritter (2012), the minimum acceptable response rate for surveys is 60%. Therefore, the 83% response rate attained by the researcher is acceptable.

The rest of the chapter will follow the same sequence as the questionnaire in presenting the results starting with classificatory information and general aquaculture MSME

business characteristics, to the use of big data, the internet, artificial intelligence and cloud computing, ending with the effect of the foregoing innovative technologies on growth in sales.

4.6 Classificatory and General Aquaculture MSME Business Information

This section presents classificatory data such as the gender, age of respondents, level of education, job position, experience in the sector, etc. and general aquaculture MSME business information ranging from company age, number of employees to legal status or registration with PACRA. The major aim of the questions in this section of the questionnaire was to collect relevant classificatory information which was pertinent to the study in order to build up a profile of the aquaculture MSMEs and develop an insight into the internal structure of the sector for a deeper understanding of the construct. The information obtained from the section was also used to cross tabulate variables such as age range, gender, experience, against sales, for a deeper understanding.

4.6.1. Gender of the Respondents

From the 142 respondents, 95 were male and 47 were female, representing 67% and 33% respectively (Table 4.4).

Table 4. 4: Gender of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Male	95	66.9	66.9	66.9
	2 Female	47	33.1	33.1	100.0
	Total	**142**	**100.0**	**100.0**	

The gender of respondents was vital in the study in order to ascertain the assertion that males are dominant in aquaculture MSMEs. A smallholder fish farmers' census survey conducted in the Northern and Luapula provinces revealed that males made up the highest percentage of fish farmers at 86% (WorldFish and Musika, 2020). Another study

conducted in 2021 revealed that 75% of the smallholder fish farmers were male (Kalaba et al., 2021).

The involvement of women in aquaculture is highly relevant and beneficial for several reasons. Firstly, women constitute a significant potential proportion of the global aquaculture workforce, particularly in developing countries like Zambia where the population of women out numbers that of men (ZamStats, 2022). Their participation not only contributes to the economic growth of communities but also plays a crucial role in job creation, poverty reduction and food security (The World Bank, 2017).

Furthermore, involving women in aquaculture has proven social and empowerment benefits. By engaging in aquaculture activities, women can gain economic independence, improve their livelihoods, and enhance their decision-making power within households and communities (Dey et al., 2020). This empowerment has a ripple effect, as studies have shown that women tend to reinvest their income in education, healthcare, and the well-being of their families (Kantor & Johannessen, 2021; Tlusty, 2019).

To fully harness the potential of women in aquaculture, it is essential to address gender disparities and provide equal access to resources, training, and markets. Policies and programs that promote gender equality and women's empowerment in aquaculture can lead to more inclusive and sustainable development, fostering resilient and thriving communities.

4.6.1.1 Crosstabulation of gender and number of ponds

Cross tabulation or contingency tables are used to compare two different categories of variables (Pallant, 2016).

Table 4. 5: Crosstabulation of Gender and Number of Ponds

		How many fish ponds do you have?				Total
		1 One to five	2 Six to Ten	3 Eleven to Fifteen	4 Over 15	
Gender	1 Male	5	30	32	28	95
	2 Female	1	20	15	11	47
Total		6	50	47	39	142

Cross tabulation of gender and number of ponds in Table 4.5 above confirms that male respondents had more ponds their female counterparts with 5 having between 1 to 5, 30 having between 6 to 10, 32 having 11 to 15 and 28 having more than 15 ponds. Whereas the females had 1 having between 1 to 5, 20 having between 6 to 10, 15 having between 11 to 15 and 11 having more than 15 ponds.

4.6.1.2 Crosstabulation of gender and level of sales

Gender was cross tabulated against the level of sales in the past five (5) years. The performance in aquaculture can vary based on gender, with both men and women making significant contributions to the sector. As alluded to in section 4.3.1 above, gender disparities exist in participation levels, and this impacts performance outcomes. Women also have limitations in terms of access to resources and decision-making power, but men often have greater access to capital, technology, and training opportunities, which can enable them to achieve higher production levels and profitability (Allison et al., 2018).

Table 4. 6: Crosstabulation of Gender and Level of Sales

Gender * On a scale of 5, indicate the level of sales you have had in the last 5 years

Crosstabulation

Count

		On a scale of 5, indicate the level of sales you have had in the last 5 years				Total
		2 Low volumes of sales	3 Moderate volumes of sales	4 High volumes of sales	5 Very high volumes of sales	
Gender	1 Male	17	23	41	14	95
	2 Female	6	8	28	5	47
Total		23	31	69	19	142

The results in Table 4.6 show that both males and females had moderate, high to very high sales. In order to show whether there is an association in the variables and if it is significant, a Chi-Square test was performed.

Table 4. 7: Chi-square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.394[a]	3	.335
Likelihood Ratio	3.408	3	.333
Linear-by-Linear Association	.668	1	.414
N of Valid Cases	142		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.29.

Even though 78 males, representing 55% and 41 females, representing 29% had moderate, high to very high sales, the Chi-Square test in Table 4.7 shows three degrees of freedom with the Pearson chi-square test statistic of 3.394, and the associated p-value of 0.335. These results suggest that there is no statistically significant association between the variables tested because the $p > 0.05$. In addition, both the Likelihood Ratio and the Linear-by-linear association results at p values of 0.333 and 0.414, show that there is no significant association and no significant linear trend between the variables, respectively.

Additionally, the information states that no cells (0.0%) have expected counts less than 5, and the minimum expected count is 6.29. This statement is relevant because when conducting a chi-square test, it is important to ensure that the expected counts in each cell are not too low. Low expected counts can affect the validity of the test results. In summary, based on the given results, there is no significant evidence to suggest an association or linear trend between the variables being analyzed.

It is notable however that women's contributions in the sector should not be underestimated and their involvement in MSME aquaculture can contribute to household food security, income generation, and poverty alleviation (Kantor et al., 2021). Studies have shown that gender-inclusive approaches, promoting equal access to resources and decision-making, can lead to improved performance in aquaculture (Baden et al., 2019; Dey et al., 2019). When women are empowered and are provided with the necessary support, they can enhance productivity, adopt innovative practices, and contribute to sustainable resource management.

It is crucial to address gender disparities and create an enabling environment that promotes equal opportunities for both men and women in aquaculture. This includes providing training, financial services, market access, and supportive policies that recognize and value the contributions of women. By fostering gender equality and empowering women, the aquaculture sector can realize its full potential and contribute to inclusive and sustainable development.

With Zambia's current population comprising of 404,657 consisting more females than males (ZamStats, 2022), it is prudent to involve women in aquaculture which in turn will result in poverty reduction. As stated by Chakanga (2019) and Dechert (2019), "involving women in fisheries and aquaculture will enable food and nutrition security and income generation, which improves household living". The government is aware of the fact that women's participation in economic development such as aquaculture is critical in poverty reduction and is encouraging more female participation in the sector through various women empowerment programs (GRZ, 2020).

4.6.2 Age Range of Respondents

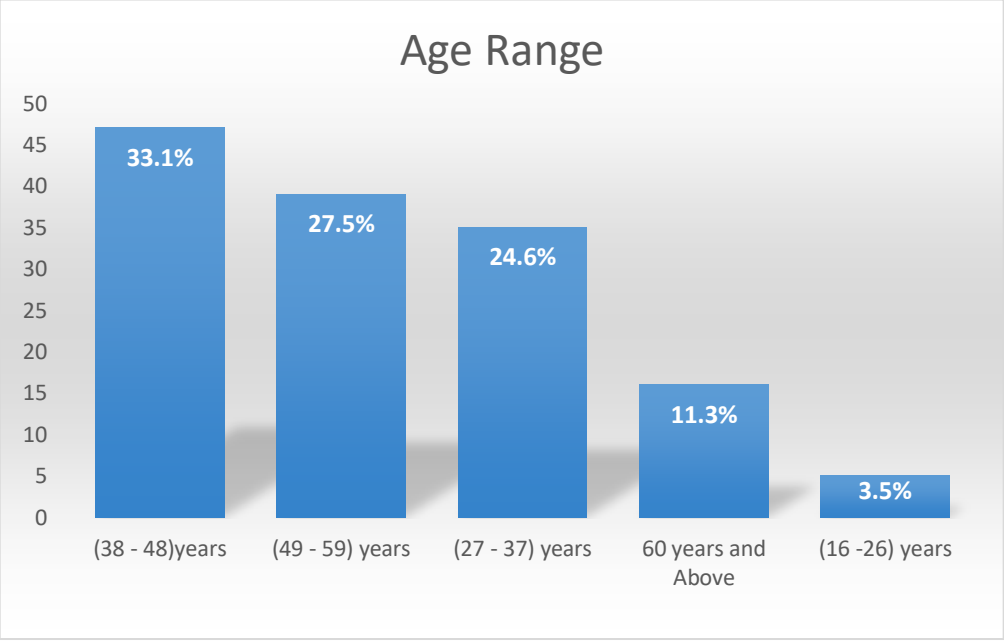

Figure 4. 5: Age Range of Respondents

Figure 4.5 above shows the results of respondents` age range and their responses were such that the highest was 33.1% who were aged between 38 and 48 years, followed by those aged between 49 and 59 years representing 27.5%. The third were aged between 27

and 37 years, representing 24.6% followed by those aged 60 years and above representing 11.3% and lastly those aged between 16 to 26 years representing 3.5%.

The research findings align with these statistics because 85.2% were aged between 27 and 59 years, 3.5% aged below 27 and only 11.3% aged 60 and above. The results from the respondents therefore suggest that the respondents between the ages of 27 and 59 years are the major participants in aquaculture MSMEs in Lusaka.

The age ranges of the respondents are cardinal because it assisted in determining sector participation by age. A study by WorldFish and Musika (2020) revealed that the largest percentage (60.8 percent) of aquaculture MSMEs were mature adults in the ages of 40 to 64 years, whereas those aged 40 years and below, only made-up 29.8 percent and the least were the elderly population, aged 65 years and above, at 9.5 percent.

4.6.2.1 Crosstabulation of age range and level of sales

Age range was cross tabulated against the level of sales in the past five (5) years.

Table 4. 8: Crosstabulation of Age Range and Level of Sales

		On a scale of 5, indicate the level of sales you have had in the last 5 years				Total
		2 Low volumes of sales	3 Moderate volumes of sales	4 High volumes of sales	5 Very high volumes of sales	
Age Range	1 Less than 30	0	3	1	1	5
	2 31 to 40	4	14	10	7	35
	3 41 to 50	12	5	22	8	47
	4 Over 50	2	6	28	3	39
	5	5	3	8	0	16
Total		23	31	69	19	142

The results in Table 4.8 show that 40 respondents aged below 40 years, representing 28% had moderate, high to very high sales compared with 86 respondents aged 41 and above, representing 61% having had moderate, high to very high sales. These results are a

confirmation of a positive relationship between one's level of education and levels of sales.

4.6.3 Highest Education Qualification

The highest qualification attained by the respondents was one of the interests of the researcher.

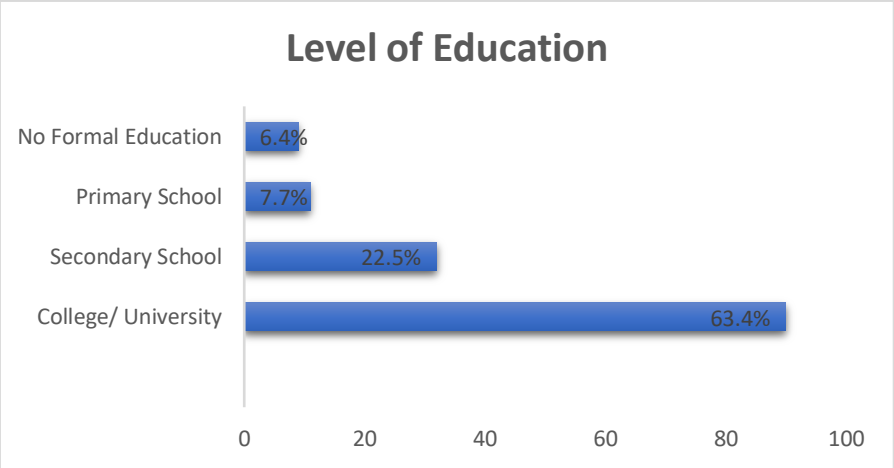

Figure 4. 6: Education Qualification

From Figure 4.6 above, the statistics show that 90 respondents, representing 63.4%, had reached College or University level, while 32 respondents, representing 22.5%, had reached Secondary School level. 11 of the total respondents, representing 7.7%, reached Primary School level and 9 respondents, representing 6.4%, had no formal education.

4.6.3.1 Crosstabulation of highest education qualification and level of sales

The highest education qualification was cross tabulated against the level of sales in the past five (5) years.

Table 4. 9: Crosstabulation of Highest Education Qualification and Level of Sales

What is the highest education qualification you have achieved? * On a scale of 5, indicate the level of sales you have had in the last 5 years Crosstabulation

Count

		On a scale of 5, indicate the level of sales you have had in the last 5 years				Total
		2 Low volumes of sales	3 Moderate volumes of sales	4 High volumes of sales	5 Very high volumes of sales	
What is the highest education qualification you have achieved?	1 No formal education	2	3	4	0	9
	2 Primary school	2	1	7	1	11
	3 Secondary school	4	6	18	4	32
	4 College/ University	15	21	40	14	90
Total		23	31	69	19	142

The results in Table 4.9 show that 9 respondents who had no formal education, representing 6% had moderate, high to very high sales. 42 respondents who had primary and secondary, representing 30% having had moderate, high to very high sales while 90 respondents who had college or university education, representing 63% had moderate, high to very high sales. A Chi-square test was performed to analyse the association between the variables.

Table 4. 10: Chi-Square Test

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.048[a]	9	.830
Likelihood Ratio	6.364	9	.703
Linear-by-Linear Association	.376	1	.540
N of Valid Cases	142		

a. 8 cells (50.0%) have expected count less than 5. The minimum expected count is 1.20.

The Chi-square test in Table 4.10 with nine degrees of freedom and the Pearson chi-square test statistic of 5.048, with the associated p-value of 0.830 suggests that there is no statistically significant association between the variables tested as $p > 0.05$.

4.6.4 Registration with PACRA and Classification of Aquaculture MSMEs

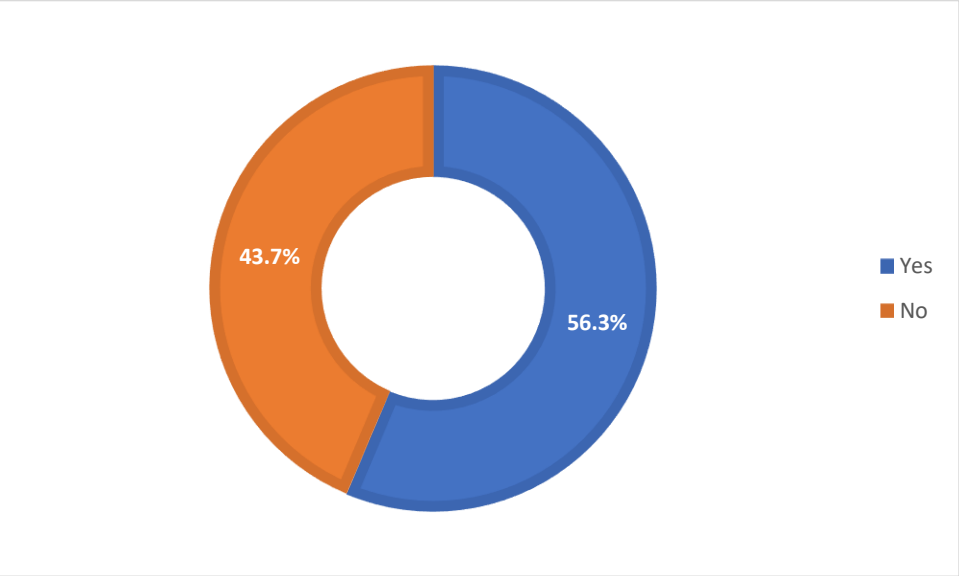

Figure 4. 7: Business Registration

Figure 4.7 shows the responses regarding whether the aquaculture businesses were registered with the Patents and Companies Registration Agency (PACRA). 62 respondents representing 43.7% affirmed having registered their businesses while 80 businesses, representing 56.3% were not registered with PACRA.

In Zambia, the Micro, Small and Medium Enterprises Policy of the Ministry of Commerce, Trade and Industry (2008), classifies MSMEs based on total fixed investments, sales turnover, number of employees and legal status.

Table 4. 11: Classification of MSMEs

No. of Employees	Category	Frequency	Percentage (%)
> 10	Micro	35	24.7
11 – 49	Small	77	54.2
Over 50	Med	30	21.1
Total		**142**	**100**

In this regard, the research findings in Table 4.11 show that 35, representing 24.7% were Micro Enterprises with less than 10 employees. Crosstabulation of the gender of

respondents and business classification in Table 4.12 below revealed that 25 males had micro enterprises and 10 were female. 77 respondents out of which 52 were male and 25 female, representing 54.2% were Small Enterprises with 11 to 49 employees while 30 with 18 male and 12 female respondents, representing 21.1% were Medium Enterprises with over 50 employees. The results confirm the fact that the subsector is dominated by males as illustrated in Section 4.3.1. Table 4.12 below shows the gender of the respondents as comprising of 95 males and 47 females.

Table 4. 12: Crosstabulation of Gender and Classification of Enterprise

		Classification of enterprise			Total
		1 Micro enterprise	2 Small enterprise	3 Medium enterprise	
Gender	1 Male	25	52	18	95
	2 Female	10	25	12	47
Total		35	77	30	142

4.6.5 Duration in Aquaculture MSME Business

The Respondents were asked how long they had been in the aquaculture sector.

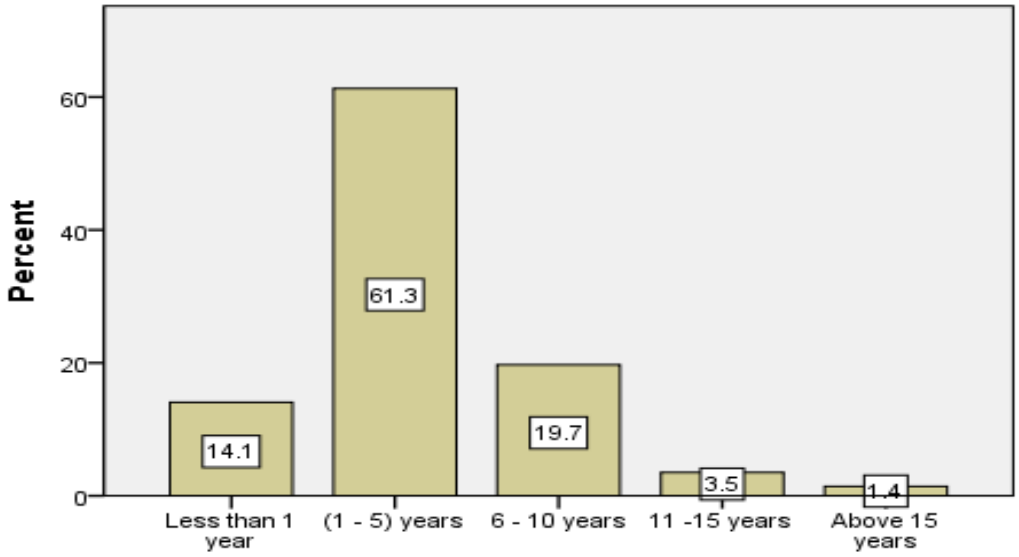

Figure 4. 8: Duration in Aquaculture MSME Business

Figure 4.8 above shows the duration the respondents had been in aquaculture business and the following were the responses; 61.3% of the respondents had been between 1-5 years in business, 19.7% had been in aquaculture business between 6-10 years, 14.1% were in the aquaculture business for less than one year, 3.5% had been the aquaculture business for a period of 11-15 years and lastly, 1.4% of the respondents had been in business for over 15 years.

Around 10 years ago, aquaculture MSMEs were dominant in the sector and were contributing 75% towards production. However, the MSMEs suffered a 27% reduction and were replaced by large scale commercial business entities which contributed 71% to the overall production whereas the MSMEs only contributed 29% (Genschick et al., 2017). In support of the foregoing, statistics indicate that three out of every five such businesses fail within the first few months or years of commencement of operations (Zambia Statistics Office, 2011). The results of the study confirm the high mortality rates of MSMEs beyond five years of existence. A total of 24.6% of the respondents indicate having been in existence beyond 5 years whereas 75.4% have been in existence for less than 5 years, suggesting that few aquaculture MSMEs continue to exist beyond their first five years of existence.

An understanding of the Venture Life Cycle theory can assist MSMEs to anticipate challenges, allocate resources effectively, and make informed decisions at each stage. The venture life cycle theory provides a framework for understanding the journey of a new venture from its inception to maturity. It identifies several stages that ventures commonly go through, including the seed stage, start-up stage, growth stage, expansion stage, and maturity stage (Churchill & Lewis, 1983).

Each stage presents unique challenges and opportunities that entrepreneurs and investors must navigate. The theory emphasizes the importance of strategic planning, securing appropriate funding, scaling operations, and maintaining sustainability. By understanding the venture life cycle, entrepreneurs can make informed decisions, allocate resources effectively, and adapt to the changing dynamics of their ventures (Timmons & Spinelli, 2009).

4.6.6 Crosstabulation of Number and Size of Fishponds

The number and size of fishponds were cross tabulated.

Table 4. 13: Crosstabulation of Number and Average Size of Fishponds

		What are the average sizes of your fishponds?				**Total**
		1 Less than $400m^2$	2 401 to $1600m^2$	3 1600 to $3600m^2$	4 Above $3600m^2$	
How many fishponds do you have?	1 One to five	3	3	0	0	**6**
	2 Six to ten	26	16	3	5	**50**
	3 Eleven to fifteen	19	9	12	7	**47**
	4 Over 15	21	8	8	2	**39**
Total		**69**	**36**	**23**	**14**	**142**

Crosstabulation results of the average fishpond sizes and the number of fishponds in Table 4.13 shows that a total 105 respondents representing 74%, had small fishponds measuring between 1 to $1600m^2$ and only 37 respondents, representing 26% had larger fishponds measuring $1600m^2$ and above. Of the 142 respondents, the crosstabulation revealed that 103 respondents, representing 73% had less than 15 fishponds whereas only 39 respondents representing 27% had more than 15 fishponds. The cross tabulation confirms the nature of the scale at which aquaculture MSMEs are producing, hence their classification into micro, small and medium enterprises.

4.6.7 Fishpond Type

Fishpond types are determined based on water sources and soil formation. People who have access to natural water bodies do not require to construct ponds, but those located away from natural water bodies will have to. The soil formation is another factor. People in areas with porous soil require to construct ponds using either concrete or pond lining plastics. The respondents were asked to indicate the type of fishponds they were using.

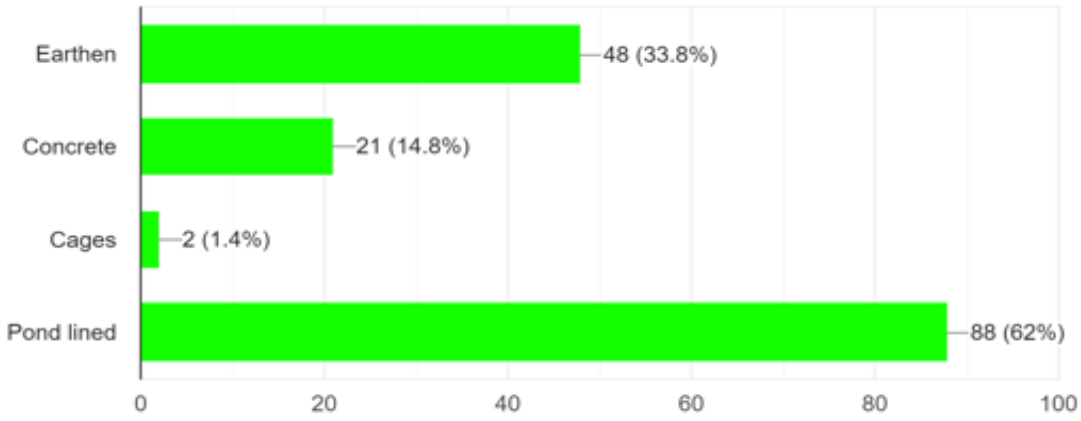

Figure 4. 9: Fishpond Type

From the bar chart in Figure 4.9, pond lined fishponds were the highest, representing 62%, followed by earthen fishponds with 33.8%. In third place, were fishponds made of concrete type of pond representing 14.8% and lastly fish cages with 1.4%.

4.7 Sales in the Past Five (5) Years

The main assumption of the study was the known goal of leaders in a firm which is to maximize the revenue and that the increase in sales will always continue, even at the expense of lower profits, in both the short and long-term. In this study, sales growth was taken as a measure of firm performance.

Table 4. 14: Estimate Percentage of Sales Growth

Sales Growth Levels	Frequency	Percentage (%)
Less than 20%	23	16.2
20% to 40%	66	46.5
41% to 60%	40	28.2
61% to 80%	9	6.3
Above 80%	1	0.7
Cannot tell	3	2.1

Regarding sales growth, Table 4.14 shows that 16.2% had levels of sales growth less than 20%, 46.5% had sales growth levels between 20% and 40%, 28.2% had sales growth levels between 41% to 60%, 6.3% had sales growth levels between 61% and 80%, 0.7% had sales growth levels above 80% while 2.1% could not indicate an estimate

because they had been in existence for a few months and had not yet started selling their products.

Table 4. 15: Level of Sales in the last 5 years

	Frequency	Percent
Low volumes of sales	23	16.2
Moderate volumes of sales	31	21.8
High volumes of sales	69	48.6
Very high volumes of sales	19	13.4
Total	142	100.0

Generally, when the aquaculture MSMEs were asked to assign their preferred ranking in terms of volumes of sales using a five-point agreement scale, the results show that a small number n = 23 (16.2%) were under performing in the last five years (Table 4-15).

4.8 Use of Innovative Technologies

Big data, the internet, artificial intelligence and cloud computing have the potential to significantly impact aquaculture MSMEs in various ways, *inter alia*, market analysis and customer insights, operational efficiency, risk management, personalized marketing and customer service, financial management and competitive intelligence (Lin et al., 2020). In this section, the extent of use of the 4IRs was measured. Use was measured on a five-point scale as follows: 1 completely disagree, 2 disagree, 3 for somewhat agree 4 for agree and 5 for completely agree.

To investigate the relationship between the independent variables big data (BD) the internet of things (IoT), artificial intelligence (AI) and cloud computing (CC) and the dependent variable sales growth (SG) correlational analysis was performed using Pearson product-coefficient. This statistic measures the relationship between two variables. The relationship can be either positive or negative and the test also shows the strength of the relationship. Positive coefficients indicate a direct relationship, indicating that as one variable increases, the other variable also increases. Negative correlation coefficients indicate an indirect relationship, indicating that as one variable increases, the other variable decreases (Statistics Solutions, 2013). This is the measure of Pearson's *r*.

Pearson's r, also known as the Pearson correlation coefficient, is a statistical measure that quantifies the strength and direction of the linear relationship between two continuous variables. It ranges from -1 to +1, where -1 indicates a perfect negative correlation, +1 indicates a perfect positive correlation, and 0 indicates no correlation.

When it comes to interpreting the results, the coefficient *r* must fall between +1.00 (indicating a perfect positive correlation) and – 1.00 (indicating a perfect negative correlation), and 0 indicating no correlation. In addition, Burns and Burns (2008) posit that values between ± 0.10 to ± 0.29 show a small correlation; values between ± 0.30 to ± 0.49 show medium correlation and values between ± 0.50 to ± 1.00 show high correlation.

The other Pearson's statistical measure is the p-value. It assesses the significance of the correlation coefficient by indicating the probability of observing a correlation as strong as the one calculated in the sample data, assuming that there is no true correlation in the population. A lower p-value suggests stronger evidence against the null hypothesis of no correlation, implying that the observed correlation is likely not due to chance. The *p* value must be less than 0.05 (Pallant, 2016).

Pearson's r and the p-value are used to evaluate the strength and statistical significance of a correlation. If the correlation coefficient is close to -1 or +1 and the p-value is below a predetermined significance level (e.g., 0.05), it suggests a strong and statistically significant correlation between the variables. Conversely, if the correlation coefficient is close to 0 and the p-value is above the significance level, it indicates a weak or negligible correlation that is not statistically significant (Burns & Burns, 2008).

Apart from correlation, ordinal regression was conducted. Regression analysis represents a set of statistical methods which are used to estimate relationships between a dependent variable and one or more independent variables. It enables a researcher to predict the dependent variable values based on knowledge of the values of the independent variables and the accuracy of the prediction is determined by the strength of the relationship.

The most common type of regressions is linear regression which is used to analyse continuous variables. The current study investigated ordinal variables based on a five-point Likert scale and as such, the researcher used logistic regression which is ideal for ordered variables. The regression model to be tested as drawn from the identified variables was represented by the formula below:

$$Y = a + bX1 + cX2 + dX3 + eX4 + \epsilon$$

Where:

(a) Y = Dependent variable (MSME Performance expressed as sales growth, i.e., SG)

(b) X1, X2, X3, X4 = Independent (explanatory) variables being the 4IRs, i.e., DB, IoT, AI, CC (see Conceptual Framework in Sections 1.8 and 2.10)

(c) a = Intercept or Constant

(d) b, c, d, e = beta coefficient of the IV's which explain the variance in Y

(e) ϵ – Residual or prediction error

The regression model derived from the foregoing formula thereby is:

$$SG = a + bBD + cIoT + dAI + cCC + \epsilon$$

It is also worth noting that since the variables of the study were ordinal, analysis of variance (ANOVA) could not be done because ANOVA requires continuous dependent variables and categorical independent variables. ANOVA cannot be performed on ordinal data because such data lacks information on the distance between measurements. The only information available is the ordered ranks. Ordinal regression for each of the independent variables was performed to determine the impact on MSME sales growth.

4.8.1 Big Data Use

Big data is useful in making management decisions especially in determining demand and likelihood of an occurrence or event. The respondents were asked to indicate their extent of use of big data.

Table 4. 16: Profile of Use of Big Data

Indicator	Completely disagree	disagree	Somewhat agree	Agree	Completely agree
I use Big Data to improve operations	77	65	-	-	-
I use Big Data to provide better customer service	94	48	-	-	-
I use Big Data to create personalized marketing campaigns	106	36	-	-	-

The results in Table 4.16 show that aquaculture MSMEs do not use big data in their businesses as the frequencies of disagreements are more than the frequencies of agreements.

Table 4. 17: Mean of Sample Score

Degree of Big Data use	Mean	N	Std. Deviation
1 Low degree of Big Data use	3.59	142	.916
Total	3.59	142	.916

In Section 3.8 (B), the main variables were operationalised and the expected scores for each IV were set. The expected score for big data use ought to have been values above and equal to 12, the lower limit (12 to 15 which is a high degree of big data use). However, the analysis shows a low degree of big data use with a mean of sample score of 4 (± 0.92 SD) which is far lower than the lower limit value (Table 4.17).

4.8.1.1 Correlation Analysis

Correlation is used to explore the strength of the relationship between two variables by giving an indication of both the direction, which can be positive (as the value of one variable increases or decreases, the value of the other variable also increases or decreases) or negative (as the value of one varibale increases or decesaes, the value of the other variable decreases or increases), and the strength of the relationhsip. Correlation therefore does not use values of one variable to predict values in another. There are several correlation indexes but the most widely used is the Pearson Product-Moment Correlation, 'r' and the direction of relationship is indicated by either + or -. According to Burns and Burns (2008), the value of r must fall between +1.00 and -1.00 and a guide to the degree of relationship, irrespective of whether they are negative or positive (negative or positive sign refers to the direction of the relationships) provides that for values between ± 0.10 to ± 0.29, there is a small correlation and the relationhsip is so small as to random. For values between ± 0.30 to ± 0.49, there is medium correlation with moderate relationhsip. For values between ± 0.50 to ± 1.00, there is high

correlation with a strong relationship. The correlation analysis results of the variables are discussed below.

4.8.1.2 Correlation Analysis to Determine the Impact of Big Data on Sales Growth

The researcher used Pearson product-moment coefficient to test the strength of the relationship between big data, one of the independent variables and sales growth, the dependent variable, after computing the variables (using composite scores) and the results are shown in Table 4.18.

Table 4. 18: Correlation Coefficient Results for Use of Big Data and Sales Growth

Correlations

		Score for Big Data use	On a scale of 5, indicate the level of sales you have had in the last 5 years
Score for Big Data use	Pearson Correlation	1	.229**
	Sig. (2-tailed)		.006
	N	142	142
On a scale of 5, indicate the level of sales you have had in the last 5 years	Pearson Correlation	.229**	1
	Sig. (2-tailed)	.006	
	N	142	142

**. Correlation is significant at the 0.01 level (2-tailed).

The results show that there is low positive correlation and a weak relationship between the two variables with $r = .229$, $n = 142$, $p = 0.006$. The r correlation is significant at $0.01 < 0.229$. The p (2-tailed) value 0.006, is less than 0.05 ($p < 0.05$ is the standard). According to Burns and Burns (2013), an r value between ± 0.10 to ± 0.29 indicates small or low correlation and a corresponding weak positive relationship.

Therefore, based on the correlation analysis given above, the correlation coefficient (Pearson's r) between the "Score for Big Data use" and the "Level of sales in the last 5 years" is 0.229. The p-value associated with this correlation is 0.006, indicating statistical significance at the 0.01 level (2-tailed).

The positive correlation coefficient suggests that there is a weak to moderate positive linear relationship between the level of big data use and the level of sales in the last 5 years. As the score for big data use increases, there tends to be a slight increase in the level of sales. However, it's important to note that the correlation coefficient of 0.229 indicates that the relationship is not very strong. The statistical significance of the correlation (p-value = 0.006) suggests that the observed correlation is unlikely to have occurred by chance. Therefore, there is evidence to support the existence of a relationship between big data use and sales.

It's worth mentioning that correlation does not imply causation. While this analysis suggests a relationship between big data use and sales, further research or additional variables should be considered to explore potential causal factors or other variables that might influence sales. Overall, these results indicate that there is a statistically significant but relatively weak positive relationship between big data use and the level of sales in the last 5 years in the given dataset of 142 cases.

4.8.1.3 Ordinal Regression for Big Data

The first table presented by SPSS when performing ordinal regression is the Case Summary Table which shows the total number of cases included in the analysis, which in this case was 142 respondents. The next output shows the Goodness-of-fit statistics in two tables, i.e., the Model Fitting Information and the Goodness-of-fit. The two output tables help to determine whether the model adequately describes the data and measuring how well the observed data corresponds to the (assumed) model respectively. The model fitting information must be less than 0.05 in order for the model to adequately describe the data, but the goodness of fit statistic indicates a poor fit if the significance value is less than 0.05.

Table 4. 19: Model Fitting Information for Big Data

Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	116.925			
Final	107.698	9.227	5	.100

Link function: Logit.

The model fitting information table for big data gives the -2 Log Likelihood (see Table 4.19) values for the baseline and the final model, and SPSS performs a chi-square to test the difference between the – 2 Log Likelihood for the two models. The non-statistically significant chi-square statistic ($p > 0.05$) which in the table is 0.100 indicates that the final model is not significant, and it does not give a significant improvement over the baseline intercept-only model. This tells us that the model does not give better predictions than if we just guessed based on the marginal probabilities for the outcome categories.

From the results, the intercept-only model serves as a baseline for comparison. The -2 Log Likelihood value for this model is 116.925. It represents the model's fit to the data without any predictor variables. The final model, with predictor variables included, has an -2 Log Likelihood value of 107.698. This indicates that the final model provides a better fit to the data compared to the intercept-only model (Alpar, 2011).

The chi-square test statistic which evaluates whether the final model's improvement in fit, compared to the intercept only model, is statistically significant, is at 9.227, with 5 degrees of freedom with an associated p-value of 0.100. This suggests that the improvement in fit is not statistically significant at a conventional significance level of 0.05.

Overall, therefore, the results indicate that the final logistic regression model provides a better fit to the data compared to the intercept-only model. However, the improvement in fit is not statistically significant at a conventional significance level of 0.05.

The next table in the output is the *Goodness-of-Fit table* (Table 4.20). This table contains Pearson's chi-square statistic for the model. These statistics are intended to test whether the observed data are consistent with the fitted model. We start from the null hypothesis that the fit is not *good.* Goodness of Fit statistic indicates a poor fit if the significance value is less than 0.05.

Table 4. 20: Goodness-of-Fit for Big Data

	Chi-Square	Df	Sig.
Pearson	36.195	46	.850
Deviance	41.506	46	.661

Link function: Logit.

From the results, the model adequately fits the data ($p > 0.05$) with an insignificant value of 0.85 which means that there are no significant differences in the observed data and fitted (assumed) model.

The Pearson chi-square test statistic is 36.195, with 46 degrees of freedom with an associated p-value of 0.850, indicating that the model's fit to the data is not statistically significant. In other words, the observed data does not significantly deviate from what would be expected based on the model. The deviance chi-square test statistic of 41.506, also with 46 degrees of freedom and an associated p-value of 0.661, suggests that the model's fit is not statistically significant. Just like the Pearson chi-square, it indicates that the observed data does not significantly deviate from the model's predictions. This means that the logistic regression model does not have a statistically significant fit to the data and further that the model may not adequately explain the relationship between the predictor variables and the outcome variable.

The subsequent table in the analysis is the Pseudo R-square. Pseudo R-squared is specifically designed for mono-linear models and it assesses the goodness-of-fit or the proportion of variance explained by the model. It attempts to quantify the improvement of the fitted model compared to a baseline model or null model. It represents the proportion of the deviance explained by the model or the reduction in deviance achieved by including predictor variables in the model. There are different variations of pseudo R-squared measures, including Cox and Snell R-squared, Nagelkerke R-squared, and McFadden R-squared. These measures range from 0 to 1, where 0 indicates that the model does not provide any improvement over the null model, and 1 suggests a perfect fit.

Table 4. 21: Pseudo R-Square for Big Data

Cox and Snell	.063
Nagelkerke	.069
McFadden	.026

Link function: Logit.

In Ordinal Regression, McFadden value of R-Square is used because, unlike the Cox and Snell or Nagelkerke R-squared, it does not directly represent the proportion of variance explained, instead, it measures the improvement in model fit when compared to a baseline (null) model. In this case, the value suggests a relatively weak improvement in model fit.

For big data, it can be stated that there has been a 2.6% improvement in the prediction of outcome (i.e., sales growth) based on the predictor, big data in comparison to the null model when there are no predictors. This is not an excellent fit as McFadden's pseudo R-squared value ought to be between of 0.2 to 0.4. The McFadden R-squared indicates a modest improvement in model fit compared to a null model. The low Pseudo R-Square of 2.6% instead of ranging between 20 % and 40%, indicates that a model containing big data is unlikely to be a predictor of the outcome of sales volume increase for any particular individual aquaculture MSME.

The last output gives the parameter estimates Pseudo R-Square and these are the core of the output, showing specifically the relationship between the independent variable (application of big data) and the outcome variable (levels of sales growth).

Table 4. 22: Parameter Estimates Pseudo R-Square

	Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Threshold							
Sales growth = Low volumes of sales	-2.57	.44	33.27	1	.00	-3.45	-1.702
Moderate volumes of sales	-1.37	.40	11.35	1	.00	-2.16	-.574
High volumes of sales	1.10	.40	7.45	1	.00	.31	1.897
Location							
Features of Big Data Very Low volume of sales	-.31	.31	.95	1	.32	-.93	.312
Utility factors of Big Data Very low volumes of sales	-.26	.43	.35	1	.55	-1.12	.598
Processing factors of Big Data Very Low volume of sales	-.71	.44	2.55	1	.11	-1.59	.162
Knowledge of Big Data Very Low volume of sales	.66	.81	.66	1	.41	-.93	2.266
complex techniques of Big Data Very Low volume of sales	-.86	.82	1.09	1	.29	-2.48	.754

Link function: Logit.

a. This parameter is set to zero because it is redundant.

From the results given in Table 4.22, the values of Wald $\chi 2(1)$ p values are all > 0.05. In addition, big data is not worth noting as a predictor of sales volume increase because the variable has shown a non-statistically significant effect since p > 0.01.

4.8.2 Internet Use

Use of the internet is important in a company for inter alia, easy communication, etc, and questions were asked as to whether the firms used internet. The data below shows that aquaculture MSMEs generally do not use much of the internet in their businesses as the frequencies of disagreements are more than the frequencies of agreements. Use however, was to some extent associated with promoting their businesses online (Table 4.23).

Table 4. 23: Profile of Internet Use

Indicator	Completely disagree	Disagree	Somewhat agree	Agree	Completely agree
I use internet for monitoring and measuring customer interest.	69	73	-	-	-
I use internet for finding new customers	120	22	-	-	-
I use internet for promoting the business online.	98	6	33	5	-

Internet use was categorised into internet use to monitor and measure customer interests, to find new customers and to promote the business online. Use was measured on a five point scale as follows: 1 for never, 2 for Rarely, 3 for occasional, 4 for frequently and 5 for Always. The results show that 38 of the respondents, representing 27% used the internet for promoting their businesses online, whereas 104 respondents representing 73% do not use the internet under all the three indicators or categories outlined in Table 4.23.

4.8.2.1 Correlation Analysis to Determine the Impact of Internet use on Sales Growth

The researcher used Pearson product-moment coefficient to test the strength of the relationship between internet use, one of the independent variables and sales growth, the dependent variable, after computing the variables (using composite scores) and the results are shown in Table 4.24.

Table 4. 24:Correlation Coefficient Results for Internet Use and Sales Growth

Correlations

		Score for internet use	On a scale of 5, indicate the level of sales you have had in the last 5 years
Score for internet use	Pearson Correlation	1	.095
	Sig. (2-tailed)		.258
	N	142	142
On a scale of 5, indicate the level of sales you have had in the last 5 years	Pearson Correlation	.095	1
	Sig. (2-tailed)	.258	
	N	142	142

The results show that there is a slight positive correlation and very little relationship between the two variables with, r = 0.095, n = 142, p = 0.258. The r correlation is significant at 0.01 < 0.095. The p (2-tailed) value is greater than 0.05 (0.258 > 0.05), therefore the results are not significant.

Table 4. 25: Degree of Internet Uuse

Degree of Internet use	*Frequency*	*Percent*
Low degree of Internet use	127	89.4
Moderate degree of Internet use	15	10.6
Total	**142**	**100.0**

Use of the internet was further broken down and the analysis in Table 4.25 shows a low degree of internet use, n = 127 (89.4%) and moderate internet use, n = 15 (10.6%).

Table 4. 26: Mean of Sample Score

Degree of internet use	Mean	N	Std. Deviation
1 Low degree of Internet use	3.57	127	.913
2 Moderate degree of Internet use	3.73	15	.961
Total	3.59	142	.916

The mean sample score as shown in Table 4.26, was 4 (± 0.92 SD) and this is within the range for low expected internet use (3 to 6) given in Section 3.8 (B). However, it was far lower than the lower limit value of the highest range of expected scores (12 to 15).

4.8.2.2 Ordinal Regression for Internet Use

Ordinal regression was performed to determine the impact of Internet use on aquaculture MSME sales growth (See Table 4.27).

Table 4. 27: Model Fitting Information for Internet Use

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	146.392			
Final	131.518	14.873	6	.021

Link function: Logit.

From the results, the -2 Log Likelihood value of the null or baseline model is 146.392 and the chi-square test statistic is 14.873, with 6 degrees of freedom with an associated p-value of 0.021, indicating that the improvement in fit is statistically significant at a significance level of 0.05. This suggests that the inclusion of the predictor variable in the model provides a better fit to the data compared to the null model.

Therefore, the results indicate that the logistic regression model with the predictor variable, internet use, provides a statistically significant improvement in fit compared to

the null model. The inclusion of the predictor variable allows the model to better explain the variation in the outcome variable, sales growth. The Model is significant, and this shows that there is a significant improvement in fit as compared to the null model, hence, the model is showing a good fit.

The next table in the output is the Goodness-of-Fit table. The Goodness of Fit statistic indicates a good fit of the data since the significance value p is > 0.05.

Table 4. 28: Goodness-of-Fit for Internet Use

	Chi-Square	Df	Sig.
Pearson	57.167	66	.773
Deviance	62.499	66	.599

Here, the significant value (> 0.05) would mean that there are significant differences in the observed data and fitted (assumed) model (see Table 4.28). The Pearson chi-square test statistic is 57.167, with 66 degrees of freedom and an associated p-value of 0.773, which indicates that the model's fit to the data is not statistically significant. In other words, the observed data does not significantly deviate from what would be expected based on the model. The deviance chi-square test statistic is 62.499, also with 66 degrees of freedom and an associated p-value of 0.599, suggesting that the model's fit is not statistically significant. Similar to the Pearson chi-square, it indicates that the observed data does not significantly deviate from the model's predictions meaning that the logistic regression model does not have a statistically significant fit to the data. This suggests that the model may not adequately explain the relationship between the predictor variables and the binary outcome variable.

The next output of the analysis is the Pseudo R-Square table as alluded to in Section 4.9, only the McFadden value is used.

Table 4. 29: Pseudo R-Square for Internet Use

Cox and Snell	.099
Nagelkerke	.108
McFadden	.042

McFadden value of R-Square for internet use in Table 4.29 shows a 4.2% improvement in the prediction of outcome based on the predictors in comparison to the null model. This is not an excellent fit as McFadden's pseudo R-squared value ought to be between of 0.2 to 0.4 (20% to 40%).

The last analysis output is the parameter estimates Pseudo R-square given in Table 4.30 below.

Table 4. 30: Parameter Estimates Pseudo R-Square

	Estimate	Std. Error	Wald	Df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Threshold							
Low volumes of sales	-3.71	.75	24.40	1	.00	-5.19	-2.24
Moderate volumes of sales	-2.49	.72	11.94	1	.00	-3.90	-1.07
High volumes of sales	.05	.68	.00	1	.93	-1.28	1.40
Location							
The firm using Features of internet very high volumes of sales	-.34	.32	1.15	1	.28	-.97	.28
The firm using Utility factors of internet high low volumes of sales	-.30	.43	.48	1	.48	-1.14	.54
The firm using Processing factors of internet high volumes of sales	-.83	.44	3.43	1	.06	-1.71	.04
The firm using Knowledge of internet high volumes of sales	.18	.62	.08	1	.76	-1.03	1.40
The firm using complex techniques of internet high volumes of sales	-1.47	.62	5.58	1	.01*	-2.70	-.25

Link function: Logit.

For the predictor internet use, only one variable is worth noting to be a significant predictor of sales growth and this is MSMEs considering using complex techniques of

the internet influencing levels of sales as high as it had a statistically significant effect, Wald $\chi 2(1) = 5.58$, with $p = 0.01 < 0.05$.

4.8.3 Use of Artificial Intelligence

The data below shows that aquaculture MSMEs do not use artificial intelligence in their business as the frequencies of disagreements are more than the agreements (Table 4.31).

Table 4. 31: Profile of Use of Artificial Intelligence

Indicator of use	Completely disagree	Disagree	Somewhat agree	Agree	Completely agree
I use artificial intelligence for spam filters.	77	65	-	-	-
I use artificial intelligence for smart email categorisation.	88	54	-	-	-
I use artificial intelligence for voice to text features.	92	50	-	-	-
I use artificial intelligence for smart personal assistants, such as Siri, Cortana and Google Now.	73	69	-	-	-
I use artificial intelligence for automated responders and online customer support.	58	84	-	-	-
I use artificial intelligence for process automation.	77	65	-	-	-
I use artificial intelligence for sales and business forecasting.	88	54	-	-	-
I use artificial intelligence for security surveillance	92	50	-	-	-

4.8.3.1 Correlation Analysis to Determine the Impact of Artificial Intelligence use on Sales Growth

The researcher used Pearson product-moment coefficient to test the strength of the relationship between artificial intelligence use, one of the independent variables and sales growth, the dependent variable and the results are shown in Table 4.32.

Table 4. 32: Correlation Coefficient Results for Use of Artificial Intelligence and Sales Growth

Correlations

		Score of Use of Artificial intelligence	On a scale of 5, indicate the level of sales you have had in the last 5 years
Score of Use of Artificial intelligence	Pearson Correlation	1	.231**
	Sig. (2-tailed)		.006
	N	142	142
On a scale of 5, indicate the level of sales you have had in the last 5 years	Pearson Correlation	.231**	1
	Sig. (2-tailed)	.006	
	N	142	142

**. Correlation is significant at the 0.01 level (2-tailed).

The results show that there is low positive correlation and a weak relationship between the two variables with, $r = 0.231$, $n = 142$, $p = 0.006$. The r correlation is significant at $0.01 < 0.231$. The p (2-tailed) value is less than 0.05 ($p < 0.05$), therefore, the results are significant.

The expected score for artificial intelligence ought to have been values above and equal to 31 the lower limit (31 to 40 which is a high degree of artificial intelligence use). However, the analysis shows a low degree of artificial intelligence use. The mean sample score was 11.4 (± 2.13 SD) and this far lower than the lower limit value.

4.8.3.2 Ordinal Regression for Use of Artificial Intelligence

Ordinal regression was performed to determine the impact of use of artificial intelligence on aquaculture MSME sales growth (See Table 4.33).

Table 4. 33: Model Fitting Information for Use of Artificial Intelligence

Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	161.685			
Final	146.543	15.142	6	.019

Link function: Logit.

The intercept-only -2 Log Likelihood value for this model is 161.685 and the final model has a value of 146.543. This indicates that the final model provides a better fit to the data compared to the intercept-only model. The difference in the -2 Log Likelihood values between the intercept-only model and the final model is 15.142. The chi-square test statistic is 15.142, with 6 degrees of freedom with an associated p-value of 0.019, indicating that the improvement in fit is statistically significant at a conventional significance level of 0.05. the results therefore indicate that the final logistic regression model provides a better fit to the data compared to the intercept-only model. The improvement in fit is statistically significant, suggesting that the inclusion of the predictor variable in the model enhances its ability to explain the variation in the outcome variable. The Model is significant, and this shows that there is a significant improvement in fit as compared to the null model, hence, the model is showing a good fit.

The next table in the SPSS analysis output is the Goodness-of-Fit statistic.

Table 4. 34: Goodness-of-Fit for Artificial Intelligence

	Chi-Square	df	Sig.
Pearson	72.654	72	.456
Deviance	76.053	72	.349

Goodness of Fit statistic indicates a good fit of the data since the significance value p is > 0.05 at 0.46. Here, the significant value would mean that there are significant differences in the observed data and fitted (assumed) model (see Table 4.34).

The next output is the Pseudo R-Square, showing the McFadden value of R-square.

Table 4. 35: Pseudo R-Square for Artificial Intelligence

Cox and Snell	.101
Nagelkerke	.110
McFadden	.043

McFadden value of R-Square for use of artificial intelligence in Table 4.35 shows a 4.3% improvement in the prediction of outcome based on the predictors in comparison to the null model. This is not an excellent fit as McFadden's pseudo R-squared value ought to be between of 0.2 to 0.4.

For the predictor use of artificial intelligence, the parameter estimates table (Table 4.36) shows the relationship between the explanatory variables (use of artificial intelligence) and the outcome variable (levels of sales growth).

Table 4. 36: Parameter Estimates Pseudo R-Square

	Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Threshold							
Sales growth = Low volumes of sales	-3.121	.690	20.427	1	.000	-4.474	-2.24
Moderate volumes of sales	-1.898	.661	8.231	1	.004	-3.194	-1.07
High volumes of sales	.660	.646	1.044	1	.307	-.606	1.40
Location							
The firm using Features of artificial intelligence very low volumes of sales	-.145	.318	.208	1	.648	-.769	.479
The firm using Utility factors of artificial intelligence very low volumes of sales	-.731	.401	3.319	1	.068	-1.517	.055
The firm using Processing factors of artificial intelligence low volumes of sales	-.206	.390	.278	1	.598	-.970	.559
The firm using Knowledge of artificial intelligence very low volumes of sales	.916	.560	2.680	1	.102	-.181	2.013
The firm using complex techniques of artificial intelligence low volumes of sales	-2.058	.627	10.762	1	.001	-3.288	-.829

Link function: Logit.

Only one variable is worth noting to be a significant predictor of sales growth and this is aquaculture MSMEs considering using complex techniques of artificial intelligence influencing levels of sales as high. This had a statistically significant effect, Wald $\chi 2(1) = 10.76$, $p > 0.01$.

4.8.4 Use of Cloud Computing

The data below shows that the majority of aquaculture MSMEs do not use cloud computing in their business as the frequencies of disagreements are more than the agreements.

Table 4. 37: Profile of Use of Cloud Computing

Indicator of use	Completely disagree	Disagree	Somewhat agree	Agree	Completely agree
I use Cloud Computing for on line data storage and recovery	56	61	25		
I use Cloud Computing for Data Analysis	88	54	-	-	-
I use Cloud Computing for business networking	92	50	-	-	-
I use Cloud Computing for Testing and Development of products	73	69	-	-	-

The results in Table 4.37 show that out of the 142 respondents, 117 representing 82%, indicated non-use whereas only 25, representing 18% indicated use of cloud computing for online data storage and recovery in their businesses.

4.8.4.1 Correlation Analysis to Determine the Impact of Cloud Computing use on Sales Growth

The researcher used Pearson product-moment coefficient to test the strength of the relationship between cloud computing and sales growth.

Table 4. 38: Correlation Coefficient Results for Use of Cloud Computing and Sales Growth

Correlations

		Score of Cloud Computing	On a scale of 5, indicate the level of sales you have had in the last 5 years
Score of Cloud Computing	Pearson Correlation	1	.234**
	Sig. (2-tailed)		.005
	N	142	142
On a scale of 5, indicate the level of sales you have had in the last 5 years	Pearson Correlation	.234**	1
	Sig. (2-tailed)	.005	
	N	142	142

**. Correlation is significant at the 0.01 level (2-tailed).

The results in Figure 4. 38 show that there is slight positive correlation and the relationship is so small as to be random between the two variables with $r = 0.234$, $n = 142$, $p = 0.005$. The r correlation is significant at $0.01 < 0.234$. The p (2-tailed) value is less than 0.01 ($p < 0.05$ is the standard) and is significant. In addition, the expected score for cloud computing provided in Section 3.8 (B) ought to have been values above and equal to 16 the lower limit (16 to 20) which is a high degree of cloud computing use). However, the analysis revealed a low degree of artificial intelligence use with a mean sample score of 6 (± 1.3 SD) which was far lower than the lower limit value.

4.8.4.2 Ordinal Regression for Use of Cloud Computing

Ordinal regression was performed to determine the impact of use of cloud computing on aquaculture MSME sales growth.

Table 4. 39: Model Fitting Information for Cloud Computing

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	129.897			
Final	118.057	11.840	5	.037

Link function: Logit.

The -2 Log Likelihood value in Figure 4.39 is 129.897, which represents the model's fit to the data without any predictors and the final model, which includes predictor variables, has an -2 Log Likelihood value of 118.057. This indicates that the final model provides a better fit to the data compared to the intercept-only model. The difference in the -2 Log Likelihood values between the intercept-only model and the final model is 11.840.

The chi-square test statistic is 11.840, with 5 degrees of freedom. This test evaluates whether the improvement in fit achieved by including predictor variables in the final model is statistically significant. The associated p-value is 0.037, suggesting that the improvement in fit is statistically significant at a conventional significance level of 0.05. The results therefore indicate that the final logistic regression model provides a better fit to the data compared to the intercept-only model. The inclusion of predictor variables significantly improves the model's ability to explain the variation in the outcome variable. The Model is significant, and this shows that there is a significant improvement in fit as compared to the null model, hence, the model is showing a good fit.

The next output in the analysis is the Goodness-of- Fit statistic given in Table 4.40 below.

Table 4. 40: Goodness-of-Fit for Cloud Computing

	Chi-Square	Df	Sig.
Pearson	38.452	52	.919
Deviance	44.323	52	.766

Goodness of Fit statistic indicates a good fit of the data since the significance value p is > 0.05. The Pearson chi-square test statistic is 38.452 and an associated p-value of 0.919, indicating that the model's fit to the data is not statistically significant. In other words, the observed data does not significantly deviate from what would be expected based on the model. The deviance chi-square test statistic is 44.323 with associated p-value of 0.766, suggesting that the model's fit is not statistically significant. Similar to the Pearson chi-square, it indicates that the observed data does not significantly deviate from the model's predictions.

Both the Pearson and deviance chi-square tests indicate that the logistic regression model does not have a statistically significant fit to the data. This suggests that the model may not adequately explain the relationship between the predictor variables and the binary outcome variable.

The other analysis output is the Pseudo R-square statistic given in Table 4.41.

Table 4. 41: Pseudo R-Square for Cloud Computing

Cox and Snell	.080
Nagelkerke	.087
McFadden	.033

McFadden value of R-Square for Internet use in Table 4-48 shows a 3.3% improvement in the prediction of outcome based on the predictors in comparison to the null model. This is not an excellent fit as McFadden's Pseudo R-squared value ought to be between of 0.2 to 0.4.

For the predictor cloud computing use, the parameter estimates table (Table 4.42) shows the relationship between the explanatory variable (cloud computing use) and the outcome variable (levels of sales growth).

Table 4. 42: Parameter Estimates Pseudo R-Square

	Estimate	Std. Error	Wald	Df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Threshold							
Sales growth = Low volumes of sales	-2.662	.445	35.787	1	.000	-3.534	-1.790
Moderate volumes of sales	-1.437	.402	12.765	1	.000	-2.225	-.649
High volumes of sales	1.071	.396	7.302	1	.007	.294	1.848
	-.240	.318	.572	1	.450	-.863	.383
Location	-.423	.403	1.101	1	.294	-1.212	.367
The firm using Features of cloud computing very low volumes of sales	-.576	.417	1.911	1	.167	-1.393	.241
The firm using Utility factors of cloud computing very low volumes of sales	.685	.571	1.435	1	.231	-.435	1.805
The firm using Processing factors of cloud computing low volumes of sales	-.953	.574	2.761	1	.097	-2.078	.171
The firm using Knowledge of cloud computing very low volumes of sales	.916	.560	2.680	1	.102	-3.534	-1.790
The firm using complex techniques of cloud computing low volumes of sales	-2.058	.627	10.762	1	.091	-2.225	-.649

Link function: Logit.

No variable in Table 4.42 is worth noting to be a significant predictor of sales growth because all the values had non statistically significant effect as $p > 0.01$.

4.9 Grounding the Discussion

This study was premised on the assumption that aquaculture MSMEs in Lusaka could not have been using new technologies (big data (BD), cloud computing (CT), the Internet of things (IoT) and artificial intelligence (AI) and that this could be the reason for their poor growth in sales. Arising from this, the aim of the study was to investigate the utilisation of these new technologies in enhancing growth in sales of aquaculture products.

4.10 Discussion of the Research Questions

Below is the discussion of each research question.

4.10.1 RQ1: The state of usage of new technologies by aquaculture MSMEs in Lusaka

The first research question related to what the state of usage of new technologies by aquaculture MSMEs in Lusaka was. Generally, investigation of the use of these technologies showed that aquaculture MSMEs completely disagreed with their usage. There was more preference for using traditional marketing strategies than conventional marketing strategies. Although WhatsApp, a popular messaging application that allows users to send text messages, make voice and video calls, and share various forms of media such as photos, videos, and documents, is highly preferred as an e-marketing strategy, the study shows that MSMEs have moved from traditional marketing strategies to e-marketing strategies as they appear to be the most effective rated tools.

The researcher did not expect new technology not to have a positive impact on sales growth. Despite the controversial arguments for and against the use of new technology, overall, the study findings tend to suggest that digital skills knowledge and attitudes could be at the centre of the levels of disagreement with their use. MSMEs may have challenges in accessing, understanding and creating information through new technology tools so they can apply them. They may lack competences that are often referred to as 'computer literacy, ICT literacy, information literacy and media literacy' (UNESCO 2018). The existence of digital skills is a key factor not only for the digital economy, but for a successful life in our interconnected society. It is also one of the factors being measured by the UN sustainable development goals (SDG).

Aquaculture MSMEs can be directly affected by lack of sufficient digital skills. The Diffusion of Innovations Theory demands that aquaculture MSMEs must be early adopters of innovative technologies so that they can be able to successfully take advantage of the digital economy. Entrepreneurs and employees need to obtain sufficient 'digital literacy for the digital economy'. This includes using ICT tools to maintain a MSME web or social media presence, sell online, use the cloud and digitalize their back-office functions. Pasadilla and Wirjo (2018), based on consultations with SMEs, also point to skills necessary to satisfy the expectation of customers who cannot examine the products physically. This includes skills necessary to present products with pictures,

videos or written descriptions, manage endorsement from other customers, make the products discoverable with the use of relevant keywords and ad words (Pasadilla and Wirjo 2018).

While the role of governments in this regard is to support aquaculture MSMEs to get digital literacy, particularly as these MSMEs may not have any budget to train their employees, there is also a role to promote business support services so that aquaculture MSMEs can outsource some of the 'digital skills' necessary to participate in the digital economy. This will depend on the availability of services suppliers domestically (for instance, developers or digital marketing companies), platforms offering these services, or whether these services can be outsourced from other countries, highlighting the importance of facilitating trade in aquaculture relevant for the digital economy (software publishing, computer programming, and other IT services).

It is surprising that some aquaculture MSMEs may not be using new technology like Facebook and WhatsApp that have become some of the most popular new technology platforms. The increasing adoption of new technology by MSMEs is leading to the shift of traditional marketing to social marketing not only as shown by this study but as shown in some other research (Nadaraja & Yazdanifard, 2013).

In addition, new technology platforms are employing mobile and web-based technologies to create highly interactive platforms through which firms can create, discuss and share information with users and increase business value (Fan and Gordon, 2014). In line with Schumpeter's Innovation Theory and the Technology Acceptance Model, aquaculture MSMEs need to accept use of innovative technologies and 'disrupt', or they will perish.

Aquaculture MSMEs in Egypt, Ghana and Kenya combine big data, artificial intelligence, the internet of things and cloud computing to analyse large volumes of data to identify trends and this helps in decision making regarding aquaculture practices such as feed management, water quality control, prevention of disease and production planning which in turn enables them to operate efficiently, enhance their product quality optimize resource allocation and contribute to the growth of the aquaculture sub sector (Amenyogbe et al., 2018; ILO, 2021; Obiero et al., 2019).

4.10.2 RQ2: The state of growth in sales of aquaculture MSMEs in Lusaka over the past five years

The second research question was, "What has the state of growth in sales of aquaculture MSMEs in Lusaka been over the past five years? Aquaculture production in Zambia has experienced rapid growth and part of this could be attributed to aquaculture MSMEs though their contribution to total production is only about 30% (Department of Fisheries, 2015). The distribution of small-scale production in Zambia is particularly low for Lusaka (Genschick et al., 2018). The study established that there is still a deficit of 87,000 tonnes and the aquaculture industry does not appear to be fully responding to the increasing demand (Kefi and Mukuka, 2015; Oladapo et al., 2016). Recent estimates by the Zambian Department of Fisheries (DoF) indicate that aquaculture MSMEs contributed about 32,888 tonnes of fish representing 27% of the total national fish production recorded in 2019 (Figure 4.10).

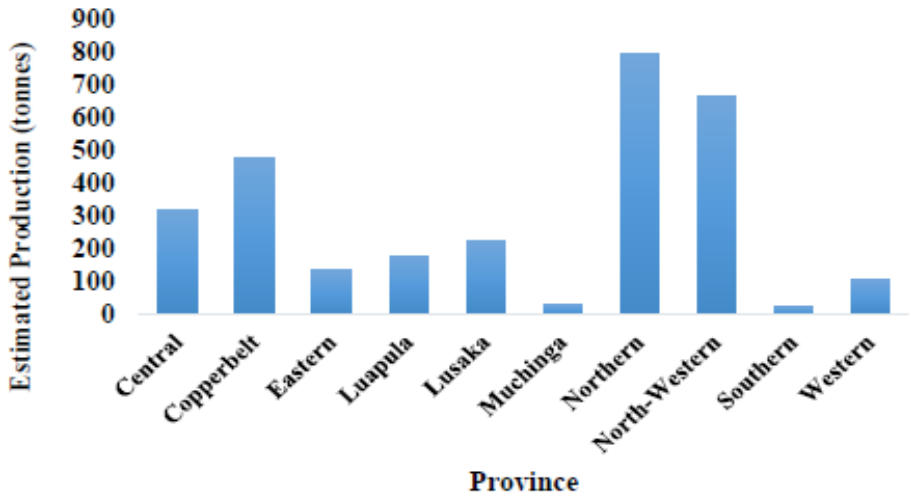

Figure 4. 10: Distribution of Small-Scale Production in Zambia

Source: Department of Fisheries, Zambia (2015)

While provinces like Northern or North-Western have higher total production as a result of the large number of farmers, farm productivity per hectare could have been higher in Lusaka had it expanded to beyond 1 to 5 fishponds and the surface area exceeding 400m (Genschick et al., 2017; Mudenda, 2009). This is due to what could be graded as semi-intensive level of production, capital investment, labour, and management practices employed. These production systems have been more diversified over the years than they were in the early years of aquaculture production when earthen ponds were the major

systems used. If the earthen reservoirs could be upgraded, sales volumes would increase (Mudenda, 2009).

4.10.3 RQ3: New technologies as predictors of increase in sales of aquaculture MSMEs

The third research question that was considered was, “what new technologies are predictors of increase in the sales volumes among aquaculture MSMEs?” The data shows that more than half of the aquaculture MSMEs n = 88 (62%) experienced high volumes of sales and n = 19 (13.4%) experienced very high volumes of sales. The four new technologies were associated with low improvement in the prediction of sales volume increase for any particular individual aquaculture MSME. McFadden's Pseudo-R-squared values were lower than the normal reference values which ought to be between of 0.2 to 0.4.

4.10.4 RQ3: How to enhance growth in sales among aquaculture MSMEs

Literature shows that the aquaculture sector in countries like Egypt and China which have harnessed new technology such as big data, the internet of things, artificial intelligence and cloud computing, has been able to enhance its performance. If adopted by aquaculture MSMEs in Zambia, the same new technologies can enhance their sales growth. The study has recommended several strategies which require further attention and ought to be taken into consideration by the various stakeholders in order that the subsector can be given the much-desired attention.

The strategies require a paradigm shift among the aquaculture MSMEs to move away from traditional methods and begin to adopt new technologies, not only Facebook and WhatsApp. They must begin exploring other data-handling tools and methods. Another strategy is networking and collaboration among aquaculture MSMEs, research institutions and government agencies to facilitate capacity building, knowledge sharing, exchange of best practices, access to resources, new business opportunities and collective efforts to address common challenges and advocate for regulatory and policy support.

Aquaculture MSMEs need to register their businesses with PACRA so that they gain legal recognition and protection. Registration with PACRA has the potential to increase the credibility and trustworthiness of the aquaculture MSMEs in the eyes of customers,

suppliers, and partners and demonstrates that the business is committed to professionalism, transparency, and compliance with regulatory requirements.

In addition, aquaculture MSMEs must conduct market research and product development to identify and appreciate domestic and international consumer demands, consumer preferences, and emerging trends in the aquaculture industry such as value addition. The last strategy is to improve aquaculture MSME distribution networks and channels to ensure efficient and timely delivery of aquaculture products by exploring partnerships with wholesalers, retailers, restaurants, and hotels to expand market reach.

4.11 Regression Model & Hypothesis Testing

In this study, the researcher was committed to testing the null hypothesis relating to the use of innovative technologies by aquaculture MSMEs in Lusaka. Null hypothesis testing is a formal approach to deciding between two interpretations of a statistical relationship in a sample. One interpretation is called the null hypothesis and the other, the alternative hypothesis. The null hypothesis presumes that the assumptions are true until evidence indicates otherwise. In testing the null hypotheses, the steps were as follows:

a) Assuming that the null hypothesis is true, there is no relationship between the independent variables and the dependent variable,

b) Determining how likely the relationship would be if the null hypothesis were true,

c) If the sample relationship would be extremely likely, then rejecting the null hypothesis in favour of the alternative hypothesis and

d) If it would not be extremely unlikely, then retain the null hypothesis.

A crucial step in null hypothesis testing in this study was finding the likelihood of the sample result if the null hypothesis were true. This probability is the ***p*** value. A low ***p*** value means that the sample result would be unlikely if the null hypothesis were true and leads to the rejection of the null hypothesis. A high ***p*** value means that the sample result would be likely if the null hypothesis were true and leads to the retention of the null hypothesis (Cohen, 1990; 1994).

But how low must the ***p*** value be before the sample result is considered unlikely enough to reject the null hypothesis? In null hypothesis testing, this criterion is set to 0.05. If

there is less than a 5% chance of a result as extreme as the sample result if the null hypothesis were true, then the null hypothesis is rejected. When this happens, the result will be determined to be statistically significant (Agresti, 1996).

If there is greater than a 5% chance of a result as extreme as the sample result when the null hypothesis is true, then the null hypothesis will be retained (Cohen, 1990; 1994; Zhao, 2015). This does not necessarily mean that the researcher accepts the null hypothesis as true—only that there is not currently enough evidence to conclude that it is true (Agresti, 1996).

The main hypothesis of the study was depicted as follows:

Use of innovative Technologies have no significant impact on aquaculture MSME sales growth (Performance).

To find out the relationship between innovative technologies and sales growth, Pearson's Correlation test was used on the four factors of innovative technologies. These were big data, the internet, artificial intelligence and cloud computing.

Table 4. 43: Regression Analysis Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.254	.459		4.912	.000	1.347	3.162
	Score for Big Data use	.220	.133	.237	1.648	.102	-.044	.484
	Score for internet use	.046	.054	.070	.852	.396	-.060	.152
	Score of Use of Artificial intelligence	-.075	.096	-.174	-.774	.440	-.265	.116
	Score of Cloud Computing	.184	.110	.273	1.672	.097	-.034	.402

a. Dependent Variable: On a scale of 5, indicate the level of sales you have had in the last 5 years

The mathematical representation of the regression model to be tested in order to determine the influence of the IV on the DV as drawn from the identified variables was represented by the formula below in Section 3.9 as:

$$\mathbf{Y = a + bX1 + cX2 + dX3 + eX4 + \epsilon}$$

Where:

Y = Dependent variable (MSME Performance expressed as sales growth, i.e., SG)

X1, X2, X3, X4 = Independent (explanatory) variables being the 4IRs, i.e., DB, IoT, AI, CC (see Conceptual Framework in Sections 1.8 and 2.10)

a = Intercept or Constant

b, c, d, e = beta coefficient of the IV's which explain the variance in Y

ϵ – Residual or prediction error

The mathematical representation derived from the regression analysis coefficients in Table 4.43 is substituted with the variables and the beta coefficients to be:

DV = Constant + (X1 BD) + (X2 IoT) + (X3 AI) + (X4 CC) + (0.05)

Therefore:

SG = 2.254 + 0.220 BD + 0.46 IoT + (-0.075) AI + 0.184CC + (0.05)

4.11.1 The Impact of New Technologies on Sales Growth

From the regression analysis coefficients given in Table 4.43, big data explains a positive slope as a predictor for SG and that there is a 22% increase for each 1-point increase in BD. The internet of things also gives a positive slope as a predictor of SG and there is a 46% increase in SG for each 1-point increase in the IoT. There is a negative slope for artificial intelligence indicating that there is a -7.5% increase in SG for each 1-point increase in AI. Lastly, there is a positive slope for CC as a predictor of SG showing an 18% increase of SG for each 1-point increase in CC. Burns and Burns (2008) posit that for continuous variables, a positive coefficient indicates a positive relationship with the dependent variable, while a negative coefficient suggests a negative relationship. For categorical variables, such as the ones used in this study, each category may have a coefficient representing its effect compared to a reference category. Larger coefficients indicate a stronger effect on the DV while small coefficients suggest a weaker effect. It can be concluded therefore that the internet of things shows the highest effect on sales

growth at 46%. Big data and cloud computing show 22% and 18% respectively and these show a weaker effect on sales growth. Artificial intelligence shows a negative coefficient of -7.5%, thereby suggesting a negative relationship.

A hypothesis test summary of the IV and the DV, based on the conceptual framework provided in Sections 1.8 and 2.10, was performed and is given in Table 4.44 below.

Table 4. 44: Hypothesis Test Summary

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Score for Big Data use is the same across categories of On a scale of 5, indicate the level of sales you have had in the last 5 years.	Independent-Samples Kruskal-Wallis Test	.108	Retain the null hypothesis.
2	The distribution of Score for internet use is the same across categories of On a scale of 5, indicate the level of sales you have had in the last 5 years.	Independent-Samples Kruskal-Wallis Test	.322	Retain the null hypothesis.
3	The distribution of Score of Use of Artificial intelligence is the same across categories of On a scale of 5, indicate the level of sales you have had in the last 5 years.	Independent-Samples Kruskal-Wallis Test	.053	Retain the null hypothesis.
4	The distribution of Score of Cloud Computing is the same across categories of On a scale of 5, indicate the level of sales you have had in the last 5 years.	Independent-Samples Kruskal-Wallis Test	.032	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

4.11.1.1 Hypothesis I

H0 The use of big data has no significant impact on aquaculture MSME sales growth.

H1 The use of big data has a significant impact on aquaculture MSME sales growth.

The results in the Goodness-of-Fit Pearson's chi-square in Table 4.20 which presents the test result whose *p* value = 0.850 thereby indicating that there is no positive relationship between the use big data and sales growth in aquaculture MSMEs is confirmed by the results of the hypothesis test summary in given in Table 4.44 above which show $p = 0.108$; therefore, the null hypothesis is retained as $p = 0.108 > 0.05$.

4.11.1.2 Hypothesis II

H0 The use of the internet data has no significant impact on aquaculture MSME sales growth.

H1 The use of the internet data has a significant impact on aquaculture MSME sales growth.

The results in Table 4.28 present the test result which shows the Goodness-of-Fit Pearson's chi-square *p* value = 0.773. The results indicate that there is no positive relationship between internet use and sales growth in aquaculture MSMEs. The hypothesis test summary in Table 4.44 above confirms Pearson's chi-square results in Table 4-28; therefore, the null hypothesis is retained as $p = 0.322 > 0.05$.

4.11.1.3 Hypothesis III

H0 The use of artificial intelligence has no significant impact on aquaculture MSME sales growth.

H1 The use of artificial intelligence has a significant impact on aquaculture MSME sales growth.

The results in Table 4.34 show the Goodness-of-Fit Pearson's chi-square *p* value = 0.456. The results indicate that there is no positive relationship between the use of artificial intelligence and sales growth in aquaculture MSMEs. The hypothesis test summary in Table 4.44 confirms Pearson's chi-square results in Table 4-34; therefore, the null hypothesis is retained as $p = 0.053 > 0.05$.

4.11.1.4 Hypothesis IV

H0 The use of cloud computing has no significant impact on aquaculture MSME sales growth.

H1 The use of cloud computing has a significant impact on aquaculture MSME sales growth.

The results in Table 4.40 shows the Goodness-of-Fit Pearson's chi-square *p* value = 0.919. The results indicate that there is a slight positive relationship between the use big data and sales growth in aquaculture MSMEs. The hypothesis test summary in Table 4.44 above confirms Pearson's chi-square results in Table 4.40; therefore, the null hypothesis is rejected in favour of the alternate hypothesis as $p = 0.032 < 0.05$.

4.12 Summary of Findings

From these findings, the summary is that aquaculture MSMEs are predominantly male entrepreneurs who are under 48 years and over 61% of the entrepreneurs had been in the business for less than 5 years. The proprietors run small scale enterprises that employed 11-50 persons and operated 1 – 5 fishponds. A small number of the aquaculture MSMEs, n = 23 (16.2%) were under performing in the last five years whereas just less than half n = 69 (48.6%) experienced high volumes of sales and n = 19 (13.4%) experienced very high volumes of sales.

Regarding big data, aquaculture MSMEs completely disagree and disagreed regarding its use in their business as the frequencies of disagreements was more than the agreements. For big data, the model was not an excellent fit as the McFadden value of R-Square for use revealed a 1.5% improvement in the prediction of outcome based on the predictors in comparison to the null model. McFadden's Pseudo R-squared value which is 0.015 ought to be between of 0.2 to 0.4. The low Pseudo R-Square indicates that a model containing big data use is unlikely to be a predictor of the outcome of sales volume increase for any individual aquaculture MSME. None of the five predictors of sales volume increase were worth noting to be significant predictors because all the variables had a non-statistically significant effect where $p > 0.01$.

Relating to internet use, aquaculture MSMEs completely disagree and disagreed regarding its use in their business. However, use was, to a lesser extent, seen in promoting business online. McFadden value of R-Square for internet use revealed a 4.2% improvement in the prediction of outcome based on the predictors in comparison to the null model. This is not an excellent fit as McFadden's Pseudo R-squared value which is 0.042 ought to be between of 0.2 to 0.4. The low Pseudo R-Square indicates that a model containing internet use is unlikely to be a predictor of the outcome of sales volume increase for any individual aquaculture MSME.

Considering artificial intelligence, aquaculture MSMEs completely disagree and disagreed regarding its use in their business as the frequencies of disagreements were more than the agreements. McFadden value of R-Square for artificial intelligence use showed a 4.3% improvement in the prediction of outcome based on the predictors in comparison to the null model. This is not an excellent fit as McFadden's Pseudo R-squared value is 0.043 and it ought to be between of 0.2 to 0.4. The low Pseudo R-

Square indicates that a model containing internet use is unlikely to be a predictor of the outcome of sales volume increase for any aquaculture MSME.

With reference to cloud computing, aquaculture MSMEs completely disagree and disagreed regarding its use in their business as the frequencies of disagreements were more than the agreements. McFadden value of R-Square for cloud computing use revealed a 7.6% improvement in the prediction of outcome based on the predictors in comparison to the null model. This is not an excellent fit as McFadden's Pseudo R-squared value is 0.076 and it ought to be between of 0.2 to 0.4. The low Pseudo R-Square indicates that a model containing cloud computing use is unlikely to be a predictor of the outcome of sales volume increase for any aquaculture MSME.

CHAPTER FIVE – CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

5.1 Introduction

The preceding chapter provided an integrated critical analysis of the findings of the study. This chapter will provide a conclusion by way of discussing the overall findings, highlight the limitations and significance of the study as well as present the recommendations coupled with possible areas of future research.

5.2 Discussion of Overall Findings

Since the discussion that follows has limited studies that link the four new technologies and sales volumes, the approach that will be used then would be to render an interpretation of the findings as generated.

Considering the rapid increase in the use of new technologies in the modern age, volume and complexity of data due to the emerging advanced technologies and diversity of aqua markets, aquaculture MSMEs paying attention to applying these in business management could have become an inevitable organizational approach. The data shows that the new technologies are not pertinent for aquaculture MSMEs.

Firm performance in terms of increase in sales volumes is contingent on numerous predictors. In this study, the four new technologies are not predictors of the observed increase. There are perhaps other predictors that could have had a direct and positive impact. The following could be influential factors to the observed to increase MSMEs sales volumes increase; education level (Akinboade, 2015), gender (Cliff, 1998), experience (Asah et al., 2015) as shown in crosstabulation of age, gender and experience in the crosstabulation tables in Sections 4.3.1, 4.3.2 and 4.3.5. Other factors increase sales could be attributed firms' characteristics (Grilo & Thurik, 2006) and issues which relate to the decisions made when starting a business (Mahmutaj & Krasniqi, 2020). All these are linked to McKinsey's Three Horizons Model, a stages-of-growth model based on the intention and capabilities of business owners to plan to grow. Some other factors include age, sector, location, size and ownership form (Smallbone & Welter, 2001).

One of the theories on which the study was based in the Technology Acceptance Model (TAM) which is used to predict the use and acceptance of information systems and technology by individual users through the determination of two key attitudinal

components, namely, perceived usefulness (PU) and perceived ease of use (PEOU) (Masrom, 2007).

Aquaculture MSMEs must begin to appreciate the usefulness of 4IR in their businesses if they are to leverage on increased sales. They should disrupt and begin looking at new technologies as a way of enhancing their jobs or life performance. Since aquaculture MSMSs have exhibited knowledge of use of new technologies, it is expected that they will not have challenges regarding ease of use. These two factors can be influenced by various external variables (McCormack et al., 2022) and this is where the government comes in by developing aqua culture beneficial technologies.

With influence from the government support encouraging aquaculture MSMEs behavioural intention to use and adopt new technologies, there will be actual use of new technologies and an eventual further increase in sales.

This study highlights the importance of understanding new technology's potential benefits for better decision making and performance improvement because using new technologies creates many strategic and profitable opportunities for aquaculture MSMEs to succeed in a business ecosystem where competitiveness and innovation are key drivers. The 8NDP (2022 – 2026) whose theme is 'Socio-economic transformation for improved livelihoods' provides a platform for propelling the country into achieving the objectives of inter alia, the 'Vision 2030', Sustainable Development Goals, other regional such as the African Union Agenda 2063, the Southern African Development Community (SADC) Regional Indicative Strategic Development Plan (RISDP) and Common Market for Eastern and Southern Africa (COMESA) and international commitments.

Vision 2030 of becoming a prosperous middle-income country, envisions technological proficiency to be harnessed and encourages entrepreneurship as one of the drivers towards socio-economic development. Drawing from Vision 2030, one of the strategic development areas of the 8NDP is economic transformation and job creation and the first development outcome is to establish an industrialised and diversified economy. From the foregoing, some of the proposed strategies are to increase agricultural production and productivity through mechanisation. This is supported by another strategy, which is to enhance digital capacity and ensure the integration of digital technologies into business processes as a key to enhancing efficiency and productivity for economic transformation.

Programs under this strategy involve ICT infrastructure development, digital innovation and entrepreneurship development, digital skills enhancement and digital services promotion.

In pursuit of the anticipated economic transformation through job creation, industrialisation and diversification, the Government can draw lessons from this thesis on the need to adopt 4IR by MSMEs in Zambia as they have been seen to be cardinal contributors towards national GDP as they make up about 97% of businesses in the country. The study provides a detailed understanding of evaluating the impact of innovative technologies on financial performance in terms of increasing sales growth and the implication for policy is that there is need for strategic directions that could contribute to developing aquaculture-beneficial technologies that, in turn, could serve these aquaculture MSMEs if they are to further increase leverage on sales volumes and reduce the current fish deficit. It calls for the government and the stakeholders to begin considering adopting mechanisms for embracing new technologies.

New technologies (big data (BD), cloud computing (CT), the Internet of things (IoT) and artificial intelligence (AI) are a new opportunity for aquaculture MSMEs to use these tools to improve organizations' agility, ability to solve complex problems, and achieve better results and performance. As a result, fundamental changes can occur in their operations and performance and consequently, they can move towards more accurate and better information-based decision making and modelling. Therefore, using new technologies is a crucial resource for aquaculture MSMEs to create value, new knowledge, and new processes and products.

When using new technologies as a resource (Gupta & George, 2016) it can be stated that competitive advantage can be obtained and retained by creating and integrating new technology application capabilities of aquaculture MSMEs. Some previous studies (Kopanakis et al., 2016; Nasrollahi, and Ramezani, 2020. Anwar et al., (2018), Mikalef et al., (2019), Ogbuokiri et al., (2015), Oncioiu et al., (2019), and Yadegaridehkordi et al., (2019) have tried to examine the impact for instance of new technology adoption on large firm performance, but this theme in MSMEs has been probably neglected. Mikalef et al., (2019) considered managerial factors in new technologies as the sources which affect organizational performance. Previous studies have also found the importance and

positive effects of financial factors in the adoption of new technology (Gardoni, 2021; Mbassegue et al., 2021; Tian et al., 2016).

The data gathered in this study aids in explaining the state of use of new technology by MSMEs in the field of aquaculture. This survey tries to perform a detailed systematic study but also has some limitations. It fails to study in detail the 4IR techniques that are available in different sources. Furthermore, the articles which are not in the context of big data, IoT, Cloud computing and artificial intelligence were not investigated. Despite this, the results will help researchers to develop more effective 4IR methods in today's competitive business environment. Finally, within the scope of the study that has been outlined and discussed, aquaculture MSMEs ought to consider embracing new technologies.

5.3 Limitations of the Study

Every study has limitations, but the limitations are not the same. They differ from one study to another. In line with the foregoing, the following limitations related to the research design which was adopted and the methods that were applied must be looked at in this light.

The first limitation relates to generalisability of the study. The results of the study should be interpreted with caution in the sense that Lusaka should not be considered to be a prototype of a province whose findings could be transferred or generalised to other provinces in that the sample is not representative. However, the findings are only generalisable to aquaculture MSMEs in Lusaka. It is however comforting because the study was empirical and it covered a large sample of aquaculture MSMEs and yielded insights which are consistent with a rich case study.

The second limitation is attributed to the design of the research tool. Though the survey tool that was used was based on the Delphi technique of experts in aquaculture rendering, the sample was not representative of key professionals conversant with new technology and its use in aquaculture (Dorand et al., 2014; Rayens & Hahn, 2000). Only one round of the Delphi technique was applied instead of two or three rounds and this was due to time and resource constraints and also the fact the experts were not readily available for subsequent validation rounds. With all this in mind, the constructs of the questionnaire may not have measured item validity. However, reliability analysis

provided credence to the findings. Further, the use of a survey questionnaire could have faced threats to validity whereby some respondents, especially Managers of some aquaculture MSMEs who may have been assigned the duty of responding to the questionnaires or their assistants or subordinates may not have provided honest answers.

In addition, the questionnaire had closed-ended questions. Closed-ended questions are ideal for quantitative research because they enable the researcher to adequately code the data. However, questionnaires with closed-ended questions limit the number of responses that the respondents may give on a particular topic. However, it must be stated that even if open ended questions allow for solicitation of respondents' views, coding of such information for quantitative analysis is a daunting challenge.

This study has no evidence of positive predictors to increase in sales growth volumes that are related to new technology. Thus, the study should be read as a step to a much longer research program to understand determinants of sales growth increase among aquaculture MSMEs.

5.4 Significance of the Study

Despite the limitations outlined above, this study has notable significances. The study provides a better and broader understanding of evaluating the impact of innovative technologies on financial performance in terms of increase of volumes of sales growth among aquaculture MSMEs in Lusaka from a positivist paradigm. It offers a brief introspection into the current situation and the importance of aquaculture MSMEs embracing new technologies. This study makes a contribution to the understanding of the effect of technologies on financial performance in terms of increase of volumes of sales growth. This study further contributes to the literature on the effect of technologies on financial performance in terms of increase of sales growth. The research outputs are likely to add to the pool of knowledge on technologies on financial performance in terms of increase of volumes of sales growth in aquaculture. The data and methods could be accessed by other researchers, academia and policy makers for teaching, research and policy formulation purposes respectively.

To recapitulate, this study offers several theoretical and practical implications, thereby making contributions both to the literature of the subject on new technologies and increase of volumes of sales growth in business management praxis. It expands prior

theorising on the state of new technologies and increase of volumes of sales growth, showing the non-contribution of new technologies in aquaculture MSME performance. This study also adds further substance to the view that the current conceptualization of new technologies is not particularly useful in explaining increase in sales growth volume in the local situation.

Finally, this study ought to be considered for its originality. The study has tackled a topic never done before to the best of the researcher's review of available literature, especially looking at the application of new technology in aquaculture in Lusaka. The current research provides significant theoretical contributions to the literature on new technologies and increase of volumes of sales growth. Whereas no previous research has focussed on the new paradigm – new technologies, this study has scored a first in the aquaculture sector in Zambia.

5.5 Recommendations

From the foregoing, the overarching research question which needs to be addressed is, "How can growth in sales among MSMEs in the aquaculture sub-sector in Lusaka be enhanced?"

The study has shown how the use new technologies in some countries, such as China and Egypt have enhanced the aquaculture sector. There are new technologies to process big volumes of data and to retrieve meaningful information which leads to business intelligence and decisions. If adopted by aquaculture MSMEs in Zambia, these new technologies can empower them to initiate and notice new changes in their enterprises by analysing data and making informed decision and where possible, making correlations between different business elements to in turn increase sales growth. In addition, by considering all the empirical facts that have been discussed in this thesis, new technologies must be recognised as a key factor to make the businesses of aquaculture MSMEs success stories.

Based on the prevailing situation, the following strategies require further attention and ought to be considered:

I. Paradigm Shift

Aquaculture MSMEs themselves need to embark on a paradigm shift away from traditional methods to adoption of new technologies if they are to exploit the market more than they are currently doing. Currently, some of them are using platforms such as Facebook and WhatsApp but they must do more, and this requires them to investigate data-handling tools and methods outside their small structures. They must be prepared to use new innovative technologies actively in their decision-making processes. They need to be ready to dive in and explore the growing ocean of information that is waiting for them out there. The 8NDP has assured government support through ICT infrastructure development, digital innovation and entrepreneurship development, digital skills enhancement and digital services promotion and aquaculture MSMEs can leverage this to adopt new technologies. In addition, through the existing e-Government initiative, the Ministry of Fisheries and Livestock, in collaboration with the Ministry of Science and Technology, should consider development of dedicated software and hardware for aquaculture that could be used to train aquaculture MSMEs in the appreciation of new technology.

This requires the Ministry of Fisheries and Livestock to embark on information sharing on new technologies. Borrowing from Schumpeter's Innovation Theory, aquaculture MSMEs need to use innovative technologies and 'disrupt', or they will perish. Zambian aquaculture MSMEs can learn valuable lessons from aquaculture MSMEs in Egypt, Ghana and Kenya who combine big data, artificial intelligence, the internet of things and cloud computing to analyse large volumes of data to identify trends, which helps in decision making regarding aquaculture practices such as feed management, water quality control, prevention of disease and production planning, which in turn enables them to operate efficiently and productively while enhancing their product quality, optimizing resource allocation and ultimately contributing to the growth of the aquaculture sub sector and national GDP.

II. Networking and Collaboration

Networking and collaboration among aquaculture MSMEs, research institutions and government agencies must be encouraged. This networking and collaboration can facilitate knowledge sharing, exchange of best practices, and collective efforts to address common challenges. Collaborative initiatives can provide aquaculture MSMEs with

access to resources, information, and new business opportunities, thereby contributing to efficient and effective productivity and resulting in enhanced sales growth.

Since some aquaculture MSMEs do not belong to any cooperative, the Ministry of Fisheries and Livestock can facilitate networking and collaboration among aquaculture MSMEs by leveraging on the strategies of the 8NDP to facilitate the formation of co-operatives by all aquaculture MSMEs through which skills education, positive attitudes and knowledge about new technologies could be enhanced and fostered.

By so doing, the theme of the 8NDP, 'Socio-economic transformation for improved livelihoods' through job creation, industrialised and diversified economy will be realised. Since one of the strategies of the 8NDP is to enhance digital capacity and ensure the integration of digital technologies into business processes as a key to enhancing efficiency and productivity for economic transformation, co-operatives can be a useful knowledge sharing platform. supplemented by government efforts.

III. Registration with PACRA

Registration with PACRA offers several important benefits and is crucial for aquaculture MSME operations and growth. Among the benefits is legal recognition and protection. Registration with PACRA establishes the aquaculture MSME as a formal entity, separate from its owners, and grants it legal rights and responsibilities while providing limitation of liability for the business owners. PACRA registration can also the credibility and trustworthiness of the aquaculture MSMEs in the eyes of customers, suppliers, and partners. It demonstrates that the business is committed to professionalism, transparency, and compliance with regulatory requirements. This can positively influence business relationships, attract customers, and create growth opportunities.

Further, since most financial institutions and investors require formal registration with PACRA as a prerequisite for providing funding or investment, registering strengthens the MSME's eligibility for loans, grants, and investment opportunities. It also enhances the business's financial credibility, making it more attractive to potential investors and lenders. PACRA registration may enable aquaculture MSMEs to access various government support programs, incentives, and business development initiatives which are often targeted at registered businesses.

Lastly registering with PACRA on one hand ensures that the aquaculture MSMEs comply with relevant legal and regulatory frameworks and on the other hand it enables the business to operate within the legal boundaries, ensuring adherence to tax obligations, employment regulations, and other statutory requirements. The Ministry of Fisheries and Livestock, Ministry of Small and Medium Enterprise and Ministry of Commerce Trade and Industry must simplify the licensing process and conduct intensive sensitization aimed at getting as many aquaculture MSMEs to register with PACRA.

IV. Regulatory and Policy Support

On the policy forum, given the findings and particularly the insignificant effect of new technologies, the implication for policy is that there is need for strategic directions that could contribute to developing aquaculture-beneficial technologies that, in turn, could serve these aquaculture MSMEs in various ways to increase leverage on sales volumes. It calls for government and the stakeholders themselves to consider mechanisms for embracing new technologies.

The Ministry of Fisheries and Livestock working in collaboration with the Ministry of Science and Technology must develop policies which diffuse new innovations in aquaculture. The stakeholders must advocate for favorable policies and regulations that support the growth and development of aquaculture MSMEs. This may involve engaging with government agencies such as the responsible ministry and policymakers such as the Councilors and Members of Parliament to address regulatory barriers.

V. Capacity Building

The Ministry of Fisheries and Livestock should frequently conduct training for the aquaculture MSMEs using extension officers. By so doing, the Ministry can offer capacity building programs to aquaculture MSMEs in areas such as business management, marketing, financial management and sustainable aquaculture practices. Enhancing the skills and knowledge of aquaculture MSME owners and employees can improve their ability to effectively manage their businesses, make informed decisions and adapt to market changes and improve their productivity to boost sales.

VI. Market Research and Product Development

Aquaculture MSMEs need to conduct market research in order to identify and appreciate consumer demands, consumer preferences, and emerging trends in the aquaculture

industry. From the findings of their market research, aquaculture MSMEs can develop new products, improve existing ones, and align their offerings with the identified market needs. This can in turn help to attract more customers and increase sales. In addition, aquaculture MSMEs must be encouraged to add value to their aquaculture products through processing and packaging. This could involve activities such as filleting and smoking. This value-added processing can lead to higher profit margins and increased sales by targeting different market segments, including neighboring countries and the international markets. They can in addition also consider taking advantage of the various existing trade agreements or market demand. This kind of market diversification can help reduce reliance on a single market and increase sales opportunities.

VII. Supply Chain

There is need to improve aquaculture MSME distribution networks and channels to ensure efficient and timely delivery of aquaculture products by exploring partnerships with wholesalers, retailers, restaurants and hotels to expand market reach. Additionally, aquaculture MSMEs must consider exploring online sales platforms and e-commerce to reach a wider customer base, including both domestic and international markets.

5.6 Areas for Future Research

Firstly, given the limitations of this study, a qualitative study would be recommended and this ought to target proprietors of aquaculture MSMEs. Such a study is likely to review the depth of interactions that may be existing in the use of new technology through interviews and focus group discussions where detailed and elaborate insights of the lived experiences of these aquaculture MSMEs could be investigated. The information derived therefrom could be vital to understanding technological and industry evolution, and the role that new technology can play in the management of aquaculture MSMEs. Therefore, a mixed methods study design would also be used.

Secondly, there is need to explore and examine the various barriers and challenges faced by aquaculture MSMEs in adopting new technology. Barriers such as access to infrastructure, affordability, lack of digital skills, and low levels of awareness and inadeqaute drivers of technology adoption among aquaculture MSMEs.

Thirdly, further research could also examine the potential of e-commerce platforms and digital marketing strategies for aquaculture MSMEs in Zambia by investigating the utilization of online marketplaces, social media marketing, and website development to expand market reach, connect directly with customers, and increase sales. In addition, an assessment of the effectiveness of mobile applications, online platforms, and virtual training programs in providing timely and relevant information to aquaculture MSMEs could be undertaken.

By focusing on these research areas, it is possible to gain a deeper understanding of the current use of new technology landscape in the aquaculture sector in Zambia and provide insights to promote the effective and sustainable use of new technology by aquaculture MSMEs.

5.7 Conclusion

In answering the research question "What new technologies are predictors of increase in the sales volumes among aquaculture MSMEs?", the findings of the ordinal regression showed that the four independent variables did not show an excellent fit as the McFadden value of R-Square showed improvements that are were far lower than the minimum expected value of 20%. Though the sales growth volume had increased, none of the variables were worth noting to be significant predictors of sales growth volume increase. The conclusion is that there are other determinants of increase in sales volumes and not solely new technology.

However, if the new technologies were employed, MSMEs would accelerate their sales volumes to a higher level than observed. MSMEs ought to embark on a cultural change if they are to exploit the market more than they are currently doing. This requires them to investigate data-handling tools and methods outside their small structures and be prepared to use new technologies actively in their decision-making processes. They need to be ready to dive in and explore the growing ocean of information that is waiting for them out there. This requires the Ministry of Fisheries and Livestock to embark on information sharing on new technologies.

Since some MSMEs do not belong to any cooperatives, the Ministry of Fisheries and Livestock should facilitate MSMEs to form cooperatives through which skills education,

positive attitudes and knowledge about new technologies could be enhanced and fostered. Additionally, through the existing e-Government initiative, the Ministry of Fisheries and Livestock should consider the development of dedicated software and hardware for aquaculture that could be used to train MSMEs in the appreciation of new technology. All of these strategic directions can contribute to developing aquaculture beneficial technologies that, in turn, can serve aquaculture MSMEs in various ways to increase leverage on sales volumes.

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APPENDICES

Appendix 1: Research Introductory Letter

30th August, 2022

TO WHOM IT MAY CONCERN

Dear Sir/ Madam,

RE: INTRODUCTORY LETTER FOR MS. MILDRED CHUUNGA MUHYILA (ZU17013)

This serves to confirm that Ms. Mildred Chuunga Muhyila of student number ZU17013 is a student at ZCAS University. She is enrolled on the Doctor of Business Administration (DBA) programme. Ms. Mildred Chuunga Muhyila is currently working on her research project and your organization has been chosen as the main organization for reference and research activities. The research topic is: ***" EVALUATING THE IMPACT OF INNOVATIVE TECHNOLOGIES ON FINANCIAL PERFORMANCE OF AQUACULTURE MSMEs IN LUSAKA"***

Kindly assist her with any information that maybe relevant to her in this regard. Should you need more information about the student, please do not hesitate to get in touch with undersigned on the numbers below.

Yours faithfully,

ZCAS University

Mukula Jonathan (Mr.)

DEPUTY REGISTRAR - ACADEMIC

Appendix 2: Questionnaire

AQUACULTURE BUSINESS QUESTIONNAIRE

Dear Respondent,

This study aims at evaluating the impact of using new technologies in innovation on financial performance of aquaculture MSMEs in Lusaka.

The study is purely for academic purposes and the information that you will provide will be treated with the highest level of confidentiality. Your identity will be anonymous.

The questionnaire comprises of 46 questions. I would be very grateful if are prepared to provide me with the required information.

Your cooperation will be highly appreciated.

Section A: Demographic and General Business Characteristics

This section aims at collecting demographic information and the general characteristics of your aquaculture business.

For Questions 1 to 9, please indicate the appropriate response to each question in this section by marking X in the spaces provided.

1. What is your gender?

[1] Male	[2] Female

2. What age range are you in?

[1] 16 - 26	[2] 27 – 37	[3] 38 – 48	[4] 49 - 59	[5] 60 and above

3. What is the highest education qualification you have achieved?

[1] No formal education	[2] Primary school	[3] Secondary school	[4] College/University

4. Is your business registered with the Patents and Companies Registration Agency (PACRA)?

[1] Yes	[2] No

5. How long have you been in the aquaculture business?

[1] Less than 1	[2] 1 – 5 years	[3] 6 – 10 years	[4] 11 – 15 years	[5] Above 15 years

year				

6. What is the total number of employees in your business?

[1] 1 – 10	[2] 11 – 50	[3] 51 - 100

7. How many fishponds do you have?

[1] 1 – 5	[2] 6 - 10	[3] 11 - 15	[4] Above 15

8. What type of fishponds do you have?

[1] Earthen	[2] Concrete	[3] Cages	[4] If other, please specify

9. What are the average sizes of your fishponds?

……...
……
……
……
……
……

Section B: Innovative Technologies

This section aims at gathering information about the use of innovative technologies in your aquaculture business.

For Question 10 to 39, please indicate what suits your own experience in the past five years.

10. Does your business:

Type of technology	Yes	No
[1] Generate a lot of information?		
[2] Receive a lot of information?		
[3] Store information in other places apart from paper?		
[4] Use digital equipment (like phones, tablets) in data management?		
[5] Have devices which you use and are connected to the Internet?		

Big Data

11. In what form is information stored in your business?

[1] Paper	[2] Computer	[3] Flash disks	[4] On the Cloud	[5] Paper & Computer

12. How frequent do you use the information which is generated in your business for monitoring productivity?

[1] Never	[2] Rarely	[3] Occasionally	[4] Frequently	[5] Always

13. How often do you use the information which is generated in your business for sales?

[1] Never	[2] Rarely	[3] Occasionally	[4] Frequently	[5] Always

14. Do you use big data to improve operations?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

15. Do you use big data to provide better customer service?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

16. Do you use big data to create personalized marketing campaigns?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

17. What is your degree of big data use?

[1] Low	[2] Medium	[3] High

18. Does your business:

	Completely disagree	Disagree	Somewhat agree	Agree	Completely agree
Use features of big data?					
Use utility factors of big data?					
Use processing factors of big data?					
Use knowledge					

of big data?					
Use complex techniques of big data?					

Cloud Computing

19. Do you use cloud computing for online data storage and recovery in your business?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

20. Do you use cloud computing for data analysis in your business?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

21. Do you use cloud computing for business networking?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

22. Do you use cloud computing for testing and development of products?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

23. What is your degree of use of cloud computing?

[1] Low	[2] Medium	[3] High

24. Does your business:

	Completely disagree	Disagree	Somewhat agree	Agree	Completely agree
Use features of cloud computing?					
Use utility factors of cloud computing?					
Use processing factors of cloud computing?					

Use knowledge of cloud computing?					
Use complex techniques of cloud computing?					

The Internet of Things

25. Have you used the internet in your business for monitoring and customer interest?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

26. Do you use the internet for finding new customers?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

27. Do you use the internet for promoting your business online?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

28. What is the degree of use of the internet in your business?

[1] Low	[2] Medium	[3] High

29. Does your business:

	Completely disagree	Disagree	Somewhat agree	Agree	Completely agree
Use features of the internet?					
Use utility factors of the internet?					
Use processing factors of the internet?					
Use knowledge of the internet?					

Use complex techniques of the internet?					

Artificial Intelligence (Automation)

30. Do you use artificial intelligence for spam filters in your business?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

31. Do you use artificial intelligence for smart email categorization?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

32. Do you use artificial intelligence for voice to text features in your business?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

33. Do you use artificial intelligence for smart personal assistants, such as Siri, Cortana and Google Now?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

34. Do you use artificial intelligence for automated responders and online customer support?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

35. Do you use artificial intelligence for process automation of your business?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

36. Do you use artificial intelligence for sales and business forecasting?

[1] Completely disagree	[2] Disagree	[3] Somewhat agree	[4] Agree	[5] Completely agree

37. Do you use artificial intelligence for security surveillance in your business?

[1]	[2]	[3]	[4]	[5]

Completely disagree	Disagree	Somewhat agree	Agree	Completely agree

38. What is the degree of use of artificial intelligence in your business?

[1] Low		[2] Medium	[3] High

39. Does your business:

	Completely disagree	Disagree	Somewhat agree	Agree	Completely agree
Use features of artificial intelligence?					
Use utility factors of artificial intelligence?					
Use processing factors of artificial intelligence?					
Use knowledge of artificial intelligence?					
Use complex techniques artificial intelligence?					

Section C: Financial Performance

This section aims at collecting information regarding the financial performance of your business.

For Questions 40 to 46, please indicate an estimate of your business performance over the past five years.

40. Has the number of employees in your business increased from the time you started operations?

[1] Yes	[2] No

41. In terms of the level of sales, please indicate an estimate of your business performance currently.

[1] Less than 20%	[2] 20 to 40%	[3] 41 to 60%	[4] 61 to 80%	[5] Above 80%

42. In terms of sales growth, please indicate an estimate of your business performance over the past five years.

[1] Less than 20%	[2] 20 to 40%	[3] 41 to 60%	[4] 61 to 80%	[5] Above 80%

43. In terms of profit, please indicate an estimate of your business performance currently.

[1] Less than 20%	[2] 20 to 40%	[3] 41 to 60%	[4] 61 to 80%	[5] Above 80%

44. Has your business experienced an increase in profit over the past five years?

[1] Yes	[2] No

45. In terms of profit, please indicate an estimate of your business performance over the past five years.

[1] Less than 20%	[2] 20 to 40%	[3] 41 to 60%	[4] 61 to 80%	[5] Above 80%

46. On a scale of 5, indicate the level of sales you have had in the last 5 years.

[1] Very low	[2] Low	[3] Moderate	[4] High	[5] Very high

End of Questionnaire

Thank you

Appendix 3: Normalityy Test Descriptives

Descriptives

			Statistic	Std. Error
Score for Big Data use	Mean		4.0563	.08288
	95% Confidence Interval for Mean	Lower Bound	3.8925	
		Upper Bound	4.2202	
	5% Trimmed Mean		4.0070	
	Median		4.0000	
	Variance		.976	
	Std. Deviation		.98769	
	Minimum		3.00	
	Maximum		6.00	
	Range		3.00	
	Interquartile Range		2.00	
	Skewness		.603	.203
	Kurtosis		-.661	.404
Score for internet use	Mean		4.28	.118
	95% Confidence Interval for Mean	Lower Bound	4.05	
		Upper Bound	4.51	
	5% Trimmed Mean		4.16	
	Median		4.00	
	Variance		1.977	
	Std. Deviation		1.406	
	Minimum		3	
	Maximum		8	
	Range		5	
	Interquartile Range		2	
	Skewness		1.085	.203
	Kurtosis		.268	.404
Score of Use of Artificial intelligence	Mean		11.46	.179
	95% Confidence Interval for Mean	Lower Bound	11.10	
		Upper Bound	11.81	
	5% Trimmed Mean		11.40	
	Median		12.00	
	Variance		4.548	
	Std. Deviation		2.133	
	Minimum		8	
	Maximum		16	
	Range		8	
	Interquartile Range		2	
	Skewness		.426	.203
	Kurtosis		-.280	.404
Score of Cloud Computing	Mean		6.00	.114
	95% Confidence Interval for Mean	Lower Bound	5.77	
		Upper Bound	6.23	
	5% Trimmed Mean		5.97	
	Median		6.00	
	Variance		1.844	
	Std. Deviation		1.358	
	Minimum		4	
	Maximum		9	
	Range		5	
	Interquartile Range		2	
	Skewness		.103	.203
	Kurtosis		-.619	.404

Appendix 4: MCAR Missing Data Test

Univariate Statistics

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
Gender	142	1.33	.472	0	.0	0	0
Age range	142	3.18	1.042	0	.0	0	0
Patents	142	1.56	.498	0	.0	0	0
BigData1	142	1.46	.500	0	.0	0	0
Bigdata2	142	1.34	.475	0	.0	0	0
BigData3	142	1.26	.440	0	.0	0	0
Iot1	142	1.51	.502	0	.0	0	0
Iot2	142	1.15	.363	0	.0	.	.
Iot3	142	1.61	.959	0	.0	0	0
AI6	142	1.46	.500	0	.0	0	0
AI7	142	1.38	.487	0	.0	0	0
AI8	142	1.35	.479	0	.0	0	0
CC1	142	1.78	.726	0	.0	0	0
CC2	142	1.38	.487	0	.0	0	0
CC3	142	1.35	.479	0	.0	0	0
Number of employees	142	1.96	.678	0	.0	.	.
Bigdataimp1	142	1.46	.500	0	.0	0	0
Bigdataimp2	142	1.38	.487	0	.0	0	0
Biddataimpact3	142	1.35	.477	0	.0	0	0
ImpacBogdataimpa4	142	1.49	.502	0	.0	0	0
Bigdataimpact5	142	1.53	.501	0	.0	0	0
Impact1	142	1.46	.500	0	.0	0	0
Impact2	142	1.38	.487	0	.0	0	0
Impact3	142	1.35	.479	0	.0	0	0
Impact4	142	1.49	.502	0	.0	0	0
Impact5	142	1.71	.669	0	.0	0	0
Alimpact1	142	1.49	.502	0	.0	0	0
Alimpact2	142	1.38	.487	0	.0	0	0
AIImp3	142	1.42	.495	0	.0	0	0
Alimp4	142	1.49	.502	0	.0	0	0
Alimp5	142	1.73	.662	0	.0	0	0
CCImpact1	142	1.49	.502	0	.0	0	0
CCImpact2	142	1.41	.493	0	.0	0	0
CCImpact3	142	1.35	.479	0	.0	0	0
CCImpact4	142	1.50	.502	0	.0	0	0
Sales growth	142	3.59	.916	0	.0	0	0

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

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