ISSN 2047-2854 (On-line)

THE BUSINESS & MANAGEMENT REVIEW

Volume 15 Number 1 April 2024

www.cberuk.com

CBER-MEC 13th International Conference on Business & Economic Development (ICBED), 15-17 April 2024

Hosted by the
Centre for Business & Economic Research (CBER), UK
In association with
Medgar Evers College, City University of New York, USA

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The Business and Management Review

Volume 15 Number 1 April 2024

Conference Proceedings

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CONFERENCE PROCEEDINGS
THE BUSINESS & MANAGEMENT REVIEW
ISSN 2047-2862 (ONLINE)

Contents

Measuring real money demand in Cambodia: an ARDL approach to cointegration

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Keywords
Real money demand, error correction model, long-run model, stability tests

Abstract

The findings obtained through the ARDL approach to cointegration indicate that real income, consumer price index, and interest rate are cointegrated with real money demand. In terms of the estimated results derived from the long-run model, it is observed that real income has a statistically significant positive impact on real money demand, while the general price level and interest rate have a negative impact. The short-run dynamic model, known as the error correction model, demonstrates that all explanatory variables collectively account for the growth rate of real money balances. In the short-run, the growth rate of real income exhibits a positive relationship with the demand for real money, whereas the inflation rate and changes in interest rate have a significant negative effect on the demand for real money balances. The estimated slope coefficient of the short-run dynamic model, which measures the speed of adjustment, is projected to be 60.67%. This outcome suggests that the real money balance model takes no more than two quarters to adjust towards long-run equilibrium in response to short-run dynamic shocks. Stability tests, such as the CUSUM and CUSUMSQ tests, indicate that the real money demand function in Cambodia remains stable in the long-term. The findings derived from this study provide empirical evidence in favor of the quantity theory of money.

Introduction

The demand for money function can be defined as the correlation between the desired quantity of money held by an individual or an economy and the various factors that influence this decision. It is a fundamental concept in the field of monetary economics that aids in understanding the demand for money within an economy. The demand for money function is influenced by multiple factors, including income levels, interest rates, and inflation. A comprehensive understanding of the demand for money function is crucial for policymakers and economists as it facilitates the development of effective monetary policies that can stabilize the economy and foster economic growth (Handa, 2009). The responsibility of monitoring the money supply and implementing monetary policy to ensure price stability and sustainable economic growth lies with the central bank. The efficacy of monetary policy is enhanced when the demand for currency within the economy can be accurately predicted. This enables the National Bank of Cambodia to more precisely determine the equilibrium point between the demand and supply of currency.

The primary aim of this research is to develop a real money demand function for Cambodia that can be effectively utilized by the monetary authority to implement monetary policy. To achieve these objectives, the Autoregressive Distributed Lag (ARDL) approach to cointegration is employed. It is posited that real money demand remains stable in the long term if the plot of the cumulative sum of the recursive residuals and cumulative sum of squares of the recursive residuals consistently remain within the critical bounds at a 5 percent significance level. The distinctive characteristic of the ARDL model lies in its analysis of the short-term dynamics and long-term effects between the explained variable and explanatory variables in the model, particularly the estimation of the speed at which adjustment occurs towards equilibrium. In order to determine the real broad money demand function, three key endogenous variables are taken into consideration, namely real income, consumer price index, and interest rate.

This study is structured into five distinct chapters. The introductory chapter provides an overview of the research topic. The second chapter presents a comprehensive review of the relevant literature.

Chapters three and four outline the research methodology employed and present the empirical findings, respectively. Finally, the concluding chapter summarizes the key findings and offers insights derived from the study.

Literature Review

Abbas (2008) examined the characteristic of demand for money M2 in a number of Asian nations from 1975 to 2002 employing the ARDL and Eagle-Granger techniques. The study employed annual panel data with 146 observations. The findings shown that money demand and its determining factors were co-integrated in the long run. In all of the Asian countries studied, income was more elastic. Meanwhile, the long-run money demand was explained by the capital mobility and currency substitution. While on the short-run, the money demand was influenced by income, inflation, and interest rate (Abbas, 2008). Likewise, Samreth (2009) explored the element that influence Cambodia's money demand. Giving the study of the factors influencing the money demand plays a vital in policymaking. For that reason, the study analyzed the data from IFS from 1994:12 to 2006:12. The studied indicated that inflation was a significant element in determining the amount of money demand stability in Cambodia, according to the findings. Additionally, the impact of output, inflation, and the exchange rate coefficient on the money demand were also positive and significant (Samreth, 2009). Similar study by Parvez, Nisar, Sami Bedi and Muhammad (2010) used the annual data from 1973 to 2007 to estimate the demand for money (M2) function in Pakistan. The study employed ARDL approach to determine the co-integrational link between the selected variables of the model. The study's finding determined that the demand for money in Pakistan from 1973 to 2007 was stable. Whereas the demand for money had a positive and negative relationship with the inflation and income, and exchange rate elasticity respectively (Parvez, Nisar, Sami, Bedi, & Muhammad, 2010).

In 2011, Suliman and Hala used the same ARDL co-integration approach to examine the demand for money in Sudan from 1960 to 2010. In the study, the aforementioned approach was applied to study the relationship of the variables in the long-run using the annual data from the Central Bank of Sudan. The empirical results indicated a significant relationship between the money demand and the chosen variables in the long-run. On the other hand, the study also indicated that the inflation and exchange rate caused an adverse effect on the money demand and people demand substitution assets. Giving that narrow money demand was being used for money policy analysis (Suliman & Hala, 2011). Another study by AL-abdlrazag and Abdullah (2011) to understand the crucial role of the money demand function in Jordan from 1971 to 2009, the study utilized the unit root ADF, IRFs, VDC approach and co-integration tests. The study used the time series data from 1971 to 2009. The findings suggested that the money demand and income were positively significant. In contrast, the money demand and the exchange rate depreciation were negatively significant (AL-Abdulrazag & Abdullah, 2011).

Augustine and Kiseok (2012) studied the relationship between the exchange rate and the money demand of seven countries from 1973 to 2007. The study indicated that that exchange rate had positive connection with the money demand. On the contrary, the domestic interest rate negatively affected the money demand in all of the seven countries. The study also went on to show that to achieve a worthwhile goal, the broad money (M2) was required by the monetary authorities (Augustine & Kiseok, 2012). A separate study done by Imran, Yasmeen and Fatima (2012) utilized the co-integration and Granger Causality methods to study the impression the monetary policy and inflation on economic growth of Pakistan using the time series data from World Bank and International Monetary Fund from 1972 to 2010. The study suggested that in the short-run only budget deficit affected the demand for money. Meanwhile, the result from Granger Causality test implied a two-way causal relationship between real GDP and the exchange rate. However, real GDP was unilaterally creating fiscal depth, household debt, and budget deficits. As a result, in the study of the Pakistan case from 1972 to 2010 indicated that the exchange rate caused fiscal depth and budget deficit (Imran, Yasmeen, & Fatima, 2012).

Muhammad and Muhammad (2013) investigated the relationship between the demand for real money and its determinants such as, the actual GDP, deposit rates, exchange rates, fiscal reforms and the total population. In the study, the ARDL approaches was used in the experimental analysis. Serving that purpose the data from 1972 to 2011 was utilized. The finding

suggested that the real GDP and exchange rate had a positive and negative relationship with the money demand in Pakistan respectively. Financial innovation and the total population led to more demand for money as the demand for more money for business also increases as the size of the population increases (Muhammad & Mohammad, 2013). Similar study by Adnan, Asad, and Kalim (2013) to determine the money demand function in Pakistan with the help of the monetary policy. The study employed the ARDL bounds testing approach to co-integration. This study used real GDP, industrial production index, CPI, inflation exchange rate, lending and own rate,short term and long-term risk premium as the determinants to define the money demand function. The findings suggested that all of the determinants, thereof were significantly correlated with the money demand in Pakistan over the selected period (Adnan, Asad, & Kalim, 2013).

A similar study in Pakistan case but employed different approach was conducted by Haroon, Masood, and Muhamad (2013) to study the significance of money demand on the financial sector and money policy from 1972 to 2007. The study employed ADF and PP unit root methods to test the stationary of the variables. While on the other hand, the ARDL co-integration was deployed to investigate the co-integration among the variables. The study concluded that the money demand had a positive and negative relationship with income and opportunity cost of holding money respectively (Haroon, Masood, & Muhamad, 2013). In 2014, ThankGod and Tamauntari attempted to determine the money demand function for Nigeria from 1971 to 2012. The study concluded that despites the structural changes, financial crisis, and irregular armed to public rules, the money demand in Nigeria remained unchanged. While the two most vital determinants of the money demand were the income and the interest rate. The study also suggested that in the short run, the money demand was significantly influenced by the transaction and precautionary motives. Last but not least, the finding of this study advised that interest rate played a vital role in long-run speculative for money demand (ThankGod & Tamarauntari, 2014).

On the same year, Muhamad and Khudija (2014) also attempted to investigate the connection between the money demand and its determinants employing the partial adjustment model from 1973 to 2013. In this study, the OLS and Breusch-Godfrey tests were adopted for analysis. The results indicated that the money demand had a positive and negative relationship with real GPD and interest rate respectively in both short and long-run (Muhammad & Khudija, 2014). A re-estimation attempt by Moses (2014) for the money demand function from 2000 to 2013 suggested that the income elasticity of M2 was relatively lower comparing to M3 and M1 which were 0.50, 0.77 and 1.04 respectively. The study also suggested that the depreciation of exchange rate, interest rate elasticity, inflation, and Treasury bill, all negatively affected the money demand except for the interest deposit that positively impact the money demand (Moses K. C., 2014).

Another parallel study on the determining factors of money demand was conducted by Moresblessing, Courage and Genius (2014). The study focus on the money demand function in some chosen Asian countries from 1990 to 2005. The GDP, interest rate and exchange rate were identified as the determinants for money demand. The study concluded that all of the aforementioned variables played a vital role in determining the money demand (Moreblessing, Courage, & Genius, 2014). Last but not least, a separate study on the relationship between the money demand and the exchange rate was also conduct on the case of Pakistan. (Muhammad, Ghulam, & Paras, 2015) The Johansen co-integration and ECM methods were adopted to test the impact of the nominal exchange rate in Pakistan. Comparing between the narrow and broad money, the empirical results suggested that M1 was co-integrated with all of the determinants, while in contrast, M2 was co-integrated with none. The significant nominal exchange rate demonstrated that individuals demand more money M1 as the local currency appreciates in the foreign market. Sambulo (2015) reported that the structural break in 1994 play a vital role in stabilizing the money demand function in South Africa. The data from World Bank and National Reserve Bank from 1970 to 2013 were used to examine the demand model for narrow and broad money in South Africa. By comparing the postand prior period of breaks Gregory Hansen's test finds that broad money demand function is not affected by these breaks. The study also advocated that the liberalization of monetary policies and floating exchange rate policy were necessary for South Africa (Sambulo, 2015).

To examine the short- and long-term relationship between money demand and other macroeconomic variables: official exchange rate, interest rate, gross domestic product, ratio of fiscal deficit to gross domestic product, and population in rural and urban area in Pakistan, the ARDL approach to cointegration was applied using time series data for the period ranges from 1972 to 2013. While rural population and the exchange rate have a substantial negative impact on money demand in Pakistan, the empirical results demonstrate that interest rates have a negative impact on money demand in both the short and long run (Umbreen, Dawood, & Muhammad, 2016). An error correcting model known as the ARDL method was employed to implement Taylor's rule and increase monetary policy effectiveness in Nigeria between 1998:Q1 and 2014:Q4. It was assumed in this research that the Nigerian Central Bank thought that changes in money demand were caused mostly by changes in the interest rate. Monetary policy variables are following the same trend, with inflation dropping and productivity rising (Ikechukwu, Faith, & Roseline Ike-Anikwe, 2016). Money demand function for narrow (M1) and broad (M2) money based in Yemen were developed based on ARDL bounds testing approach to cointegration and error correction modeling. The period of the study was between 2001:Q1 and 2013:Q4. There were three keys explanatory variables: real income, inflation rate, and nominal exchange rate included in the short- and long-term models. M1 and M2 had been influenced positively and negatively by real income and inflation rate respectively. In addition, the two determinant variables were explained the monetary aggregates in the long-term (Essa, 2016).

The study in Turkey had indicated that real money demand was explained by real domestic output and interest rate. The estimated method of this study was different from other research because dynamic OLS was employed on two different model log-log money and interest rate and log-log real money with real income and interest rate under annually data, 1970 and 2013. More interestingly, to take into account structural break of each time series data, besides applying ADF test for unit root, Zivot and Andrews test were also conducted. Nevertheless, long-run relationship between explained and explanatory variables instead of using the Bound test, the Johansen trace test was carried out. The empirical investigate showed that logarithm of real money balance equation perform better than logarithm of money demand specifications assuming unitary income elasticities (Oguz, 2017).

In constructing demand of money function, GDP, inflation rate, foreign exchange, domestic interest rate were always be set up as independent variables, but to re-examine the demand for broad money, M2, in Nigeria, in addition to the four key variables mentioned early, the foreign interest rate and stock market index of Nigeria were also put into the ARDL approach to cointegration model with quarterly time series data time span between the first quarter of 1985 and fourth quarter of 2016. The Bound test revealed that money demand was cointegrated with its explanatory variables or had a long-run relationship. Especially, stock index had a positive significant effect on real money stock in Nigeria (Moses, Usman, Patricks, & Nurodeen, 2018). In extension the study which was conducted by (Samreth, 2009) about real money demand in Cambodia using ARDL approach to cointegration which was developed my (Pesaran, Shin, & Smith, Bounds Testing Approaches to the Analysis of Level Relationships, 2001), but instead of using monthly data, (Long, Ignatius, & Agus, 2018) applied annually data between 1996 and 2016. The log of real money demand was run with four independent variables: log of real income, inflation rate, exchange rate and dummy variable (1 for the period 1997-1998 and 0 elsewhere) which represented political turmoil in Cambodia. In addition, M2 was used instead of M1 as a proxy of money demand. The main objective of the study was to investigate the stability of money demand in Cambodia. As indicated by the CUSUM and CUSUMSQ test, the real money demand function was stable. The empirical result further showed that inflation rate and exchange rate explained real money demand.

Over the period 1970-2018, the analysis of money demand function in Malaysia under ARDL approach to cointegration had shown that financial innovation and real GDP had positive and negative significant explained real money demand, respectively. More interestingly, the depreciation of exchange rate by one unit would cause the increase in real money demand by 0.97 in the long-run, while a 1 percent increase in real GDP would decrease real money demand by 0.6395. Nevertheless, the estimated model seems to be not stable as indicated by CUSUMSQ test (Muhammad & Jauhari, 2019). The factor which determined the demand for real monetary aggregate (M1 and M2) in Indonesia such as real income, price level, domestic interest rate and foreign interest rate were found to having a long run relationship

regarding the result of the bound test. The real demand for M1 and M2 in short and long term were positively explained by inflation rate, real income and exchange rate. Moreover, domestic and foreign interest rates had a significant effect just only on M2 but had no influence on M1. As referring to CUSUM and CUSUMSQ test, the real money demand of Indonesia was not stable within the time frame between 2000:Q1 and 2019:Q4. Two particular reasons had been raised up to explain the instability of real money demand Indonesia. The first reason is due to the flexibility of inflation targeting which was always been carried by the Bank Indonesia. The second reason is because of macroeconomic stability which caused money demand being negatively affect by exchange rate (Mahrus, 2020). The monetary aggregate in Algeria had been classified into three different types: Cash, M1 and M2. The long-run equation of each real money demand was run with real GDP, Treasury bill rate, inflation rate and exchange rate. The time span of the study was between 1979 and 2019. The estimated elasticity of the scale variables was 1.019, 1.040, and 1.006 for M2, M1, and Cash respectively and each estimated parameter was statistically significant. The elasticity of inflation rate was also significant explain the three aggregate of real money demand, while Cash generated the highest one. The empirical result of this study had further revealed that real money demand for M1 and M2 were stable, while the demand for fiat money was unstable (Raouf, Mohammed, & Mohamed, 2021).

Regarding the monetary economic theory, real demand for money is a function of income and interest rate, but in practice the demand for money could be determined by not just only income and interest rate, but it could be explained by other variables as well such as nominal exchange rate and consumer price index as well. As referred to the above literature reviews, the empirical result from different countries generated different conclusion regarding the variables which had a significant effect on money demand. The causes of the different might have explained by different characteristic of each country economic structure or the behavior of economic agents react toward the demand for money. In addition, despite using the same model as such ARDL model to investigate or construct a real demand for money function, but different time series data set would produce different result.

As show earlier in this literature reviews, a real money demand function in Cambodia was firstly established in 2009 and then again in 2018 by Samreth (2009) and Long et. al (2018). To construct a real narrow based money (M1), the first paper used monthly time series data between December 1994 and December 2006, but there were only three keys macroeconomic variables: real income, inflation rate and exchange and one dummy variable to control for political upheaval during 1997-1998 which included in the ARDL approach. The second paper replicated the first paper since the research methodology was exactly the same, but instead of determining the real narrow based money demand function, this study created a real broad money (M2) demand function. Despite using the same methodology as the first paper, but annually data were employed between 1996 and 2016. These two research articles did not take into account one of the most important macroeconomic indicator which was interest rate. Thus, to fill out this gap, interest rate variable is incorporated into the ARDL approach to cointegration in order to develop a real broad money demand function for Cambodia. In addition, quarterly time series data between 2012:Q1 and 2022:Q4 are applied.

As demonstrated in previous literature reviews, the establishment of a real money demand function in Cambodia occurred in 2009 by Samreth (2009) and was subsequently revisited in 2018 by Long et. al (2018). The initial paper utilized monthly time series data from December 1994 to December 2006, incorporating three key macroeconomic variables: real income, inflation rate, and exchange rate, along with a dummy variable to account for political upheaval during 1997-1998. This approach was employed within the ARDL framework to construct a real narrow-based money (M1) demand function. The second paper replicated the methodology of the first paper, but instead focused on determining the real broad money (M2) demand function. However, despite utilizing the same methodology, the second paper employed annual data from 1996 to 2016. Notably, both research articles overlooked the inclusion of a crucial macroeconomic indicator, namely the interest rate. In order to address this gap, the ARDL approach to cointegration was augmented with the incorporation of the interest rate variable, enabling the development of a money demand function for Cambodia. Furthermore, quarterly time series data spanning from 2012:Q1 to 2022:Q4 were utilized in this study.

Methodology

ARDL approach to cointegration is applied in order to determine a long-run relationship between dependent and independent variables which was developed by Pesaran and Shin (1998). A real money demand function which is the ratio between broad money (M2) and price level, in Cambodia is constructed as a function of consumer price index (CPI) and interest rate (R). The reasons that this study applies ARDL approach to construct real money demand function because this technique provides three ways of economic analyses: cointegration analysis, long-run relationship analysis, short-run dynamic analysis and especially the analysis the speed of adjustment which are different from the other models which could not perform the three analyses at the same time. Cointegration represents the existence of the long-run relationship between the real money demand (dependent variable) and its independent variables—real income, consumer price index and interest rate. In econometrics theory, a spurious result will not be produced, if a regression of time series data in level is deployed between explained variable and explanatory variables regardless each series has a unit root or non-stationary. In summary, the estimated result can't be generated, if cointegration on long-run relationship between dependent variable and independent variables does not exist. In this case, only short-run dynamic regression result is estimated and presented. The estimated parameters which are made from ARDL regression result are technically used for developing diagnostic and cointegration tests not for making any economic interpretation. The interpretation is made just only on long and short run regression result. The short-run dynamic model is so called a model at different level of variables which is different from long-run model which is estimated based on at level variables. ARDL model and long-run equation as well as error correction model specification are presented in equation (1) and (2) respectively.

ARDL Model and Long-Run Equation

$$DlnM2_t = \delta_0 + \sum_{j=1}^{q} \varpi_j DlnM2_{t-j} + \sum_{j=1}^{p} \theta_j DlnGDP_{t-j} + \sum_{j=1}^{l} \tau_j DlnCPI_{t-j} + \sum_{j=1}^{d} \varphi_j DR_{t-j} + \delta_1 lnM2_{t-1} + \delta_2 lnGDP_{t-1} + \delta_3 lnCPI_{t-1} + \delta_4 R_{t-1} + v_t \quad (1)$$

All variables are expressed as a natural logarithm which is denoted as ln except interest rate, R. D represents first difference and the first difference of log is interpreted as growth rate. $\delta, \varpi, \theta, \tau,$ and φ are the parameters to be estimated and v is the error term of the model. The optimal lags length of the model is determined using Schwarz Bayesian Criterion (SBC). The lower the SBC, the better the model. To fulfill the requirement of the model a diagnostic tests including Lagrange Multiplier (LM) test for the *n*th order of autocorrelation, Ramsey's test (RESET) for functional form misspecification, Jarque-Bera (JB) test for normality of the residuals term, and White's test for heteroscedasticity (HET) are performed.

Bound test was developed by Pesaran et al. (2001) to define a long-term relationship between explained and explanatory variable in the model. The test was developed based on the *F*-Statistic. As referring to equation (1), the null hypothesis of no cointegration which is $H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ against the alternative hypothesis of cointegration which is $H_A: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$, among variables under investigation are created. The null hypothesis is rejected when the calculated *F*-Statistic is greater than critical bound *F*-Statistic. In addition to the diagnostic tests and the bound test of the ARDL model, the Cumulative Sum (CUSUM) of the recursive residuals and Cumulative Sum of Squares (CUSUMSQ) of the recursive residuals tests which was developed by Brown et al. (1975) are employed to check the stability of real money demand function. After obtaining the empirical estimate of ARDL model and long-run equation, a short-run dynamic model known as error correction model (ECM) is established. The purpose of this model is to examine the impact of the growth rate of real domestic output, inflation rate, and change in interest rate on the growth rate of real money demand. Specifically, it aims to estimate the speed of adjustment, which elucidates the rate at which the economy adapts towards long-term equilibrium in response to any shock that disrupts the short-term dynamic model's equilibrium. The equation (2) below presents the ECM.

Error Correction Model (ECM)

$$DlnM2_t = \alpha + \gamma(lnM2_{t-1} - \hat{\tau} - \hat{\zeta} lnGDP_{t-1} - \hat{\lambda} lnCPI_{t-1} - \hat{\xi} R_{t-1}) + \sum_{j=0}^{q} \psi_j DlnM2_{t-j} + \sum_{j=0}^{p} \pi_j DlnGDP_{t-j} + \sum_{j=0}^{l} \phi_j DlnCPI_{t-j} + \sum_{j=0}^{d} \eta_j DR_{t-j} + \varepsilon_t \quad (2)$$

Where α is intercept, γ is speed of adjustment, $\psi, \pi, \phi,$ and η are slope of each respected explanatory variables. The estimated coefficients: $\hat{\tau}, \hat{\zeta}, \hat{\lambda},$ and $\hat{\xi}$ are extracted from long-run equation, equation (2).

Table 1. Expected sign of long-run effect of real money demand function

Explanatory variables	Expected sign
Real income	+
Price level	-/+
Interest rate	-

The anticipated indication, which illustrates the impact of each individual variable on the long-term real money demand function as presented in Table 1, has been formulated based on the characteristics of the Cambodian economy.

Data

This research utilizes quarterly time series data spanning from 2012:Q1 to 2022:Q4. The data on broad money and interest rates are sourced from the International Financial Statistics (IFS) of the International Monetary Fund (IMF), while consumer price indexes are obtained from the website of the National Bank of Cambodia (NBC). Unfortunately, quarterly gross domestic product data is not available for the study period. To address this, a quadratic interpolation technique is employed to disaggregate the annually reported real gross domestic product data from the Asian Development Bank (ADB) into quarterly time series data (Asian Development Bank, 2023). Given the use of time series data, an Augmented Dickey-Fuller (ADF) test is conducted to test for unit root.

Empirical Result

This section has been subdivided into three primary components, namely descriptive statistics, unit root test, and the estimated outcomes of the long-run and short-run equations derived from the ARDL approach to cointegration.

Table 2. Descriptive Statistics

	DLNM2	DLNGDP	DLNCPI	R
Mean	4.149403	1.361369	0.701537	11.34722
Median	4.551028	1.699658	0.825294	11.00744
Maximum	18.09134	3.148886	3.370533	13.37000
Minimum	-9.116375	-3.419739	-2.339795	10.12400
Std. Dev.	4.055339	0.955468	0.972400	1.032327
Skewness	0.607752	-3.085566	-0.605368	0.692247
Kurtosis	7.941438	15.75687	5.574898	2.115814
Jarque-Bera	47.47464	368.1710	14.84263	4.947453
Probability	0.000000	0.000000	0.000598	0.084270
Sum	182.5737	59.90024	30.86764	499.2777
Sum Sq. Dev.	707.1684	39.25551	40.65918	45.82504
Observations	44	44	44	44

During the study period spanning from the first quarter of 2012 to the fourth quarter of 2022, a total of 44 observations were included in the sample. The average quarterly growth rate of real broad money

amounted to 4.15 percent. Concurrently, real income experienced a growth rate of 1.36 percent, while the inflation rate stood at 0.70 percent. Notably, the average interest rate was notably high, approximately 11.35 percent per annum. According to the Jarque-Bera test, it was observed that the series for broad money, real GDP, and inflation rate did not follow a normal distribution, as the probability values obtained from the test were all below 5%. Conversely, the interest rate series exhibited a normal distribution, as the null hypothesis of the Jarque-Bera test failed to be rejected at the 5% significance level.

Table 3. ADF Unit Root Test

		At Level			
		LNM2	LNGDP	LNCPI	R
With Constant	t-Statistic	-1.6441	-1.4840	0.4810	-2.3868
	Prob.	0.4519	0.5319	0.9840	0.1514
		n0	n0	n0	n0
With Constant & Trend	t-Statistic	-0.9637	-1.6743	-3.0595	1.0962
	Prob.	0.9385	0.7450	0.1288	0.9999
		n0	n0	n0	n0
Without Constant & Trend	t-Statistic	4.9103	2.3765	4.5689	-2.4623
	Prob.	1.0000	0.9950	1.0000	0.0150
		n0	n0	n0	**
		At First Difference			
		DLNM2	DLNGDP	DLNCPI	DR
With Constant	t-Statistic	-7.2475	-2.9976	-5.7905	-11.8870
	Prob.	0.0000	0.0433	0.0000	0.0000
		***	**	***	***
With Constant & Trend	t-Statistic	-7.6384	-3.1932	-5.7784	-6.6919
	Prob.	0.0000	0.0996	0.0001	0.0000
		***	*	***	***
Without Constant & Trend	t-Statistic	-2.0905	-1.6753	-4.3909	-11.1432
	Prob.	0.0365	0.0884	0.0000	0.0000
		**	*	***	***

Notes:

a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

b: Lag Length based on SIC

c: Probability based on MacKinnon (1996) one-sided p-values

The Augmented Dickey-Fuller (ADF) tests were conducted on each time series data being investigated using three different regression models: a model with a constant, a model with a constant and trend, and a model without a constant and trend. The results of these tests can be found in Table 3. At the chosen significance level, the null hypothesis for real broad money, real GDP, and the consumer price index cannot be rejected for any of the three models of the ADF test. This suggests that these variables have a unit root. However, when considering the model with a constant and the model with a constant and trend, the interest rate variable does have a unit root. On the other hand, when using the model without a constant and trend, the interest rate variable is stationary. When taking the first difference of the data series, all variables exhibit no unit root or stationarity, as the null hypothesis of the test for each variable is rejected. In summary, all variables under investigation are integrated of order one, denoted as I(1).

The subsequent step involves the implementation of the ARDL approach to cointegration. The optimal length of lags for the model selection criterion is determined by the Schwarz Bayesian Information Criterion (SBC). The order of the model regressors is arranged in the following sequence: real broad money expressed in lag term, real income, price level, and interest rate. The estimation of the model

is expressed as ARDL(q,p,l,d), where q, p, l, and d represent the optimal lag length with respect to the order of each respective variable set up above. Based on the SBC, the optimal lag length of the model is ARDL(1,0,0,1). The estimated parameters indicated in Table 4 serve three primary objectives, namely, to perform a stability test of the real money demand function, to test for the existence of a level relationship among the variables in the ARDL model, and to generate a long-run model of real money demand, which will be subsequently used to establish a short-run model, known as the error correction model, especially to predict the speed of adjustment.

Table 4. Autoregressive Distributed Lag Estimates

ARDL(1,0,0,1) selected based on Schwarz Bayesian Criterion

Dependent variable is LNM2

44 observations used for estimation from 2012Q1 to 2022Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LNM2(-1)	0.3933	0.1397	2.8158[.008]
LNGDP	0.5816	0.1474	3.9461[.000]
LNCPI	-0.5403	0.2658	-2.0326[.049]
R	-0.0581	0.0144	-4.0431[.000]
R(-1)	0.0263	0.0139	1.8900[.066]
TREND	0.0181	0.0042	4.3279[.000]
R-Squared	0.9977	R-Bar-Squared	0.99744
S.E. of Regression	0.0267	F-Stat. F(5,38)	3345.9[.000]
Mean of Dependent Variable	6.0445	S.D. of Dependent Variable	0.52762
Residual Sum of Squares	0.0271	Equation Log-likelihood	100.1769
Akaike Info. Criterion	94.1769	Schwarz Bayesian Criterion	88.8243
DW-statistic	1.7209	Durbin's h-statistic	2.4606[.014]

Table 5 displays the diagnostic tests for this model. The interpretation of these tests is based on the Lagrange Multiplier (LM) Version, which relies on the assumption of a Chi-square distribution. With regards to the serial correlation test, at a 5% significant level, the null hypothesis that the residual terms are serially uncorrelated cannot be rejected. Furthermore, the Ramsey's RESET test, which uses the square of the fitted values, has indicated that the ARDL model is correctly specified, as the probability of the calculated Chi-square is 94.3%, which is greater than the 5% significant level. However, the residual terms of the estimated model do not follow a normal distribution, as the probability of the normality test is less than the 5% significant level. The White's test for heteroskedasticity has shown that the variance of the error term is constant or homoskedastic. In summary, the estimated results of the ARDL approach to cointegration have passed all diagnostic tests. Furthermore, it is noteworthy that all slope coefficients collectively account for the dependent variable, as evidenced by the *F*-statistical probability of 0.000, which falls below the 1% level of significance. Of particular interest, the model explains 99.77% of the variance in the fitted data within the regression model.

Table 5. Diagnostic Tests

Test Statistics	LM Verstion			F Version		
A:Serial Correlation	CHSQ(4)	=	2.6359[.620]	F(4,27)	=	0.5417[.706]
B:Functional Form	CHSQ(1)	=	0.0051[.943]	F(1,30)	=	0.0043[.948]
C:Normality	CHSQ(2)	=	16.7029[.000]	Not applicable		
D:Heteroscedasticity	CHSQ(1)	=	2.6650[.103]	F(1,40)	=	2.7079[.107]

A:Lagrange multiplier test of residual serial correlation

B:Ramsey's RESET test using the square of the fitted values

C:Based on a test of skewness and kurtosis of residuals

D:Based on the regression of squared residuals on squared fitted values

In order to check for the existing of a level relationship or cointegration among the variables in the ARDL model, bound test is carried out. There are two different type tests of statistics, *F*-statistic and *W*-statistic, using within the bound test. In each test of statistic, the lower and upper bound at 90 percent and 95 percent confident level are provided. The null (H_0) hypothesis and alternative (H_A) hypothesis are written as follow. H_0 is rejected when the *F*-statistic or *W*-statistic is greater than the upper bound.

$$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$$
$$H_A: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$$

The outcome of the bound test, as displayed in Table 6, indicates that the 95 percent lower and upper bounds are 3.5447 and 4.7921, respectively. This is due to the fact that the *F*-statistic, which stands at 7.7798, significantly exceeds the upper bound value. Consequently, the null hypothesis, which suggests the absence of a level relationship or cointegration among the real broad money, real income, price level, and interest rate in the ARDL model, is rejected. The consistency between the *F*-statistic and *W*-statistic further supports this conclusion.

Table 5. Testing for existence of a level relationship among the variables in the ARDL model

F-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
7.7798	3.5447	4.7921	2.9124	4.0304
W-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
31.1191	14.1786	19.1684	11.6497	16.1215

In the long-term, the demand for real money in Cambodia exhibits a positive correlation with real income at a significant level of 1 percent. This empirical finding aligns with the theory of real money demand, which suggests that as people's real income increases, their demand for money also increases. Additionally, in the long-term, the demand for real money demonstrates a negative relationship with the general price level at a significant level of 10 percent. This implies that an increase in prices leads to a decrease in the demand for money. As anticipated, the interest rate has a negative impact on the demand for real money, and this impact is statistically significant at a level of 5 percent. Specifically, as the interest rate rises, the demand for real money decreases.

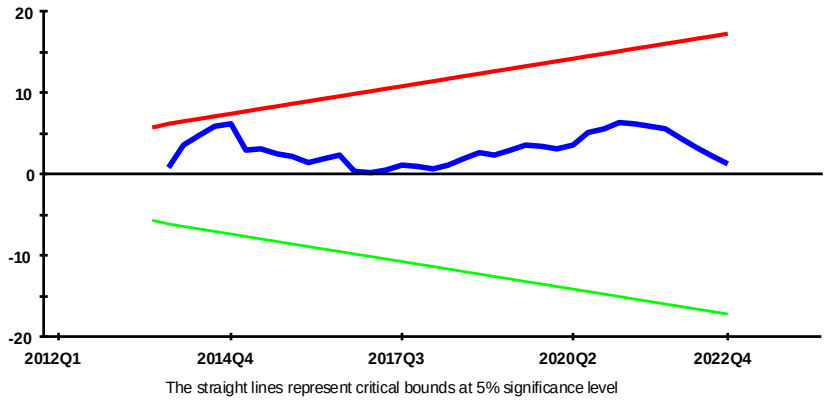
Table 6. Estimated Long Run Coefficients using the ARDL Approach
ARDL(1,0,0,1) selected based on Schwarz Bayesian Criterion

Dependent variable is LNM2
44 observations used for estimation from 2012Q1 to 2022Q4

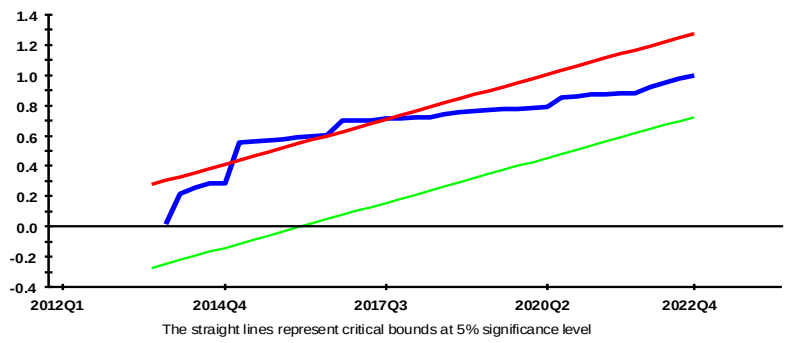
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LNGDP	0.9587	0.1920	4.9932[.000]
LNCPI	-0.8905	0.4553	-1.9557[.058]
R	-0.0524	0.0253	-2.0697[.045]
TREND	0.0299	0.0026	11.5524[.000]

In order to check the stability of real money demand function, the cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) recursive residuals tests are employed. As showed in Graph 1 and Graph 2, the plot of CUSUM and CUSUMSQ are statistically smoothly stay in the critical bounds at 5 percent significant level which claimed that the real broad money demand is stable.

Graph 1. Plot of Cumulative Sum of Recursive Residuals



Graph 2. Plot of Cumulative Sum of Squares of Recursive Residuals



The findings presented in Table 8 indicate that there is a positive correlation between the growth rate of real GDP and the real growth rate of money demand. The sample parameter for this relationship is 0.5816, which is statistically significant at the 99% confidence level, as the p-value is lower than 0.01 (0.000). On the other hand, the inflation rate and changes in interest rate have a negative impact on the real growth rate of money demand, with significance levels of 5% and 1% respectively. These results are consistent with the long-run model, which suggest that these factors have a negative effect on money demand.

According to the findings of the same model, it has been observed that the slope coefficient of the error correction term is -0.6067, which aligns with the principles of econometric theory. It is worth noting that this coefficient holds great significance at the 1 percent level. In the field of economics, the estimated parameter of the error correction term is utilized to gauge the rate at which variables within the model adjust in response to short-term dynamic shocks that may influence the long-run equilibrium. Specifically, the estimated parameter of the error correction term indicates the time required for the long-run real money demand function to converge towards equilibrium if the short-term dynamic equation deviates from equilibrium. The projected speed of adjustment is estimated to be 60.67% per quarter, implying that in the event of any economic shock affecting the short-term dynamic growth rate of the real money demand function, the time needed to readjust towards long-run equilibrium would not exceed two quarters. This outcome accurately reflects the current state of Cambodia's economy, where the National Bank of Cambodia, also known as the central bank, consistently formulates comprehensive strategies to address any adverse effects on the economy, particularly concerning money demand and supply.

Table 8. Error Correction Representation for the Selected ARDL Model

ARDL(1,0,0,1) selected based on Schwarz Bayesian Criterion

Dependent variable is DLNM2

44 observations used for estimation from 2012Q1 to 2022Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DLNGDP	0.5816	0.1474	3.9461[.000]
DLNCPI	-0.5403	0.2658	-2.0326[.049]
DR	-0.0581	0.0144	-4.0431[.000]
DTREND	0.0181	0.0042	4.3279[.000]
ecm(-1)	-0.6067	0.1397	-4.3434[.000]
R-Squared	0.6164	R-Bar-Squared	0.5659
S.E. of Regression	0.0267	F-Stat. F(4,39)	15.264[.000]
Mean of Dependent Variable	0.0415	S.D. of Dependent Variable	0.0406
Residual Sum of Squares	0.0271	Equation Log-likelihood	100.1769
Akaike Info. Criterion	94.1769	Schwarz Bayesian Criterion	88.8243
DW-statistic	1.7209		

Furthermore, the study also includes a simultaneous test to determine the significance of the population parameters of the regressor in explaining the growth rate of real broad money demand. This is done using the *F*-statistic. The results, as presented in Table 8, indicate that the calculated *F*-statistic is 15.264, with a test probability of 0.000, which is less than 1 percent. Based on these findings, it can be concluded that all slope coefficients in the error correction model collectively contribute to explaining the growth rate of real money demand. This implies that both the independent and dependent variables are highly statistically significant. Additionally, the *R*-square value of 0.6164 indicates that the model accounts for 61.64% of the variation in the fitted data within the regression model.

Conclusion

In this study, the ARDL approach is adopted to study the cointegration between variables. The result indicated that the real GDP, consumer price index and interest rate have a long-run relationship with real money demand. In other word, meaning that all observed variables are cointegrated. Moreover, the result of the study also demonstrated that in the long-run, the real income, general price level, and interest rate are significant to explain the real money demand. Furthermore, the stability tests, CUSUM and CUSUMSQ tests in this study have also revealed that the real money demand in Cambodia is stable.

Additionally, the short-run dynamic model, ECM, suggests that all variables incorporate to explain the growth rate of real broad money as demonstrated in *F*-test. In the short-run, the growth rate of real GDP still has a positive relationship with the demand for real money, while the inflation rate and changes in interest rate have negative relationship. It has been observed that the slope coefficient of the error correction term is -0.6067, which is consistent with the principles of econometric theory. It is important to note that this coefficient holds significant value at the 1 percent level. In the field of economics, the estimated parameter of the error correction term is used to measure the rate at which variables in the model adjust in response to short-term dynamic shocks that may impact the long-run equilibrium. Specifically, the estimated parameter of the error correction term indicates the time it takes for the long-run real money demand function to converge towards equilibrium if the short-term dynamic equation deviates from equilibrium. The projected speed of adjustment is estimated to be 60.67% per quarter, suggesting that in the event of any economic shock affecting the short-term dynamic growth rate of the real money demand function, the time required to readjust towards long-run equilibrium would not exceed two quarters. The findings derived from this study provide empirical evidence in favor of the quantity theory of money

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Servant leadership and employee innovative behaviour: Unpacking the role of support for innovation and creative self-efficacy in knowledge intensive service context

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Keywords
Servant leadership, support for innovation, creative self-efficacy, innovative behaviour, Pakistan

Abstract

Employee innovative behaviour is widely emphasized as a critical driver of organizational innovation. Drawing on social information processing theory, this research proposes that by exhibiting servant leadership style, organizational managers can stimulate employee innovative behaviour directly and through the mechanism of support for innovation. This study also anticipates that the role of of employees' creative self-efficacy in strengthening the influence of support for innovation on innovative behaviour. To test the proposed relationships, data is collected from 338 IT professionals working in twelve large-sized IT-based service organizations of Pakistan. The results surfaced from PLS-SEM analysis indicate strong support for direct and positive linkage between servant leadership and innovative behaviour and significant role of support for innovation in mediating this relationship. However, the accentuating role of creative self-effecacy is not supported. This study extends existing knowledge concerning the nexus between servant leadership and innovation by examining the mechanism of support for innivation by which servant leadership can augment employee innovative behaviour. Findings of this research entails vital implications for service organizations striving for superior innovation performance. Furthermore, some contradictory findings of this research call for further empirical investigation for more finegrained managerial implications.

Introduction

Innovation has been widely recognized as the key determinant of organizational performance, competitiveness and longterm survival in dynamic business environment and volatile marketplace (Hughes, Lee, Tian, Newman, & Legood, 2018, Jia, Chen, Mei, & Wu, 2018). In an organizational context, whether it is manufacturing or services-oriented, innovation is mainly driven by employees by producing and implementing novel ideas (Iqbal, Nazir & Ahmad, 2022). Employees' behaviour, directed at creation and implementation of new and novel ideas is defined as innovative behaviour (Scot & Bruce, 1994). However, exhibition of such a risky and proactive behaviour requires a workplace environment that support novel ideas (Haider, Zubair, Tehseen, Iqbal, & Sohail, 2023). Prior research has continuously emphasized the role of leadership in shaping a supportive work environment that is conducive to employees' involvement in risky and proactive behaviours such as innovative behaviour (Lee et al., 2020).

Earlier research has documented the importance of various leadership styles in stimulating employees' innovative behaviours (Lee et al., 2020). These leadership styles include but not limited to transformational, transactional (Gu, Duverger, & Yu, 2017), entrepreneurial (Iqbal et al., 2022), authentic (Schuckert, Kim, Paek, & Lee, 2018), and ethical leadership (Ullah, Mirza, & Hameed, 2022). Given that innovation activities are risky and proactive in nature, an employee-oriented form of leadership is more conducive to innovative behaviour. Moreover, in a knowledge-intensive work context such as information technology service organizations, employees remain under consistent pressure to come with up novel ideas (Iqbal, Latif, & Ahmad, 2020). Therefore, in such knowledge-based organizations, employees are more concerned about their wellbeing. Hence, an employee-centric form of leadership is more relevant in

such work contexts. Servant leadership as a moral and employee-oriented leadership style that primarily focuses on employee needs (Greenleaf, 1970). In recent years, the burgoing research has provided an increasing evidence regarding the role of servant leadership in fostering positive behaviours and performance outcomes at individual level (Eva, Robin, Sendjaya, van Dierendonck, & Liden, 2019). Additionally, recent meta-analytic studies and emprerical investigations have documented that in comparison with other leadership behaviours such as ethical and authentice leadership, servant leadership has stronger association with positive employee behaviours and has the ability to generate an additional variance in employees' attitudinal, behavioural and performance outcomes (Hoch, Bommer, Dulebohn, & Wu, 2018).

Although, several studies have examined the nexus between servant leadership and innovative behaviour; however, contradictory results of these studies warrant further exploration of the mechanisms and boundary condition under which the influence of servant leadership can be best translated into employees' innovative behaviour (Newman, Neesham, Manville, & Tse, 2019). In line with such calls for further investigations and borrowing theoretical perspectives from social information processing theory, the present study intends to examine the mediating role of perceived support for innovation as an important mechanism limking servant leadership and followers' innovative behaviour. Additionally, this research is also proposed to examine the role creative self-efficacy as a critical boundary condition accentuating the influence of perceived support for innovation on employee innovative behaviour.

Theoretical background

Servant leadership as an antecedent of employee innovative behaviour

Due to consistent pressure for innovation, knowledge-based organizations have extended their focus on employee-centric forms of leadership to promote positive behaviours of their employees while ensuring their wellbeing (Newman et al., 2018). According to seven-dimension conceptualization, as theorized by Liden et al. (2015), servant leaders have conceptual skills, exhibit ethical behaviour, show concern for community, put thier followers first, focus on their emotional healing, empower thier subordinates, help them grow and succeed. In leadership studies, Blau's (1964) social exchange theory (SET) has been frequently used to understand the association between leadership and follower outcomes. Consistent with reciprocity norms that are the core tenets of SET, it is argued that when employees receive positive treatments from their leaders, they are highly motivated to reciprocate with effective performance and improved work attitudes and extra-role behaviors that benefit the organization (Iqbal et al., 2020; Jaiswal & Dhar, 2017).

Extant research reveals that employee-centric forms of leadership such as servant leadership can positively influence key outcomes at followers' level uch as organizational citizenship behavior (Newman, Schwarz, Cooper, & Sendjaya, 2017), voice behavior (Chughtai, 2016), and performance (Liden, Wayne, Liao, & Meuser, 2014). Servant leadership focuses on serving-others and thus has the ability to honor commitment, care and empower subordinates, develop their competencies and emphasize their interests (Liden et al., 2014). In line with SET, these leaders with such people-oriented characteristics prompt their followers to exhibit greater responsibility at work (Hale & Fields, 2007) and reciprocate with improved performance and demonstrate creative behaviour (Karatepe, Ozturk, & Kim, 2019). Consistent with this reasoning, several empirical investigations have demonstrated positive effects of servant leadership style on employee innovative behaviour. Thus, drawing support from social exchange perspective and based on the findings of previous research, this study proposes the following.

H1:Servant leadership has positive association with employee innovative behaviour.

Mediating role of perceived support for innovation

Contradictory results of prior research suggests that the effects of servant leadership on followers' innovative behaviour do not take place in a simple and straight forward. This study focuses on emplyees' perception of support for innovatiob in transmitting the effect of servant leadership on employee innovative behaviour. Perceived support for innovation reflects employee's perception that they are encouraged to produce creative ideas, they can solve problems differently without any negative consequences and their organization is characterized by flexibility and continuous change where

employees' ability to generate new ideas is respected (Scot & Bruce, 1994). Consistent with notion, social information processing (SIP) (Salancik & Pfeffer, 1978) theory can be invoked to explain the linkage of servant leadership with employees' innovative behaviour via their perception of support for innovation at workplace. SIP theory posits that employees in a group, team or department do not operate in isolation. Instead, they conduct their work through a complex social process whereby they tend to seek and interpret social cues from their work environment to build their perceptions regarding workplace climate or environment. Leadership is a prominent source of social information to perceive work environment.

Servant leaders pay personal attention to empowerment, growth and development of their follower and they are open new ideas from their subordinates thus engendering perceptions of psychological safety (Chughtai, 2016). These social cues from leaders make employees feel that their work environment is supportive for engagement in innovation related activities and do not fear any retaliation for their new ideas and novel solutions to work related issues. This perception of support for innovation prompt employees to engage in creation and rationalization of novel ideas. Prior research indicates that perceptions of support for innovation at work is positively related to employee innovative behaviour (Akbari, Bagheri, Imani, & Asadnezhad, 2021). Aligned with assertions of SIP theory and earlier evidence, the current research proposes the following relationship:

H2:Perceived support for innovation mediates the positive association between servant leader and employee innovative behaviour.

Modratiing role of creative self-efficacy.

Prior research argues that employees' ability to produce and implement new and complex ideas also plays a critical role in shaping their innovative behaviour. Employees' self-efficacy is mainly rooted in social cognitive theory which suggests that self-efficacy is a required condition that enable individuals to exhibit specific behaviours (Bandura, 1997). Creative self-efficacy is a particular facet of self-efficacy that refers to an individual's perception that he/she has the capability of realizing creative tasks (Tierney & Farmer, 2002). According to Hsu et al. (2011), creative self-efficacy refers to "one's confidence in the ability to perform a specific task in the innovation process" (p. 259). Prior studies suggest that employees with enhanced creative self-efficacy more strongly tend to exhibit innovative behaviour. Likewise, employees with greater self-efficacy, who are already motivated by support for innovation, are more likely to demonstrate innovative performance. Hence, it can be assumed that creative self-efficacy will accentuate the relationship between perceived support for innovation and employee innovative behaviour. Consequently, this study proposes the following (Figure 1):

H3: Creative self-efficacy moderates the association between perceived support for innovation and employee innovative behaviour such that the association is stronger when creative self-efficacy is high.

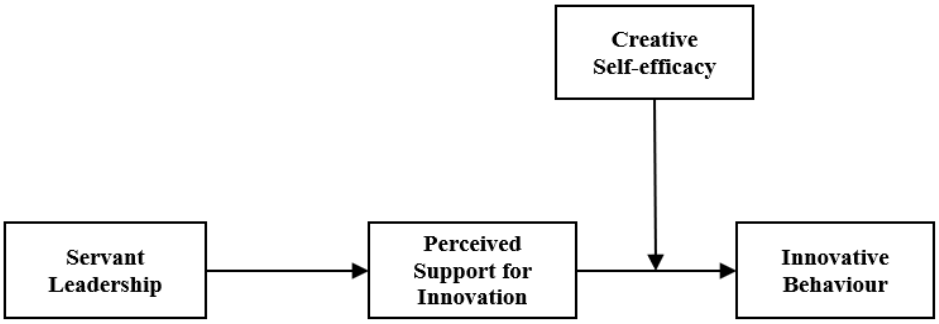

Figure 1: Proposed research model

Methodology

Sample and procedures

Using cross-sectional study design, data was gathered from 338 employees of twelve large-sized organizations providing information technology services and located in Rawalpindi and Islamabad

regions of Pakistan. In final sample, the male respondents accounted for 79% and female 210 indicating age of 26 years on average. Additionally, 62% of the respondents had a professional diploma or bachelor's degree. The mean job tenure of the participents in their respective organization was 4.5 years. Instruments used current study are portrayed in Table 1 and tapped using five-point Likert scales ranging from 1 for "strongly disagree" to 5 for "strongly agree".

Data analysis and results

PLS-SEM technique was employed data anyalysis and testing the proposed relationship through SmartPLS 4 software (Ringle *et al*., 2022) by following recent guidelines and recommendations (e.g. Hair *et al*., 2019). Initially, measurement model was assessed to confirm and establish reliability and validity of study constructs. Table 2 shows that outer loadings of indicators of all the constructs are above 0.70. Composite reliabilities of all constructs are well above minimum threshold of 0.70 and average variance extract (AVE) values meet the minimum requirement of 0.50. Likewise, Table 3 indicates that HTMT ratios indicating adequate discriminant validity. Collectively, these results establish that the quality of measurement model is satisfactory.

Table-1: *Measurement Instruments*

Construct	No. of Items	Source
Servant leadership	7	Liden et al. (2015).
Support for innovation	6	Scot & Bruce (1994)
Creative self-efficacy	3	Tierney and Farmer (2002)
Innovative behaviour	6	Scot & Bruce (1994)

Table 2: *Factor loadings, CR values and average variance extracted*

Construct	Indicator	Loading	CR	AVE
Servant leadership	SL1	0.794	0.909	0.589
	SL2	0.754		
	SL3	0.747		
	SL4	0.803		
	SL5	0.799		
	SL6	0.758		
	SL7	0.712		
Creative self-efficacy	CSE1	0.899	0.909	0.769
	CSE2	0.843		
	CSE3	0.888		
Support for innovation	SI1	0.798	0.890	0.620
	SI1	0.856		
	SI3	0.794		
	SI4	0.718		
	SI6	0.740		
Innovative behaviour	IB1	0.796	0.915	0.643
	IB2	0.860		
	IB3	0.829		
	IB4	0.783		
	IB5	0.808		
	IB6	0.730		

Table 3: *Discriminant validity (HTMT criterion)*

	CSE	IB	SI
IB	0.876		
SI	0.669	0.724	
SL	0.665	0.695	0.827

Note: SL = servant leadership, SI = support for innovation, IB = innovative behaviour, CSE = creative self-efficacy.

Note: SL = servant leadership, CSE = creative self-efficacy, SI = support for innovation, IB = innovative behaviour, AVE = average variance extracted, CR = composite reliability.

In the next step, structural model was evaluated for explanatory power and relevance and statistical significance of hypothesized relationships using bootstraping procedure with 10,000 sub-samples. To this end, we first evaluated R^2 value of target construct. The results show R^2 = 0.451 indicating that the hypothesized model exaplain a variance of 45% in innovative behaviour. This value of R^2 demonstrates medium explanatory power of the model. Table 4 exhibits results of hypothesis concerning direct, indirect and moderated relationships. The results indicates that servant leadership has positive relationship with innovative behaviour (β=0.368, t=5.561, $p < 0.01$) showing support for H1. The results further reveal that servant leadership has positive association with support for innovation (β=0.707, t=20.023, $p < 0.01$) and support has positive linkage with innovative behaviour (β=0.357, t=5.856, $p < 0.01$). These results points to the mediating role of support for innovation. Consequently, the results exhibit that support for innovation play a significant mediating role in the linkage between servant leadership and innovative behaviour (β=0.253, t=5.381, $p < 0.01$) providing support for H2. However, the results do not validate the role of creative self-efficacy in strengthening the relationship between support for innovation and innovative behaviour (β=-0.036, t=1.740, $p > 0.05$). Hence, H3 is not substantiated.

Table 4 : *Results of structural model evaluation*

Relationships	β	t-Value	p-value
Direct effects			
SL → IB	0.368	5.561	0.000
SL → SI	0.707	20.023	0.000
SI → IB	0.357	5.856	0.000
Indirect effects			
SL→SI→IB	0.253	5.381	0.000
Moderating effect			
CSE x SI → IB	-0.036	1.740	0.082

Note: SL = servant leadership, SI = support for innovation, CSE = creative self-efficacy, IB = innovative behaviour.

Discussion, implications and future research directions

Prior studies have widely documented the critical role of servant leadership in shaping positive behaviours. The objective of present study was to exame the nexus between servant leadership style and followers' innovative behaviour and exploring the underlying mechanism and boundary conditions under which this relationship can occur. Based on data collected from employees of IT-based organization in Pakistan, findings of this investigation entail several theoretical implications. First, this study extends growing and conflicting evidence concerning the role of employee-centric leadership in directly stimulating innovative behaviour. In congruence with the propositions of SET (Blau, 1964), findings of current investigation indicate positive direct relationship between servant leadership style and subordinates' innovative behaviour. This finding contradicts the results of study conducted by Newman et al. (2018) who did not find direct linkage between servant leadership and innovative behaviour. However, in line with the propositions of SET, the findings of current study substantiate the evidemce

concluded by Iqbal et al. (2019) which suggest that when employees receive positive and favourable treatment from their leaders, they tend to go beyond transactional obligations and reciprocate with desirable behaviours.

Second, building upon SIP theory (Salancik & Pfeffer, 1978), the present study extends prior evidence by assessing and documenting the role of support for innovation in mediating the relationship of servant leadership with followers' innovative behaviour. In alliance with the core tenets of SIP theory, fingings of present research suggest that social cues of empowerment, growth and development, concerns for individual intrests and openness for new ideas that employees receive from servant leadership foster perceptions of support for innovation (Reiter-Palmon & Illies, 2004; Shin, 2015) that in turm prompt them to engage in innovative behaviour (Akbari et al., 2021). In doing so, this research not only contributes to servant leadership and innovation literature but also confirms the validity of SET and SIP theories in explaining the nexus between leadership with servant characteristics and employee behaviour. However, contrasting findings concerning the moderating role of employees' creative self-efficacy as concluded in present study call for futher exploration of the mechanisms and boundary conditions underwhich servant leadership can better shape employee innovative behaviour. Additionally, this research calls for further empirical investigations in various work contexts for findgrained practical understanding of the mechanisms linking servant leadership and employee innovatve behaviour.

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Assessing the financial literacy strategy of small businesses utilizing information technology within Umhlathuze Municipality

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Keywords
Financial Literacy, Small Businesses, Information Technology, Umhlathuze Municipality and Economic Growth

Abstract

This study examines the financial literacy strategies employed by small businesses operating within the Umhlathuze Municipality in South Africa with a particular focus on their utilization of Information Technology (IT). Small firms are of great importance in promoting economic development within a dynamic business environment. Their capacity to efficiently handle financial resources is crucial for their long-term viability and achievement.

Quantitative data was collected from a sample of 385 small business participants, representing a diverse range of industries and sectors within Umhlathuze Municipality. Also, qualitative data was collected from 13 IT and Finance specialists. The objective of this research endeavour was to evaluate the degree to which financial literacy programmes for small businesses integrate information technology.

The findings of this study reveal key insights into the financial literacy practices of small businesses within Umhlathuze Municipality. As indicated by the research findings, the function of information technology in promoting financial literacy is growing in significance. Hence, numerous organisations have embraced diverse IT tools, including accounting software, online banking, and financial management applications, to augment their financial literacy efforts. Furthermore, the study's findings highlight how the use of IT improved these institutions' financial management practises, resulting in greater decision-making capacities and a more solid financial position.

Notwithstanding these circumstances, there were nevertheless discernible obstacles pertaining to the adoption of information technology and financial literacy, including restricted availability of technology in some regions, deficiencies in expertise among employers and workers, and apprehensions about the security of data. These challenges underscore the need for tailored support and training programs to empower small businesses in leveraging IT for financial literacy effectively.

This research sheds light on the evolving landscape of financial literacy strategies among small businesses in Umhlathuze Municipality, emphasizing the role of Information Technology. This study provides valuable insights to policymakers, business support organizations, and stakeholders interested in enhancing small business financial literacy and resilience. Ultimately, fostering greater IT integration and promoting financial literacy can contribute to the long-term success and sustainability of small businesses, ultimately driving economic growth in Umhlathuze Municipality.

Introduction

In agreement with prior studies, the first step to be able to access the financial literacy level of small businesses would be to survey the owners themselves on their knowledge regarding financial management (Lusimbo, 2016). Previous studies in the area, which have used survey method to dissect the knowledge of financial literacy in correlation with micro and small business owners' financial behavior, have found that the data collected was sufficient in order to make conclusions regarding the owners' overall financial status of the business (Derbyshire, 2016).

According to the recent survey conducted on small businesses around the world, it is found that over the years, many entrepreneurs have been obligated to exit the business industry due to the failure to manage finances incurred from the business itself (Cherugong, 2015). While other entrepreneurs

comprised of beginning and experienced business owners have hindered their own business growth with the lack of financial management costing them the loss of potential profit and effective business growth (Gaudence, Patrick & Denys, 2018).

The unending struggle for survival and competition in the business environment has made the significance of financial literacy level among small businesses greater than before, and the success of the business largely depends on the financial literacy level (Bushe, 2019). Unfortunately, it is found that a large number of small businesses lack financial literacy, and these low levels of financial literacy are associated with adverse consequences for the survival and growth of small businesses (Tuffour, Amoako & Amartey, 2022). Knowledge about financial issues can help small business owners to manage their firms more effectively, avoid failure, especially in the early years, and increase the likelihood of growth (Hussain, Salia & Karim, 2018).

Background

Small businesses are one of the most important sectors in South Africa, which contributes significantly to the economy activity, employment creation, and equitable income distribution. However, entrepreneurs face a lot of struggles when it comes to managing the financial aspect of their business (Ayandibu & Houghton, 2017). Managers have different levels of financial literacy and most of them are not equipped with financial knowledge (Plakalović, 2015). This is due to the fact that the manager or the owner has an additional role to play compared to managers in large firms. Roles of small business managers are usually multi-tasking and handling a wide area of functional areas of the business (Plakalović, 2015). Limited resources in terms of money, time, and human capital also contributed to the necessity of contracting out some of the functions or combining them with others, thus limiting the owner's ability to perform a particular function in a professional manner (Hayton, 2005). This includes functions related to financial management (bookkeeping, accounting, internal control, and financial reporting) and the preparation of financial statements. Due to the lack of specific management in the financial areas and the combination of the owner's personal finances with the businesses, it is not uncommon for the financial management of the business to be given minimal attention (Hayton, 2005).

This study will be examining the financial literacy strategies of small businesses in the area of Umhlathuze Municipality. The term financial literacy refers to an individual or a group's ability to make informed decisions based on the understanding of the financial concepts (Remund, 2010). The focus will be on financial reporting, financial statement preparation, internal control, and cash management. The study looked at the methods used and sought by small business owners to increase their financial competency. This includes hiring professional help such as accountants or accounting students and attempts at self-education in the financial areas. The study attempts to gauge the level of competency in the aforementioned financial areas and discover any correlations between the financial literacy and the financial success of the businesses.

Problem Statement

This paragraph has a number of critical elements to be teased out. First is the concept of financial IT decisions. IT users must make a wide array of information technology decisions that can have varying effects on the financial literacy competency of their small business and/or themselves. An IT decision is simply the act of choosing between two or more methods of obtaining an IT goal (Hwang & Masud, 2012). This can be anything from choosing which software to use, weighing up the costs and benefits of an IT solution, to determining how best to use an existing IT tool. It can be a deliberate decision to pursue an IT goal with specifically allocated resources or simply the decision to continue the status quo of an IT activity. A method is a way of doing something or an act of procedure often involving an input and producing an output. IT methods can have massive impacts on financial literacy competency, but it may not always be immediate or intended (Mcbride & Philippou, 2022). For example, a method of automating a record-keeping process may free up time and resources but be an opportunity forgone to develop staff financial literacy competency in doing the task manually and learning from the output. This must be realized and weighed up when making method decisions.

An information technology (IT) financial literacy strategy is a planned and integrated course or effort by an Umhlathuze small business to teach its information technology users how to understand and use financial literacy skills and concepts for the purpose of developing competent financial technology decisions. This is the strategic issue facing small businesses within Umlathuze Municipality. Small business IT users must understand financial literacy concepts, terms, and skills and know how to integrate them into information technology decisions to achieve a desired financial literacy outcome. Currently, there is no clearly defined understanding of what constitutes financial literacy skills and concepts for generic IT users and how to best integrate this understanding into information technology decisions for small businesses. Conversely, small businesses are struggling to develop generic financial literacy skills and concepts into a practical course or integrated effort that will teach IT users how to use IT to functionally improve their financial literacy competency.

Research Objectives

The aim of this article is to assess how small business enterprises in the uMhlathuze Municipality can benefit from having a well-defined financial literacy strategy primarily focused on the use of information technology (IT). There has been increasing evidence to suggest that there is a direct relationship between improved financial management and improved survival and success rates of small enterprises. While many small enterprises may be practicing good day-to-day financial management, very few have a defined financial strategy. The purpose of this study is to define the financial management practices of small business enterprises with the ultimate aim of designing an effective financial literacy program.

The specific objectives of this research study are:

- To determine the general financial management practices of small business enterprises.
- To identify strengths and weaknesses in financial management.
- To ascertain financial training needs.
- To assess the extent of IT usage in financial practices.
- To provide general insights into possible methods of improving financial management.

Literature Review

Literature surrounding small businesses, financial literacy, and information technology, individually, is prevalent. However, an intersection of the two has sparse coverage. Dahmen and Rodríguez, 2014, for example, covered the small business and financial literacy area thoroughly, but only scratched the surface when mentioning "this new computer technology". This gives insight into the IT aspect in financial decision making but does not detail an understanding of how specifically IT has influence. The article also fails to mention the shift from traditional pen/paper record-keeping method to a more IT-oriented method and how this affects financial literacy. On the information technology side, Street, and Cameron, 2007, covered an array of IT topics in small businesses, but only in relation to its effect on business success. This article does, however, emphasize that IT is a critical investment for any small business, which gives a clear indication that any financial decision on investment should include considering an investment in IT. A study by Caldeira and Ward, (2003) takes a look into the effect of the IT investment decision process itself and the difference between successful and unsuccessful IT adopter companies. This study gives some insight into the thought process of a manufacturing SME when considering an IT investment but does not detail the investment decision process compared to other types of investment, and ultimately how it correlates to financial literacy.

Financial Literacy in Small Businesses

Understanding of accounting is an important aspect of overall financial literacy. Lack of accounting knowledge can result in failure to organize financial information and use financial resources optimally. This includes categorizing costs and revenue in order to understand the profitability of specific products or services, which is crucial to the decision-making process in small businesses. Accounting knowledge also aids in the preparation of financial statements and budgets. These are tools which Damayanti, Al-Shami, Rahim, Rahim, Marwati and Malaysia (2018) stated can help small business owners to obtain financing and plan for the future. Finally, a greater understanding of accounting should enable small

business owners to understand and prepare their tax returns. This may help to prevent unnecessary loss of resources due to penalties incurred from ignorance of tax laws.

Financial literacy is of paramount importance in the context of small businesses. When the business ventures into its operations, it needs sufficient capital to sustain its growth. However, a lack of financial literacy among small businesses can mar their capability to obtain financing. Studies like Mutegi, Njeru and Ongesa, (2015); Okello-Candiya Bongomin, Mpeera-Ntayi, Munene and Akol Malinga, (2017), have shown that having low levels of financial literacy can lead to a higher probability of loan defaults and thus constrain the access to financing. Therefore, one of the main reasons that small businesses do not survive is their lack of understanding of how money works in the business. An important consideration is the prevailing crisis in South Africa, of the high rate of fatal small business closures that may be due to the lack of an understanding of the financial environments in which these businesses operate. High levels of financial literacy give small business owners a better chance of their businesses continuing to survive and grow.

Importance of Information Technology in Small Businesses

An article on Forbes suggests that without the implementation of IT, many of the tasks and processes that are involved in the operation of a business are performed manually. This includes record keeping, calculating, and financial analysis. These automated processes can provide small businesses with time to check the accuracy of the data, time to analyze information to better understand the financial position of their business and identify potential cost savings and efficiency improvements (Ramaswamy, 2019). Financial management in almost every business scenario is about the management of an enterprise to better understand its financial health and improve the firm's profitability (Shaheen, Ağa, Rjoub & Abualrub, 2020). Furthermore, AT&T released a poll with small business owners who claimed that IT helps them serve the customer better, stay in touch while out of the office, and make their business more efficient (At&t, 2013). These indirect effects of IT can greatly assist small businesses in managing their finances and mapping out a strategy to improve their financial literacy.

Another concept that has been identified is that IT enables greater learning and understanding. Fiksel & Fiksel, 2015 understands that learning is essential for better human performance and an essential aspect of survival in fast-moving, risky, and uncertain environments, including small businesses. IT and the internet can be educational tools for businesses to acquire more financial know-how as a means of self-learning. IT can provide access to online financial information, tutorials, and software. A recent trend is the use of internet-based software known as "cloud computing" that provides users with services over the internet rather than application software and access to digital storage that eliminates the need for hard copies. This can be a relatively cheap and efficient way to store and access financial data and learn to use various financial management tools.

A forthcoming and interesting notion to come out of a New Zealand government report is the effect that IT has on the life and well-being of business owners (Roberts, Brower, Kerr, Lambert, McWilliam, Moore & Wratten, 2015). The idea of improving life quality and reducing stress resulted in Frederiks, Stenner and Hobman, (2015) proposing that by reducing the cognitive efforts we put into decisions, problem-solving, and actions, we can achieve goals with lesser cost and energy. The computer has changed the way people deal with information and accomplish tasks and, to an extent, taken the load off humans. This cause-and-effect situation would suggest that by a small business owner investing time into learning to use IT for financial management, they can achieve a greater understanding of their financial position, without being overwhelmed and stressed by the process.

Previous Studies on Financial Literacy and Information Technology

Abdullah, Fazli, and Muhammad Arif (2019) studied the relationship between money attitude, materialism, and debt on the financial literacy of households. It is not exactly a study on how to improve financial literacy, but it provides insight into the condition of people who do not have enough financial literacy. A conclusion from this research is that there is a negative relationship between debt and financial literacy. This is one finding on the importance of financial literacy for a person or a household. Debt management is a part of financial management that requires someone to have knowledge of the best

strategy to reach the ultimate goal, which is to minimize the cost. Debt that occurs due to a lack of information will burden a person because it costs too much. This will reduce the ability of a person to hold emergency funds and face any unexpected events that require a cost. As for small business owners, unexpected events that require a cost may damage the business if the owner does not have enough preparation. Lusardi and Tufano, (2015). also conducted another research that investigates the debt literacy condition around the globe. It provides a detailed comparison between countries on debt literacy and debt behavior. Debt literacy is a concept that involves the understanding of debt terms and conditions. This study measured debt literacy by questionnaires that cover the basic knowledge of interest rates, inflation, and risk diversification on debt. This study found evidence that people who understand debt terms have better debt management compared to those who do not understand it and borrow money at high interest rates. Debt literacy also has a close relationship with debt behavior.

Several studies investigate the effectiveness and the effect of financial literacy and the role of information technology on financial management. Kulathunga, Ye, Sharma and Weerathunga, (2020) conducted a study to investigate the spread of financial literacy around the globe and the impact on saving behavior. The result of this study has provided evidence that people who are more financially literate are more likely to save before consuming and are more likely to compare prices before making decisions. This study also found evidence that those with higher financial literacy are less likely to engage in impulse buying, borrow at high interest rates, and manage their debt.

Theoretical Framework

Information technology (IT) has now become a commodity and is essential in the business industry. It is a firm's main tool to achieve competitive advantage in the global market. IT is transforming the way business is done. It is facilitating the businesses to conduct R&D, advertise and reach new customers. It is enhancing the production of new products and services, and finally, IT is leading to improvements in the logistics and supply chain management. These factors were identified by small business owners within the Umhlathuze municipality as ways in which they can grow their businesses. The increasing intensity of IT employment by small business owners makes it ever more important for them to understand and make better use of their IT investment. This is supported by evidence which shows that in every sector, IT-intensive firms tend to enjoy better productivity, profitability, and growth relative to their peers (Chang & Gurbaxani, 2013). With the combination of financial literacy and IT being essential in the way business is done, it is important to note that there is a gap between the two concepts. There are limited resources on the best way to manage IT using financial management and cost analysis. This study looks on providing a solution for this gap within the context of the Umhlathuze Municipality.

The theoretical framework utilized for this study includes e-learning, p-learning, financial literacy, information technology, and small business, all streamed down from the general framework of the study. This study is solidified under the research topic "Assessing the Financial Literacy strategy of small businesses utilizing information technology within Umhlathuze Municipality". Financial literacy is a prerequisite for an entrepreneur and small business owner. Practically, it is the ability to read and understand basic financial statements such as balance sheets, profit/loss statements, and to cost and financial management in ways that improve the likelihood of business success, and the ability to effectively carry out this task (Vuković, Peštović, Mirović, Jakšić & Milutinović, 2022). A financially literate entrepreneur is empowered to access, use, and produce financial information that guides the business to growth and sustainability.

Methodology

The approach was to validate the proposed strategy to improve financial literacy by:

- Testing the knowledge and understanding of the target group regarding financial management.
- Consulting with relevant stakeholders to attempt to identify the challenges and enablers relevant to the target group.
- Describing the characteristics of the Financial Literacy program/service that would best enable the target group to more effectively manage their finances.

- Analyzing the attributes of IT that would potentially enable the target group to more effectively manage their finance and deduce the IT know-how and resources of the target group.
- Using this info to design the most effective way of bridging the gap between the current and desired financial management ability using IT. A follow-up study can then validate this strategy.

Research Design

The study was exploratory, descriptive, and analytical. Descriptive research is used in the first browsing for the level of some phenomenon, and analytical research tries to explain why and how there is a change in the level of the phenomenon. Exploratory research is most generally unstructured, "informal" research that is used to gain background information about the general nature of the research problem. These methods are using both qualitative and quantitative methods to give a broad understanding of the financial literacy levels of small business owners within Umhlathuze Municipality and to provide an understanding of how IT is being used to assist these entrepreneurs with both their financial management and their general levels of financial literacy. Interviews are generally more informal than surveys and they are structured around set questions and allow for follow-up questioning to gain clarity or to gain a deeper understanding of the current question. They were conducted with both business owners and IT consultants in order to get a full understanding of the current environment. Questionnaires were used to gather the background and general information about the small business in order to assist in choosing a sample for both the in-depth research and the case studies. The choice of using questionnaires also allows for easier comparison of responses with a larger group of people.

The in-depth research began with case studies into the businesses of the IT consultants. This gave a good understanding of the levels of financial literacy compared to other educated professionals as well as giving some insight into the levels of literacy prior to the introduction of the IT consultant. A case study was followed into the entrepreneurs IT consultants, again with the similarities of the educated professional it can give insight into the levels of understanding of the entrepreneurs as they attempt to mirror the success of these consultants. The final case study was that of a comparison of businesses that are currently employing IT consultants, to those that are not. An in-depth understanding was gained as to the change in financial literacy levels as a direct result of the IT. This determined if IT is an effective tool in improving financial literacy.

Sample Selection

The sample selection stages involved a process of isolating businesses that are small in nature and predominantly are one-man owned enterprises. The logic behind this is that one-man businesses are usually run by individuals who, at some stage in their life, embarked on prioritizing asset building and financial planning for the future. Practice of some sort of financial planning or strategy in the past provides a basis for a health check into the current business practices. Small business was classified according to the European Union (EU) definition, that being a business employing less than 50 people. This limit is sufficient for separating small enterprise from large enterprise without using the criteria of turnover or profit. This is a fair indicator for business size in South Africa due to large black economic empowerment policies and affirmative action value chains which often classify businesses on their employee numbers rather than their turnover. This often means there are many businesses with large turnovers but still using small business strategies. The municipality of Umhlathuze was selected as the research environment due to its classification as a microcosm of South African in terms of first, second, and third worlds existing simultaneously. This is due to contrasts of wealth stemming from industrialization with 1st world in affluent areas and upper working-class suburbs, 2nd world in standard lower-class suburbs, and mostly rural 3rd world in the peri-urban and tribal authority area. A plethora of information technology resources were employed such as broadband, ADSL, IDSN, GPRS, 3G, WIFI, and even VPN with the overall aim of providing municipality inhabitants greater accessibility to technology resources for IT facility purposes. This allows for a larger business scope as the rapid rise in internet usage in South Africa has made access to global information and markets more feasible for these business owners.

Data Collection

Second step includes a General Financial Literacy Test and Specific IT assessment. The purpose of this type of testing is to enable the diagnosis of small business owners' individual needs and provide direction for subsequent decisions in the program design. In other words, the tests are going to help the association figure out what level of financial and IT literacy the small business owner has, so the appropriate form and amount of help may be administered. The general financial test has been taken from the International Adult and Literacy Survey (IALS), consisting of math-based questions which are specific to the testing of financial management skills. An example of a question which the IALS believes measures a low level of financial literacy is, "If you buy a R100000 car on credit at an annual interest rate of 10%, how much will you have to repay if you decide to pay off the loan in two years' time?". This should take no longer than 10 minutes and will be done in a group testing environment.

First step of data collection involves the arrangement of semi-structured interviews with various Financial and IT specialists. This involves conducting interviews with open-ended questions based around the issues and objectives contained within this study. The sample size suggested for this specific study was between 10 and 15 Finance and IT specialists as greater insight may be gathered with a selection of small business owners through questionnaires rather than an entire population. The saturation principle was employed, and the qualitative data collection stopped at 13 since no more information was being obtained (Aguboshim, 2021). Interviews was recorded to ensure consistency in the data. This then allows for the informed consent of the respondents, providing them with a sheet of paper which informs them of the nature of the interview and that their responses will be tape recorded and kept confidential, taking into consideration their rights of anonymity. Sample size of 385 was used for the quantitative study.

Data Analysis

First look at the data obtained from the baseline with regards to small business owners' financial literacy using IT. Frequency analysis was carried out for this data to determine whether small business owners' financial literacy using IT is predicted by their demographic characteristics. In particular, cross-tabulations were performed for demographic variables including age, education level, digital literacy skills, household income level, and business size. Analysis was elucidated whether there are any particular groups of small business owners with low financial literacy using IT and whether it would be worthwhile to target these groups in future financial literacy initiatives. A second method of analysis wa through IT and Financial specialist's interviews with those identified as having an inadequate awareness of financial literacy programs being offered. These individuals were sampled purposefully based on their responses to the baseline survey and questions asked primarily open-ended. The goal of these interviews was to assess why these small business owners have low financial literacy using IT, whether they perceive a need for financial literacy education, and the challenges they face in improving their financial literacy.

Results and Findings

The findings suggest that the majority of the small business owners are male, between the ages of 25-45, and have completed at least a matric/grade 12 qualification. Although there is a high level of educational background, it does not necessarily translate to a better understanding of bookkeeping and accounting practices. This is also evident in the lack of financial planning and record keeping done by these business owners. Around 90% of the respondents have not undertaken any financial management courses as they felt that it was irrelevant to them at that time. The younger generation of business owners seems to have a different attitude, as they attribute the success of their business to financial management and planning. This suggests that financial literacy may not be a problem at present for them, but it still poses a significant threat to the sustainability of their business in the future. IT can also be seen as something of great influence, as the older generation of business owners did not utilize it as much compared to the younger generation. IT could be a potential tool to enhance financial knowledge, but it is still uncertain at this stage.

The research findings are presented in terms of the study objective, which aimed to identify and assess the financial literacy levels of small business owners and to determine the strategies used to

enhance financial literacy by utilizing IT. A total of 385 small business owners in Umhlathuze Municipality participated in the survey. These findings are useful because they identified the needs and aspirations of small business owners in enhancing their financial knowledge in order to sustain and expand their business.

Financial Literacy Levels among Small Businesses

Using a variety of statistical tests like descriptive, inferential and Factor Analysis, this provides evidence of differing levels of financial literacy among many different groups within the community. This evidence suggests that there are quite a few individuals who could benefit from small increases in financial knowledge to avoid negative financial events. This includes people with low-income jobs, elderly people, and single women with children. This should be used in the future to develop targeted education programs for the benefit of those groups.

The clusters of demographic groups indicate two variables. The first is age, measured in three groups: 18-29, 30-49, and 50-64. The second variable is household income, and measures three groups: less than R200,000, between R400,000 and R500,000, and more than R500,000. The results suggest that the age of an individual does not affect financial literacy; however, there is a strong indication that household income does. The findings are consistent with other studies of financial literacy. This would suggest that younger people can still be targeted to increase financial literacy, but it would be most effective for those in higher-income households (Johnson & Sherraden, 2007).

Utilization of Information Technology in Small Businesses

Based on the responses from this line of questioning, it was indicated that the level of utilization of information technology was quite low, as computer technology is quite complex and difficult to understand. This may stimulate further research in having to assess the levels of computer literacy in the small businesses sector. This will help to find out if the understanding of information technology has any effects on financial literacy in small businesses. This line of questioning to specify exactly how information technology was being used helped to give a solid understanding that information technology is indeed a broad field, and many things fall under that category (Omrani, Rejeb, Maalaoui, Dabić, & Kraus, 2022). This will help in future research on whether different forms of information technology have different effects on financial literacy in small businesses.

The small businesses that indicated that they were using information technology were asked to specify exactly how they were using it. A large majority of the respondents stated that they were using information technology to assist in the day-to-day running of their businesses. This included the storing and sending of business documents; as it is stated by one respondent "I am using a computer to keep all my quotes and invoices, it's much easier than keeping all the paperwork." Other common uses of information technology included marketing and advertising, and about 30% of the small businesses using information technology indicated that they were using it to help gain knowledge on how to expand or improve their businesses. Only 5% of the businesses using information technology stated that they were doing it for research purposes.

The primary focus of this research was to assess the financial literacy strategies of small businesses using information technology. However, before conducting research in assessing financial literacy, it was necessary to determine whether small businesses were indeed using information technology and in what ways they were utilizing it. Out of the 385 small businesses that filled the questionnaires, 95% indicated that they did use information technology in their business. When asked to specify what they considered to be information technology, many of the respondents listed computers, internet, software, and cellular phones; 25% of the respondents indicated that they did not understand what information technology was. Since small businesses are generally attributed as the leaders of economic development, it is vital that if they are trying to incorporate information technology, which is the key to pulling South Africa into the information age, that they have an understanding of what they are trying to do.

Relationship between Financial Literacy and Information Technology

As outlined in the rationale, the study was aimed to assess the financial literacy strategies of small businesses utilizing information technology within the Umhlathuze Municipality. Generally, entrepreneurs were found to require information technology for information seeking and learning purposes. This supports the theory where people often acquire information for the purpose of enhancing knowledge which in turn leads to informed decisions (Sitaridis & Kitsios, 2024). In this instance, it is recognized knowledge enhancement will lead to informed financial decisions. Information technology provides a vast array of knowledge resources, from online articles and tutorials to interactive software. This is evident from the survey where more than 95% respondents agreed information technology provides access to a range of free and easy to use resources. The easier the access to the resources, the more frequent they will be utilized. This was supported by the 72% of the respondents who mentioned information technology resources save time. Time saving resources may have a compounding effect to knowledge acquisition and decisions on the business long term. Finally, it is documented that one of the fundamental aspects of financial literacy is the ability to make informed decisions regarding money management (Oppong, Salifu Atchulo, Akwaa-Sekyi, Grant & Kpegba, 2023). The decisions made are over a wide range of issues such as whether to take a loan, investment for the business or preparation of an emergency fund. The better decisions are often those that are well informed. Although a detailed assessment was beyond the scopes of the study, it may be possible to compare decisions made by entrepreneurs who utilize information technology to those who do not, and an evaluation of which has a greater impact on their relative issues in the long term. This may provide a clearer understanding of what aspects of information technology have the greatest impact on financial literacy.

Discussion

Identification of areas of improvement will enable business owners to focus on specific areas in which they lack knowledge. This can inhibit detrimental decisions being made through a lack of knowledge. In order to compete with large businesses, small businesses need to adopt modern technologies. However, the repercussions of this strategy could be negative if business owners do not have the correct knowledge on how to use financial software tools. This may lead to incorrect record keeping and thus produce inaccurate financial statements. It has been noted that most entrepreneurs have a lack of knowledge on how to approach and use IT effectively. Through the automation of financial tasks, it is essential for entrepreneurs to be financially literate in order to carry out the correct interpretation of financial information (Alshebami, & Al Marri, 2022). This supports the argument that the more complex the accounting activities of a business, the greater the level of financial literacy needed.

Financial literacy for entrepreneurs has gained prominence as a significant area for investigation. The financial literacy program has been adopted by most governments, including Durban, South Africa, through the "Financial Literacy Strategy of Small Businesses Utilizing Information Technology within Umhlathuze Municipality." The findings of the study are expected to aggrandize the awareness of financial literacy as an essential element for the success of small businesses.

Implications of the Findings

A very interesting result we found was that the younger and more highly educated entrepreneurs displayed a lower tendency to apply for financing as well as a lesser need for further training in financial matters, whereas the older and less educated entrepreneurs showed a higher tendency to both apply for financing and have a need for training. This is contradictory to the assumption that the younger and more educated would have a higher need to acquire resources as well as enhance and make use of their financial literacy to ensure the success of their businesses. This result requires further investigation, however with regards to the entire study what this suggests is that the financial literacy strategy for small businesses need to be aimed towards the older and less educated entrepreneurs, without discouraging the younger and more highly educated entrepreneurs from doing so. In any case, improvement in the financial literacy of all small business entrepreneurs can only be beneficial.

One of the key findings of this research is that small businesses often delegate their financial matters to someone else, which often means that they don't have full control over the financial literacy of their

business (Benedic, 2024). This finding is rather alarming given that we know from the literature review that the understanding and use of financial information is crucial for the sustainability, growth and survival of small businesses, but is also consistent with research conducted in both Australia and the United States which showed that small businesses often neglect their financial management duties due to the overwhelming nature of other aspects of their business (Yew Wong & Aspinwall, 2004). What this implies is that there is an opportunity for small businesses within Umhlathuze Municipality to better their financial literacy by taking part in training programs such as the SEDA course, and that the effectiveness and content of the training must be relevant and easy to apply to their own personal business situations. Failure to do so could result in small businesses resorting back to old habits of delegating the finance management role.

Comparison with Previous Studies

In the context of small businesses, no other studies were found which utilized exactly the same strategy. Hence, the study's findings could not be compared directly with another similar research. However, the study's findings indicate several comparisons with studies involving similar strategies on different topics. The key similarity between this study and other literacy strategies is the strong indication of cause and effect between the introduction of the strategy and an increase in knowledge and understanding. Most studies involving a literacy strategy refer to literacy as learning, knowledge, and understanding in a particular area. Knowledge and understanding are broad terms but are directly related to the daily tasks involved in running a small business. The strategy usually takes the shape of a skills mix and an increase in resources to provide a certain level of knowledge and understanding to all. This also applies to a Cronbach and Associates research model from 2001, which states that training employees to use IT is the most significant IT innovation to apply in an organization. This can be directly related to the strategy undertaken by SMBs in that IT training for employees will be the first step, aiming to increase employee knowledge and use of IT in order to progress in the literacy levels outlined in the key findings. This is supported by the strong indication of perceived changes, in that before and after the strategy, there was a significant change in employee IT knowledge and understanding. Though this wasn't the main focus of the strategy, a mix of personal and working IT use has forced employees to increase IT literacy in order to do tasks. This also indicates some form of informal learning, which according to Hamilton's 2006 research, is a key feature of literacy learning in that employees could be picking up IT knowledge and skills in their own time, which is directly related to work-related tasks. This change was evident at all levels of literacy and is an indicator of the strategy having an effect across the whole organization.

Limitations of the Study

There were numerous limitations to this study, the most prominent being time and access to businesses. The time given to conduct the research was not enough to collect substantial quantitative data as some businesses did not have accountants to take part in the questionnaires, and this led to many questionnaires being handed out but not completed. The time constraint also forced the researcher to use a non-probability sampling method, which may have questioned the representation of the population, as those who did not respond to the questionnaires may have had different results. The use of a non-probability sampling method may have led to some of the smaller businesses being under-represented as they could not afford an accountant, and the larger business might have been over-represented. The response rate to the questionnaires also caused a major limitation, as more than 50% of the questionnaires handed out were not returned or incomplete. This led to the data collected not being as accurate as anticipated.

Access to businesses was another major limitation, with the most significant aspect being the fact that some accountants did not take part in the semi-structured interviews. This was due to a variety of reasons ranging from either the accountant just did not have the time to take part or a failure to call back and arrange a time for the interview. This limited the researcher to only three interviews that were conducted. Another aspect of lack of access to businesses was the fact that many businesses who were targeted to participate in the study had changed details or were not operating when the researcher had come round

to give them the questionnaires. This had a follow-on effect on the questionnaire response rate in that many questionnaires remained uncompleted.

Conclusion

Summary of Findings

Financial literacy of small businesses in the study appeared to be at a low level. This is evident from the fact that almost all the owner-managers use on-the-job learning and external consultants to increase their financial knowledge. Generally, they were not interested in educating themselves for the sake of it because they believed time is money. There appeared to be an overconfidence effect in their competence with managing the finances of the business. They scored themselves higher than we scored them for their ability to perform such tasks as record keeping, financial statements analysis, and ratio calculation. This has strong implications because overestimation of ability can lead to failure to seek help and subsequently poor decision making. Many felt that their banks did not understand their businesses and were not meeting their needs. This concurs with the debt and equity issues of the businesses. The small businesses were more inclined to use debt as a financing option, yet they perceived it as less available. The debt users' debts were usually unsecured, and they had difficulty in obtaining finance, so they used their personal assets or distributed profits. On the whole, the owners did not like owing money, and they were risk-averse. This is not necessarily a bad thing, but the debt users were not making risk-return considerations compared to equity users, and it is possible that a cost of debt capital was not determined. This should be a point of focus for improving financial literacy. The overall situation at present is damaging to these businesses because they are not using the most suitable finance mix in capital structure, and they are not making informed investment decisions. This is impeding potential business growth.

Recommendations for Small Businesses and Policy Makers

The most significant recommendation to small businesses resulting from this research is that technology should be utilized as a means to better understand the customer and not only to increase profit. The method of surveying the residents using the website will fulfill this recommendation. It will enable the company to build a better understanding of the local residents and their needs and, in turn, will be an aid to making more informed decisions. This too will change the way in which the products or services are marketed and how the company will go about reaching the residents.

Internal training should be conducted from time to time on Financial Literacy. This can be done by employing a Financial litrate person or inviting an external financial expert to do this.

Areas for Future Research

The impact of IT on firm performance can vary between different types of IT and firm environment. The current research considered all forms of IT as equal, and the firm environment was regarded as a single collective variable. A more intricate study would disentangle the complex relationship between IT and firm performance and identify the moderating and mediating factors. An interesting study would be to follow a sample of traditional business owners who intend to adopt IT over a period of time. This observation of IT adoption would also be able to track changes in business performance over time.

Lack of financial management and business knowledge was identified by the business development agency as the main reason that businesses fail. This highlights the importance of understanding the knowledge levels of the business owners and their commitment to enhancing their financial skills. An in-depth study of the financial knowledge of the business owners would provide insight into the services most needed by the small business community.

The areas highlighted for future research in this paper provide a framework for extending the current research into a larger scale with more diverse and complex variables. It is important to note the limitations of the current study and areas which can be improved upon to provide a more comprehensive understanding of the impact of financial literacy strategy and IT on firm performance.

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Productivity of Employees within a hybrid Work Ecosystem

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Keywords
Employee productivity, Work environment, Training and development, Work models, Employee motivation and Technology

Abstract

***Purpose of the research**: The focus of this study pays critical attention on the new norm in the work environment, investigating how the workplace has change drastically and the employee behaviour has also been influenced by this so-called change. The productivity of employees within the organisation has also taken a new turn. Therefore, investigating the influence, actions and reactions of both the employees and organisations to this change has become extremely pivotal to this study. The literature review of indicated the evolving nature of the topic due to the fact that the topic is somewhat new, adapting sunders research onion explain the methodology.*

***Methodology**: This research is quantitative Mono-method and Primary data collection engaged the participation of a sample size of 50 respondents that will include managers and employees. From data collection to analysis, Saunders research onion is adopted to explain in detail, each layer of the onion as applicable the research topic. The research onion may not be perfect but contributes immensely in making holistic decision in research methodology design and details.*

***Findings**: This investigation indicated that the introduction of new productivity tools in a hybrid work environment amounted to personal development, effectiveness and growth among employee and management, with work environment being reinvented, motivation, job development and technology. Also, the post-pandemic workplace is more technological and has a very wide depts of new and updated productivity tools in line, calling for more training and of employee to attain efficiency.*

***Implications Practical**: The findings of this studies imply that the adoption of new productivity tools promotes job effectiveness of employees, promotes job retention, and build motivated and relevant workforce. Therefore, employees are able to work well under any when they are adequately equipped with the right technology.*

***Conclusions**: The study concluded that productivity tools are essential to the productivity of employees and organisational effectiveness. However new technology requires training to enhance the fluidity of employee workflow and keeps the organisation relevant.*

Introduction

This shift from traditional workplaces has been extensively studied and documented, with research conducted by Waheed and Jam in 2010, Hanaysha in 2016 and Kurter in 2020. The idea of remote work was first proposed by Jack Nilles, a former NASA engineer, in his book "The Telecommunications-Transformation Tradeoff" in 1972. Nilles suggested remote work as a solution to traffic congestion and conservation. Remote work model has become an increasingly popular form of work in recent years, and experts have defined it in various ways.

This research discusses Productivity of Employees within a hybrid Work Ecosystem and the adaptation of flexible but workable work patterns looking at technology that empowers a balance corporate responsibilities and personal commitments. Pre-pandemic, companies like GitLab Automattic, InVision, Buffer, Zapier, Toggl, Doist and Scrapinghub were either predominantly remote or fully remote (Belzunegui-Eraso and Erro-Garcés, 2020). Significant aspect of daily model for operation. However, in recent time remote and hybrid have become intricately woven into the fabric of the present-day organisations, institutions and businesses, including Government establishments and agencies. The dynamics of the Productivity of Employees within a hybrid Work Ecosystem as the topic implies, thrive

on the following key elements: the workplace flexibility, leadership support, technology and work design, motivation, social capital and work-life balance. The interaction of these elements creates the environmental dynamism navigation for employee in a hybrid work setting.

The employee productivity ecosystem is extensively characterised by the incorporation of technologies built for collaboration and work process efficiency that support Hybrid work settings, emphasising team performance and collaboration within the office and virtually (Bladen, 2022). Within this ecosystem, job design and motivation playa an important role also in the in structuring of employee productivity, performance and engagement. The hybrid work environment requires management support and leadership as key element in the creation of supportive hybrid work environment that is inclusive. Having a vibrant leadership approach that is supportive with clear communication and the right resources are pivotal to the employee well-being and productivity boost (Hopkins and Bardoel, 2023). In addition, Productivity of Employees within a hybrid Work Ecosystem values employee well-being as integral fibre for the sustainability of productivity and job satisfaction in the hybrid work setting, hence work-life balance.

The multifaceted nature of hybrid work ecosystem and environment must be carefully considered flexibility within the workplace, collaboration, technological infrastructure, wellbeing, leadership support, and employee motivation to ascertain increase productivity of employees within the hybrid work model (Kohll, n.d.).

Literature review

Literature review establishes the research topic through analysis. The research aim, discussion the research topic, analysis of research papers, opinion of diversity of authors, praised and adopted in relation to the topic from different perspectives (Antonio, n.d.).

lifestyle and work-related characteristics

An Austrian research team conducted an online survey to analysed how COVID-19 mitigation measures have affected Austrians' lifestyle and work-related characteristics. The survey was conducted during a three-week period from June 3 to June 23, 2020. This study included 1,010 participants who were chosen randomly from an online panel (Hopkins and Bardoel, 2023).

The panel was meticulously sampled to ensure that it accurately represented the overall population of Austria in terms of age, gender, and county distribution. The purpose of the survey was to gather data on various aspects of the Austrian population and to provide insights into trends and patterns that can inform decision-making in business and academic settings. The survey results are expected to be highly valuable for researchers, policymakers, and other stakeholders interested in understanding the characteristics and preferences of the Austrian population. The participants rated any significant lifestyle and quality of life changes on a 5-point Likert scale. They perceived productivity during the COVID-19 mitigation period (March 16 to May 1, 2020) compared to before the pandemic. The scale ranged from "decreased importantly" to "increased importantly". The survey results reveal how COVID-19 measures affected Austrians' lifestyle and work. (Weitzer et al., 2021).

The Interrogate survey comprised 81 questions and lasted around 30 minutes. According to Weitzer et al. (2021), a survey was conducted to explore various topics, such as fluctuations in quality of life and productivity, factors responsible for positive and negative changes in quality of life, and the impact of working from home on changes in quality of life and perceived productivity. The survey results provide insights into the relationship between these variables. (p. 5).

The remote nature of Hybrid work setting

The pervasive adoption of digital technology, coupled with the rapid progress made in the field of information and communication technology, has significantly impacted the quality of work and personal life (McGregor and Bergmann, 2022). As a result, businesses and organisations have had to adjust their operations to remain competitive and relevant, while individuals have had to adapt to new ways of working and communicating. In light of recent changes, benefits and challenges have emerged, necessitating a continuous pursuit of innovation and adaptability to remain at the forefront of progress

(Bladen, 2022). In order to stay ahead of the curve, it is imperative that we embrace a culture of agility and flexibility, one that enables us to effectively respond to the ever-evolving landscape of the business or academic environment. With this in mind, we must remain vigilant in our commitment to excellence, constantly seeking new and innovative solutions to the challenges we face, while also recognising and capitalising on the opportunities that arise

(Hopkins and Bardoel, 2023). By putting in a deliberate effort to keep ourselves updated with the latest developments in our industry, we can guarantee that we keep on making impactful contributions to the progress of our sector (Morrison, 1994).

Additionally, we can also provide exceptional value to our customers or stakeholders. These findings have been supported by studies such as Elshaiekh et al. (2018) and Shahbaz et al. (2016), highlighting the impact of technology on various aspects of society. The emergence of Wi-Fi and internet-based tools has revolutionized the way people communicate and collaborate. These tools have enabled workers to seamlessly connect from remote locations, saving time and costs associated with in-person meetings and travel. Remote work has become more efficient and productive with the help of these tools. Recent research conducted by AlMarar et al. (2021) shows the significant impact of Wi-Fi and internet-based tools on modern workplaces. The availability of collaborative tools has revolutionised the way workers share information in real-time, regardless of their physical location (Kohll, n.d.).

A recent study underscores the advantages of these tools, which have facilitated an environment where workers can stay connected and collaborate effectively without the constraints of physical boundaries. In recent years, cloud services have gained immense popularity. This technology allows individuals to access work applications and tools from anywhere, thereby leading to the emergence of remote work, telework, and work from home (WFH) as viable alternatives to traditional workspaces (Ali et al., 2010; Monteiro, Straume & Valente, 2019).

In 2020, remote work gained even more significance The World Health Organization (WHO) has announced the COVID-19 outbreak to be a global pandemic. The illness is caused by a new strain of the coronavirus. This has had a major impact on public health and the global economy. According to the latest reports, millions of people worldwide have been affected by the pandemic, which continues to present a significant challenge to medical professionals and researchers. The World Health Organisation, along with other healthcare organisations, worked tirelessly to prevent the further spread of the virus and create a successful vaccine. As a result of lockdowns and regulations across countries, organizations had to adapt their business practices, and governments implemented measures to protect public health and prevent the virus from spreading. Employees were subsequently required to work from home (Bladen, 2022).

The definitions

According to the International Labour Organisation (2016), remote working refers to a type of work where individuals carry out their duties in a location separate from the central office or production facilities. This separation from co-workers allows for the use of new technology to facilitate communication. On the other hand, Elshaiekh et al. (2018) define remote working as a flexible work plan that enables employees to perform their duties from a worksite other than the company's premises, where an employee would typically report for work. Remote work is ideal for jobs that require output-based monitoring, independent work, and minimal face-to-face contact (Weitzer, J. et al. (2021) In a global economy, the efficiency of business operations is more critical than physical location (SHRM, 2021).

According to Cambridge English, teleworking refers to a work arrangement where an employee performs their duties remotely from their home, communicating with their employer and clients through phone or email (Rañeses, et al. 2022). This setup has recently gained popularity due to its numerous benefits, such as increased productivity and reduced commuting time. A study conducted by Ghanbari and Bakhtjoo (2017) identified three critical key factors for optimizing the benefits of remote work. These factors are people, process, and infrastructure. The people involved in remote work play a critical role, including stakeholders who are directly impacted by the work. Team members are responsible for managing different work-related tasks and technology assignments. The process factor addresses various questions related to remote work, such as what work needs to be done, what is the best way to complete it, and how remote workers will be assessed (Novotny, 2004). Policies and procedures should be

established to manage or control remote working processes, including time management, information management, and virtual organizational structures. Infrastructure is also critical in facilitating remote work. This includes the technological and physical aspects, particularly communication tools such as the Internet, messaging platforms, email, and other communication channels (Walker, 2006).

The key elements of the hybrid work ecosystem

Flexibility in the workplace

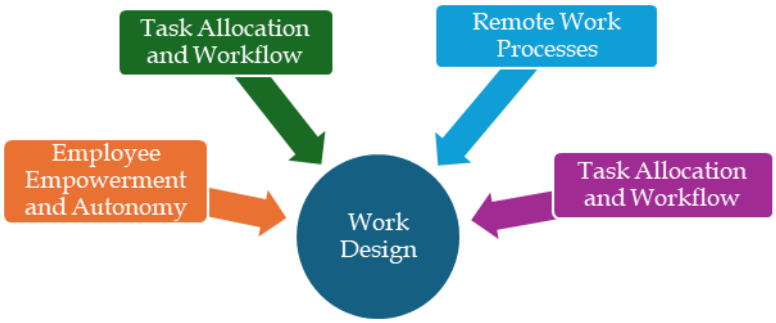
Flexibility in the workplace gives the employees the power to choose where, when, and how they work (Choudhury et al., 2024). In a hybrid work ecosystem, this flexibility allows employees to work from the office, from home, or from other remote locations (Kelly and Moen, 2007). This enables the employees to adjust work schedules to give room for personal responsibilities. With flexible work hours, employees are able to better their productivity. Working from different locations creates a balance in a hybrid work setting. According to Gajendran and Harrison (2007), workplace flexibility is extremely significant, as it enhances job satisfaction, creates a good work life balance that improves the well-being of employees. Stipulating the positive effect of flexible work pattern on the job attitudes contribute to a more robust levels of employee productivity and employee engagement (Petani and Mengis, 2023). The flip side of this is that the challenges of remote work environments post-pandemic can create professional isolation that may occur affecting job performance due to lack of effective communication-enhancing tools and face-to-face interactions mitigation (Song et al., 2022).

The role of technology in employee productivity

The contribution of technology in employee productivity plays an immense role in the enabling hybrid work ecosystem success (Jaiswal and Prabhakaran, 2023). Technology integration enabled effective communication, task execution and collaboration within a hybrid work arrangement. The digital collaboration tools such as project management software, virtual conferencing platforms, and other digital solutions enables seamless collaboration and communication for hybrid employees (Tang et al., 2024). Slack, Microsoft Teams, and Zoom, are essential for facilitating seamless communication and collaboration among remote and in-office employees. Features like screen sharing, virtual whiteboards, and breakout rooms facilitate interactive and productive meetings, bridging the physical gap between remote and in-office employees. as Asana, Trello, and Jira, plays a crucial role in organizing tasks, tracking progress, and managing workflows in the hybrid work setting. The use of technology effectively allows the employees to work efficiently in a hybrid work setting, gain access to resources needed wherever the location (Zenger and Folkman, 2022).

Work Design

Work design involves structuring job roles, tasks, and responsibilities in a way that optimizes productivity, engagement, and well-being (Yang et al., 2022). In the context of the hybrid work ecosystem, effective work design encompasses the organization and allocation of tasks, the establishment of clear workflows and processes, and the consideration of job demands and the working environment. A well-designed work structure ensures that employees can perform their roles effectively, regardless of their work location, and supports their professional development and growth. Work design involves the strategic structuring of tasks, workflows, and processes to accommodate both remote and in-office work, ensuring optimal performance and collaboration. Grant, A. M., & Ashford, S. J. (2008) explores proactive behaviours and the influence of new adaptation within the organisational, focusing on the relevance of work arrangements and integration (Edleston, 2023). This study explores proactive behaviours and their influence on newcomer adaptation within organisational contexts, showcasing the relevance of adaptive work behaviours in the context of flexible work arrangements and newcomer integration (Dufour et al., 2021).



Social Capital

The networks, relationships, and social connections within an organisation is known as social capital which contributes to the effective success and functionality of organisations (Yang et al., 2022). Steigenberger, N., Wilms, K., & Schermuly, C. C. (2021) explores the effects of video-mediated communication on team trust formation, shedding light on the role of virtual interactions in building social capital and trust within distributed teams post-pandemic. Within the hybrid work ecosystem, social capital maintains the team collaboration, cohesion and effective communication in a hybrid work model as social capital supports team-building activities that foster strong relationships among employees (Teng-Calleja et al., 2023). A good social capital creates a positive work culture, enhances collaboration, and supports employee well-being. Building a strong social connections and network within a team of employees contribute immensely to the creation of a cohesive work environment that enhances productivity within hybrid place. The role of social networks in the creation of entrepreneurial capital, shedding light on the relevance of social connections and network resources in facilitating innovative and collaborative outcomes within hybrid work settings cannot be over emphasised (Evans, 2021).

Employee Motivation

Motivation as a key driver of employee performance and engagement. Kniffin, K. M., Narayanan, J., Anseel, F., Antonakis, J., Ashford, S. P., Bakker, A. B., Bamberger, P. A., Bapuji, H., Bhave, D. P., Choi, V. K., Creary, S. J., Demerouti, E., Flynn, F. J., Gelfand, M. J., Greer, L. L., Johns, G., Kesebir, S., Klein, P. G., Lee, S. Y., Ozcelik, H., ... & Vugt, M. V. (2021) discusses the implications of COVID-19 on workplace dynamics, addressing issues related to motivation, well-being, and future research directions, providing insights relevant to post-pandemic hybrid work environments (Kniffin et al., 2021). In the hybrid work ecosystem, maintaining high levels of motivation among employees is essential for sustaining productivity. This involves understanding individual and collective motivators, providing meaningful work, setting clear goals, and offering recognition for achievements. Deci, E. L., Olafsen, A. H., & Ryan, R. M. (2017) also view motivation from the standpoint of Self-Determination Theory within work organisations, highlighting the application of the theory in understanding employee motivation, engagement, and performance, particularly within the context of remote and hybrid work environments (Deci et al., 2017). Leaders and managers play a pivotal role in cultivating motivation by creating an inclusive and supportive work environment, empowering employees, and aligning individual goals with organizational objectives. Deci and Ryan's Self-Determination Theory (2000) highlights the significance of intrinsic motivation, autonomy, and competence in enhancing employee engagement and well-being to increase and sustained productivity hybrid work context.

Research methodology

This research is quantitative Mono-method and Primary data collection engaged the participation of a sample size of 50 respondents that will include managers and employees. From data collection to analysis, Saunders research onion is adopted to explain in detail, each layer of the onion as applicable the research topic. The research onion may not be perfect but contributes immensely in making holistic decision in research methodology design and details. Saunders research onion is engaged in this methodology from data collection to analysis, highlighting the methodology and describes the process of the research **Saunders' (2007)**

Philosophical resolve is positivism, Research Strategy (Methodological Choices), survey is select and more appropriate in this study, to investigate the productivity dynamics of hybrid work ecosystem. Research Choices is quantitative with deductive Approach. **Time horizon** is cross-sectional, and **Techniques and procedures** is data collection method and analysis (with random sampling) (Jansen, 2021). By using the Research Onion model, the research is systematically aligning with philosophical principles, and the nature of data collection and analysis which helps in developing a comprehensive and coherent research design that accommodates the dynamics of the hybrid work ecosystem.

Findings

The study indicated that hybrid work settings are the future of work about 70% of the survey participants are pleasantly very satisfied. The however indicated that the employees are motivated and productive with the advent of the This investigation indicated that the introduction of new productivity tools in a hybrid work environment amounted to personal development, effectiveness and growth among employee and management, with work environment being reinvented, motivation, job development and technology. Also, the post-pandemic workplace is more technological and has a very wide depts of new and updated productivity tools in line, calling for more training and of employee to attain efficiency. The primary findings of this research and secondary sources of data explored the integrated approach. This gives a clearer view on the impact of productivity of employees within a hybrid work ecosystem with technology in the nucleus of productivity within the organisation. Ultimately, the findings show that employees are better equipped to carry our corporate duties with the introduction and provision of new productivity enhancing technology also designing training packages that ultimately enhances and implore employee productivity within an organisation.

Discussions and conclusions

The findings of this studies imply that the adoption of new productivity tools promotes job effectiveness of employees, promotes job retention, and build motivated and relevant workforce. Therefore, employees are able to work well under any when they are adequately equipped with the right technology. This investigation indicated that the introduction of new productivity tools in a hybrid work environment amounted to personal development, effectiveness and growth among employee and management, with work environment being reinvented, motivation, job development and technology. Also, the post-pandemic workplace is more technological and has a very wide depts of new and updated productivity tools in line, calling for more training and of employee to attain efficiency (Oppong Peprah, 2023).

Limitations and direction for future research

The findings of this research indicated that limitations to consider in the research on the productivity of employees within a hybrid work ecosystem and addressing these limitations through careful study design, data collection strategies, and analytical approaches can strengthen the validity and relevance of the research findings. In this research however, the primary data is framed to the sample size. The pandemic which gave rise to the rapid evolution of remote work practices and technologies may impact the relevance of findings over time and productivity vary based on the nature of work, organisational culture and individual preferences, making it challenging to draw universal conclusions. Recognising these limitations is essential for designing robust research methodologies and interpreting the results effectively. Data privacy and security concerns are sensitive to productivity when working remotely, impacting data collection and analysis indicating the productivity of employees within a hybrid work ecosystem has improved creativity, technological Knowledge and team innovation by more than 60%, over 75% indicated employee productivity increase.

The secondary data is limited due to the newness of the topic and for the future researchers, the investigation will be more robust as the topic grows by the year and the conducting the research with a larger number of employees will create a more comprehensive coverage (Hopkins and Bardoel, 2023). The disparities in access to reliable technology and internet connectivity among employees may affect the consistency of remote work experiences and productivity levels. Managerial styles and support for remote

work arrangements may introduce confounding factors that influence productivity outcomes. Productivity measurement within a hybrid work ecosystem may pose measurement challenges and complicate comparisons in diverse roles and industries. Poor employee well-being may cause a draw back for employee productivity since isolation can degenerate to mental breakdown

(Hopkins and Bardoel, 2023). Organisational Policies and Practices is the support structure that upholds remote or hybrid work and may also bring about inconsistencies in employee productivity measures and experience. Distractions forma a major obstacle in a remote work environment and can also affect hybrid work arrangement since they both have similar pros and cons. This may affect productivity immensely, although differing from one individual to another thereby influencing outcome of the study. Considering these potential limitations can guide researchers in designing comprehensive methodologies and interpreting the results within the appropriate context.

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The mediating role of risk tolerance in the relationship between behavioural factors of small investors and investment decisions in the saudi stock market.

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Keywords
Behavioural factors, small investors, financial investment decisions, risk tolerance, Saudi stock market

Abstract

The aim of this study was to examine the mediating role of risk tolerance in the relationship between behavioural factors of small investors and investment decisions in the Saudi stock market. A random sample of small investors in the Saudi stock market was selected, with a sample size of 384 investors. Descriptive statistical methods such as mean, standard deviation, and frequencies were used to describe the study variables, and the mediation regression analysis was employed to test the study hypotheses.

The main findings of the study revealed that individual investors' risk tolerance acts as a partial mediator in the relationship between behavioural factors and investment decision-making in the stock market. There is a significant relationship between the behavioural factors of small investors and their ability to make investment decisions in the Saudi stock market. Additionally, there is a significant relationship between risk tolerance of small investors and their investment decisions in the Saudi stock market.

Based on the study findings, several recommendations were proposed, including the consideration of behavioural factors and risk tolerance of small investors by brokers and financial advisors in the Saudi stock market when providing advice and guidance on financial investments. They should also provide information based on accurate securities analysis to facilitate sound investment decisions in the Saudi stock market.

Introduction

The investment decision is one of the crucial decisions for the individual investor, as the investor's success and survival within the capital market depends on the accuracy of the investment decision taken. It has been shown that individual investors' investment decisions are affected by their personal characteristics, cognitive levels, and emotional biases, in addition to a group of demographic factors (Al-Najjar, 2017). Investment decisions in the stock markets are equally important for small investors, as there are many factors that can influence the buying or selling decisions that investors make when dealing in securities. Therefore, investors, especially small investors, which is the subject of the study, must take into account many factors. Which would influence their investment decisions, as these factors may be external, over which he has no control (Hussein and Khudair, 2013).

Many researches in the field of behavioural finance have shown that there is a group of psychological and social factors that affect the investment decisions of investors, which may lead to deviations in investor behavior. These deviations in investor behavior are called behavioural biases. The main reason for the emergence of these biases in investor behavior is due to... The attitudes and emotions of individuals differ from each other. On the other hand, individual investors represent the category most vulnerable to being affected by these behavioural biases than other institutional investors, as they may not have sufficient information about the market and may not have the ability to analyze this information. They do not rely on the specialized scientific methods that institutional investors rely on. On the contrary, institutional investors have enormous resources and professional teams to collect and analyze information and make trading decisions based on specialized knowledge. Therefore, they have the greatest ability to make investment decisions that are characterized by rationality and independence in order to achieve appropriate rates. of profits (Al-Badawi, 2016).

Research problem:

Securities prices are affected by the decisions of individual investors within the financial markets. Small individual investors within the Saudi stock market are distinguished by their privacy, which is governed by general economic conditions, in addition to the fact that there is a prevailing investment culture, which requires a study of the conditions of behavioural factors and their impact on small investors' investment decision-making and special factors. Within the capital market, by focusing on behavioural factors, as most studies aim to study and explore the impact of behavioural factors on investors' decisions (Hamada, 2022; Al-Najjar, 2017). Accordingly, the problem of the study is to answer the following main question: What is The Mediating Role of Risk Tolerance in the Relationship between Behavioural Factors of Small Investors and Investment Decisions in the Saudi Stock Market?

Research Hypotheses

Considering the research problem and objectives, the research hypotheses can be formulated as follows:

- H1- There is a statistically significant effect of behavioral factors on investment decision-making for small investors in the Saudi financial market.
- H2- There is a statistically significant effect of behavioral factors on the risk acceptance of small investors in the Saudi financial market.
- H3- There is a statistically significant effect of the extent of risk acceptance on investment decision-making for small investors in the Saudi financial market.
- H4- There is a statistically significant effect of the extent to which small investors accept risk in the relationship between behavioral factors and investment decisions in the Saudi financial market.

Objectives of the Research

The objectives of the research are to identify

- The four behavioral factors for small investors in the Saudi capital market.
- The level of investment decisions of small investors in the Saudi financial market.
- The level of risk among small investors in the Saudi financial market.
- The impact of the level of risk tolerance of small investors on the relationship between the behavioral factors of these investors and their investment decisions in the Saudi financial market

Theoretical framework

The Saudi stock market, known as "Tadawul," was established in 1985 and has become one of the largest stock markets in the Arab region (Alshammari, Citationm 2021). It has experienced rapid growth in recent years, reaching a market capitalization of $2.6 trillion by the end of 2022. However, stock market bubbles are notorious for their detrimental effects on investments and the overall economy. In financial economics, a bubble occurs when an asset's trading price deviates systematically from its fundamental value (Almansour & Elkrghli, 2023).

Determinants of Investment Decision-making

The investor usually looks for high returns in the levels of risk and return to come up with a right investment decision. Risk is categorized according to their source as the following (Kingdom of Saudi Arabia Capital Market Authority):

1. Business Risk: It is the risk that comes from the nature of the industry.
2. Economic Risk: It is the risk resulting from changes macroeconomic factors such as rates of unemployment, inflation, government spending, budget deficits and so on.
3. Interest Rate Risk: It is the risk resulting from changes in interest rates in the financial system of the economy.
4. Exchange Rate Risk: The risk stemming from changes in currency exchange rates. Usually, companies working in the business of importing and exporting are more influenced by this type of risk.
5. Liquidity Risk: The risk arising from the possibility of converting investment into cash (liquidating it).

One of the important principles that the investor must adhere to when making an investment decision is that information is the main and decisive element in decision-making. Information is what enables him to judge the feasibility of the investment, its suitability to the investment objectives, the risks

to which he may be exposed, and the return he can obtain and benefit from the information. It depends on the investor's technical ability to analyze data, otherwise he must resort to specialists and experienced people to seek guidance from their technical advice and opinions (Kadawi, 2008).

Information plays an extremely important and vital role when making an investment decision, provided that this information is correct and accurate, which is what the law requires and what the rules and regulations governing the stock market require. It is provided through disclosure tools such as the subscription prospectus, financial statements, annual reports, and others (Hamada, 2022).

Factors influencing investment decision-making.

Behavioural finance recognizes that individuals' cognitive biases and emotional responses can influence their investment decisions. Risk perception, in this context, serves as a crucial intermediary variable that helps explain how individuals perceive and interpret risks, which subsequently affects their investment decisions.

studies (Saleh, 2014) indicate that the investment decision is linked to the psychological and emotional factors of the individual investor. In applied studies conducted by the American psychologist Daniel Kahneman, it was found that people view the loss of money in a different way than they view the loss of any other material thing, even if Its value was equal to the value of the lost money.

According to studies, behavioural finance theory believes that emotions influence the mind when any financial crisis begins, so companies must first look at the extent of dealing with the risks that the customer can bear before he loses his money and build his financial portfolio. This is behavioural finance, which changes investors' actions into decisions that are manipulated by emotion, fear, and other psychological reasons. Proponents of behavioural finance believe that financial markets sometimes do not have information efficiency (Al-Najjar, 2017).

The History of Behavioral Finance

The concept of behavioral finance dates to 1912 when George Seldon published "Psychology of the Stock Market." However, the theory gained popularity and momentum in 1979 when Daniel Kahneman and Amos Tversky proposed that most investors tend to make decisions based on subjective reference points rather than objectively choosing the best option. Behavioral finance is based on the alternative notion that investors, or at least a significant minority of them, are subject to behavioural biases that mean their financial decisions can be less than fully rational. Evidence of these biases has typically come from cognitive psychology literature and has then been applied in a financial context (Byrne & Gifford, 2008).

Behavioural finance also challenges the use of conventional utility functions based on the idea of risk aversion. For example, Kahneman and Tversky (1979) propose prospect theory as a descriptive theory of decision making in risky situations. Outcomes are evaluated against a subjective reference point (e.g., the purchase price of a stock) and investors are loss averse, exhibiting risk-seeking behaviour in the face of losses and risk-averse behaviour in the face of gains.

Many investors tend to follow the crowd or exhibit overconfidence biases when making investment decisions. This herding behaviour stems from investors' low-risk propensity or risk avoidance, driven by their desire to minimize the risk of financial loss (Dickason et al., Citation, 2018). During herding, individuals who are otherwise rational start behaving irrationally by relying on the judgments of others. This behaviours may stem from a lack of investment knowledge or the inclination to follow the opinions and directions of others (Wattanasan et al., Citation, 2020). Financial behaviour is of great importance which is manifested through the investors' decisions in the financial market that plays an important role in defining the market trend, which then influences the economy in general. Financial behaviour directly affects the development of the financial system and the increase of the competitiveness of the financial markets (Gorshkova & Ksenda, 2020). It is reasoned that willingness to change financial behaviour may play a pivotal role in the emotional and cognitive experiences associated with decisions and financial hardship (Fiksenbaum, Marjanovic & Greenglass, 2017).

Financial behaviour is associated with one's responsibility regarding their way of managing his investments, and that financial culture for investors has an influence on financial behaviour (Andarsari & Ningtyas, 2019). The quality of information source has an impact on investor behaviour as a piece of news

reliable may lead to more trading than from a less trustworthy one. So in behavioural finance literature, a few studies have modelled the trading behaviours of investors based upon the insights taken from psychology (Tauni, Fang, & Iqbal, 2016). Good investment decisions can lead to high returns and long-term growth for investors, while poor investment decisions can result in significant losses. For this reason, investors must carefully research and analyse different investment options before making a decision.

Behavioural Theory

Behavioural finance psychology has explored various levels of rationality and irrational behaviour in which individuals and groups may act (Ritter, 2003). Here are some theories regarding the behaviour of the investor that explain the factors that affect his decisions in the stock market:

- **Regret Theory:** this theory deals with the emotional reaction investors experience after realizing they have made an error in their evaluation and then their decision, faced with the prospect of selling a stock, investors become emotionally affected by the price at which they purchased the stock (Forgel & Berry, 2006).
- **The Theory of Overconfidence** affects investor decisions and risk perception, causing investors to underestimate risks and exaggerate their ability to control events (Strong, 2006).
- **Over/Under Reacting Theory**: It says that investors get optimistic when the market recovers. On the contrary, investors become extremely pessimistic when the market goes into recession. A consequence of anchoring is an over- or under-reaction to market events which results in prices falling too much on bad news and rise too much on good news (Hong and Stein, 1999).
- **Herding Theory**: It is the behavior of an individual who gives up his decision in favor of the group. Herd theory is the economic theory about the stock market, the stock market is reflected by this theory especially when declining markets collapse as investors get Hysterical selling out of fear of loss and the loss of their capital which is called" herd sale "(Shleifer, and Vishny, 1997).
- **Risk Perception**: It is the subjective judgment that people make about the characteristics and severity of a risk. Risk perception refers to people's judgments and evaluations of hazards they are or might be exposed to (Ricciardi, 2004).

Literature review

Behavioural Factors Influencing Investment Decision Making Investment decision-making is a very difficult task. According to (Kannadhasan, 2010) investors must keep themselves updated in multidimensional fields to achieve their desired objectives in business. According to most financial and economic theories individuals act rationally and think about all accessible information for decision-making of investment. However behavioural finance believes that investors act irrationally in the stock market. (Pavabutr, 2002) said investors' psychology, behavioural biases, and emotions lead to systematic errors in the way in which they process their information. Studies done by (Kahenman & Tverseky, 1979 & Waveru, Munyoki & Uliana, 2008) also show that the decisions of investors are affected by behavioural, emotional, and psychological factors. The empirical findings of studies done by (Chen, Kim, Nofsinger & Rui,2005) illustrate that investors make poor trading and investing decisions because of behavioural biases. (Ricciardi and Simon, 2000) also identified many different behavioural factors that affect investment decision-making. However, a study done by (Hunjra , Rehman & Qureshi, 2012) illustrates that behavioural factors have a positive impact on investment decision-making.

Financial behavior is the level of change in the selection of the financing sources in the terms of ownership (Al_Duhaidahawi et al, 2020) Funding sources are divided into owned funding sources Which the owners pay to the organization from the paid-up capital which is the Common stock the other type is borrowed financing these are the loans taken by the owners. The traditional finance theory assumes that investors always make rational decisions based on complete information, but behavioural finance argues that investors are influenced by their emotions, biases, and cognitive limitations (Almansour & Arabyat, Citation, 2017). Financial behavior directly affects the development of the financial system and the increase of the competitiveness of the financial markets (Gorshkova & Ksenda, 2020).

The methodology of research:

The current research follows an analytical descriptive methodology. This methodology consists of a set of procedures, which include:

- **Research Sampling**: The study population consists of small investors in the Saudi stock market, and their number is unlimited. The ideal sample size should be around 384 individuals, based on the equation by Krejcie and Morgan (1970). However, due to time constraints and the refusal of many individuals and brokers to provide investor data (which is legally prohibited), a convenience sampling method was utilized.
- **Data collection tool :**The data collection tool consists of a questionnaire, prepared to gather data related to the characteristics of the study sample and their perception of study variables. The questionnaire is comprised of three parts. The first part includes a set of statements that measure the demographic characteristics of the study sample, such as age, educational qualification, years of experience, income level, and the amount allocated for financial investment in the stock market. The second part of the questionnaire contains a scale of behavioural factors with its four dimensions, according to the scale developed by Al-Najjar (2017). The third part of the questionnaire includes a scale of investment decisions, according to the scale developed by Hamada (2022). Lastly, the fourth part of the questionnaire includes a risk acceptance scale.

Reliability and validity of the study variables measurement.

Reliability of research variables measurements

The Reliability of study variables measurement refers to the consistency or reliability of measurement results when the measurement is repeated, either over different time periods or by using alternative measures to assess the same phenomenon, or when the measurement result is consistent with that of another validated measure. This means that when the measurement is repeated on the same sample, consistent measurements are obtained (Elmokadem, 2020). Additionally, stability indicates the absence of random error in the measurement. A measurement is considered stable if the value of the Cronbach's alpha coefficient (α) is 0.70 or higher (Hair, 2014). Table 1 shows the values of the alpha coefficient for the stability of the study variables.

Table (1): Reliability of Study Variables Measurement

Variable	Dimension	No of items	α
Behavioural factors	Expectations	4	0.655
	Herd Behavior	4	0.877
	Inference	8	0.74
	Market Developments	6	0.659
Behavioural factors			**0.732**
Investment Decisions	Selection	5	0.721
	Timing	5	0.759
	Diversification	6	0.667
Investment Decisions			**0.72**
Risk tolerance		7	0.657
Total reliability			**0.84**

The table indicates that the overall reliability coefficient of the study variables' measurements is (0.840). The reliability coefficient for all dimensions was greater than (0.6) based on the Cronbach's alpha test. This means that the sample respondents' answers were consistent and homogeneous in their response to all dimensions and study variables.

Validity of research variables' measures:

The validity of research variables was measured by assessing the construct validity through the Extracted variance of scale items, ensuring that these items are closely related to the intended variable being measured. A scale is considered to have construct validity if the average extracted variance is 50%

or higher, indicating that the scale items explain 50% or more of the variance in the intended variable. The scale is considered ideal if the extracted variance is 70% or higher. Table 2 illustrates the average extracted variance of the study's variable measures, reflecting the construct validity.

Table 2: Extracted Variance of Study's Variable Measures

Variable	EV
Expectations	52.41
Herd Behavior	63.87
Inference	71.781
Market Developments	75.83
Selection	81.67
Timing	77.24
Diversification	83.33
Risk tolerance	73.33

It is evident that all of the study's variable measures have an acceptable level of interpretive variance. The interpretive variance values for the study's variable measures ranged from 52.41% to 88.61%, indicating that the study's measures have an acceptable level of construct validity.

Hypothesis Testing:

Hypothesis 1: There is a statistically significant effect of behavioural factors on the investment decision-making of small investors in the Saudi stock market.

To confirm the validity of this hypothesis, simple linear regression analysis was employed, and the results of the regression analysis are presented in Table 4:

Table 4: Significance of the impact model of behavioural factors on the investment decision-making of small investors in the Saudi stock market.

Model	R	R^2	adj R^2	F	df_1	df_2	Sig
1	0.641	0.41	0.402	50.831	1	73	0.000

Table 5 illustrates the significance of the elements in the impact model of behavioural factors on the investment decision-making of small investors in the Saudi stock market.

Table 5: Significance of the Impact of Elements in the Model of Behavioural Factors on the Investment Decision-Making of Small Investors in the Saudi Stock Market

	Non standardized parameters		standardized parameters	T	sig
	b	SD	B		
Constant	1.393	0.311		4.48	0
Behavioural factors	0.61	0.086	0.641	8.888	0

Based on the previous analysis, the alternative hypothesis is accepted, indicating that there is a significant effect of behavioural factors on the investment decision-making of small investors in the Saudi stock market. The correlation coefficient is 0.641, indicating a statistically significant relationship between behavioural factors and investment decision-making in the Saudi stock market. Additionally, the behavioural factors variable explains 41% of the variance in the dependent variable, as indicated by the coefficient of determination (R-squared) value of 0.410. This is further supported by the regression model, where the beta regression coefficient (B) is 0.610, with a t-test value of 7.130 and a significance level of 0.000, confirming the impact of behavioural factors on investment decision-making in the Saudi stock market.

The analysis of variance also demonstrates the significance of the relationship in the regression model between behavioural factors and investment decision-making in the Saudi stock market, with an F-value of 78.992, exceeding the critical F-value, and a significance level of 0.000. This indicates the significance of the relationship and the validity of the regression model.

Therefore, the first hypothesis stating that there is a statistically significant effect of behavioural factors on the investment decision-making of small investors in the Saudi stock market is accepted. It is found that a 100% change in behavioural factors leads to a 61% change in investment decision-making. Furthermore, the variation in behavioural factors explains 39.3% of the observed variation in investment decision-making in the Saudi stock market.

Hypothesis 2: There is a statistically significant effect of risk tolerance on the investment decision-making of small investors in the Saudi stock market.

To test this hypothesis, simple linear regression analysis was conducted, and the results of the regression analysis are presented in Table 6 and 7.

Table 6: Significance of the risk tolerance model on the investment decision-making of small investors in the Saudi stock market.

Model	R	R^2	adj R^2	F	df_1	df_2	Sig
2	0.73	0.53	0.526	83.152	1	73	0.000

Table 7: Significance of the elements for risk tolerance in the investment decision-making of small investors in the Saudi stock market.

	Non standardized parameters		standardized parameters	T	Sig
	B	SD	β		
Constant	1.279	0.256		4.988	0
Risk tolerance	0.632	0.069	0.73	9.119	0

Based on the previous analysis, the hypothesis stating that there is a statistically significant effect of risk tolerance on the investment decision-making of small investors in the Saudi stock market is accepted. The correlation coefficient is 0.730, indicating a significant and meaningful relationship between risk tolerance and investment decision-making. The risk tolerance variable explains 53.3% of the variance in the dependent variable, as indicated by the coefficient of determination (R-squared) value of 0.533. This is further supported by the regression model, where the beta regression coefficient (B) is 0.632, with a t-test value of 4.988 and a significance level of 0.000, confirming the impact of risk tolerance on investment decision-making in the Saudi stock market.

The analysis of variance also demonstrates the significance of the relationship in the regression model between risk tolerance and investment decision-making, with an F-value of 83.152, exceeding the critical F-value, and a significance level of 0.000. This indicates the significance of the relationship and the validity of the regression model.

Therefore, the hypothesis stating that there is an effect of risk tolerance on the investment decision-making of small investors in the Saudi stock market is accepted. It is found that a 100% change in risk tolerance leads to a 63.2% change in investment decision-making. Furthermore, the variation in risk tolerance explains 53.3% of the observed variation in investment decision-making in the Saudi stock market.

Hypothesis 3: There is a statistically significant mediating effect of behavioural factors on the relationship between risk tolerance and investment decision-making of small investors in the Saudi stock market.

To test this hypothesis, simple linear regression analysis was conducted, and the results of the regression analysis are presented in Table 8 and Table 9.

Table 8: Significance of the mediating effect model of behavioural factors on the relationship between risk tolerance and investment decision-making of small investors in the Saudi stock market.

Model	R	R^2	adj R^2	F	df_1	df_2	Sig
3	0.556	0.309	0.299	32.637	1	73	0.000

Table 9: Significance of the elements in the mediating effect model of behavioural factors on the relationship between risk tolerance and investment decision-making of small investors in the Saudi stock market.

	Non standardized parameters		standardized parameters	T	Sig
	B	SD	β		
Constant	1.454	0.389		3.740	0.000
Behavioural factors	0.611	0.107	0.556	5.713	0.000

Based on the previous analysis, the hypothesis stating that there is a statistically significant mediating effect of behavioural factors on the relationship between risk tolerance and investment decision-making of small investors in the Saudi stock market is accepted. The correlation coefficient is 0.556, indicating a significant and meaningful relationship between behavioural factors and investment decision-making in the Saudi stock market. The behavioural factors variable explains 30.9% of the variance in the dependent variable, as indicated by the coefficient of determination (R-squared) value of 0.309. This is further supported by the regression model, where the beta regression coefficient (B) is 0.611, with a t-test value of 5.713 and a significance level of 0.000, confirming the impact of behavioural factors as a mediating variable on risk tolerance and investment decision-making.

The analysis of variance also demonstrates the significance of the relationship in the regression model between behavioural factors as a mediating variable and investment decision-making, with an F-value of 32.637, exceeding the critical F-value, and a significance level of 0.000. This indicates the significance of the relationship and the validity of the regression model.

Therefore, the hypothesis stating that there is a statistically significant mediating effect of behavioural factors on the relationship between risk tolerance and investment decision-making of small investors in the Saudi stock market is accepted. It is found that a 100% change in behavioural factors leads to a 61.1% change in risk tolerance and explains 30.9% of the observed variation in investment decision-making in the Saudi stock market.

Hypothesis 4: Risk tolerance of small investors serves as a mediating variable in the relationship between behavioural factors and investment decision-making in the Saudi stock market.

The results of the direct effects in the model indicate that behavioural factors have a direct impact on investment decision-making (0.37) and directly influence risk tolerance (0.58), while risk tolerance has a direct impact on investment decision-making (0.517).

The results of the indirect effects in the model show that behavioural factors have an indirect effect on investment decision-making (0.299) through the mediating variable of risk tolerance.

The overall effects in the model reveal that behavioural factors have a total indirect and direct effect on investment decision-making (0.669), while behavioural factors have an indirect effect on the mediating variable (risk tolerance) (0.665), and the mediating variable has a total effect on investment decision-making (0.451).

The results indicate the presence of a direct effect of behavioural factors on investment decision-making and risk tolerance, as well as an indirect effect of behavioural factors on investment decision-making mediated by risk tolerance. Additionally, there is a total effect of risk tolerance as a mediating

variable on investment decision-making. The significance of the overall effect, direct effect, and indirect effect suggests that the mediating variable (risk tolerance) has a partial mediating effect.

Research results:

The results related to the study hypotheses are as follows: There is a statistically significant effect of behavioural factors of small investors on investment decision-making in the Saudi stock market. - There is a statistically significant effect of risk tolerance of small investors on investment decision-making in the Saudi stock market. - There is a statistically significant effect of behavioural factors of small investors on risk tolerance in the Saudi stock market as a mediating variable. - The risk tolerance of small investors has a significant impact on the relationship between their behavioural factors and investment decision-making. These results are consistent with most previous studies conducted in different contexts. This study corroborates the findings of previous studies, but within the context of the Saudi financial investment environment.

Recommendations

The key practical recommendations are as follows:

– Brokers and financial advisors in the Saudi stock market should consider the behavioural factors of small investors when providing advice and guidance. They can provide education and awareness to investors about the importance of these factors and how to properly assess and analyze them before making investment decisions.

– The relevant authorities in the Saudi financial market should enhance financial education for young individuals and provide necessary resources to develop their skills in understanding behavioural factors and making informed investment decisions. Offering lessons, training courses, and appropriate educational tools can help improve their risk tolerance and make conscious investment decisions.

– Financial companies and investment institutions in the Saudi stock market should work on providing diverse investment options that align with the risk tolerance levels of small investors. Designing products and services targeting this age group and including investment choices that cater to various levels of risk tolerance can be beneficial.

The scientific recommendations are as follows:

– It is recommended to conduct future studies to gain a better understanding of the behavioural factors of small investors in the Saudi stock market and their impact on investment decision-making. The use of longitudinal study design can track individuals over a specified period and assess changes in investment behavior and risk tolerance over time.

– Comparative studies between different age groups, occupations, and social categories of small investors in the Saudi stock market are suggested. These studies can shed light on the differences in behavioural factors and risk tolerance among these groups and provide valuable insights for financial institutions and regulatory authorities.

– Further studies are advised to understand the relationship between behavioural factors and investment performance in the Saudi stock market. Analyzing historical data of stocks, markets, and financial indicators can evaluate the impact of these factors on returns and risk levels in the market.

– The study suggests the development of new tools and measures to assess the behavioural factors of small investors in the Saudi stock market. Existing tools can serve as a starting point, and innovative tools can be developed to measure and analyze these factors in more accurate and comprehensive ways.

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The role of social media for entrepreneurs to drive financial and sustainability goals: a literature review

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Keywords
Corporate Reputation, Entrepreneurship, SME, Global Leadership, Social Media, and Sustainable Development

Abstract
Entrepreneurs are key drivers for economic development and social change based on the United Nations Sustainability Goals (SDGs). However, entrepreneurs often operate with limited resources and face a high failure rate. Social media platforms give entrepreneurs direct access to stakeholders globally to build a corporate reputation and raise visibility for their business and cause. As *entrepreneurs can engage more freely on social media compared to risk-averse leaders of large publicly owned corporations, this offers an opportunity for entrepreneurs to compete with larger organizations and drive change on a global scale. With more entrepreneurs incorporating sustainability as part of their business model, the purpose of this paper is to analyze and discuss how entrepreneurs use social media to drive their company's financial and sustainability goals. The methodology is a literature review of studies in entrepreneurial marketing, global leadership, and digital brand building to serve as a foundation for future studies. The focus is on micro, small and medium sized enterprises (MSMEs). Literature review findings suggested that a founder-led social media presence can be a competitive advantage for entrepreneurs to build corporate reputation and gain support for sustainable development goals. In addition, entrepreneurs use social media to start and finance their business. However, entrepreneurs are facing an increasingly fragmented social media landscape which makes it more challenging to select the best channels to engage stakeholders across different regions. More research is needed on emerging social media channels in Africa, Asia-Pacific, Europe, Middle East, and South America.*

The Introduction

Entrepreneurship is a key driver for socio-economic development and social change (GEM, 2023). Small and medium-sized companies are the backbone of the global economy for their ability to create more than two thirds of employment worldwide (The United Nations General Assembly, 2022). To reflect the entire spectrum of companies, the United Nations uses the term micro-, small, and medium-sized enterprises (MSMEs) (United Nations, 2017). MSMEs contribute to the achievement of the 17 United Nations Sustainable Development Goals (SDGs), especially for SDG 8, the creation of decent work and economic growth, and SDG 9, building industry, innovation, and infrastructure (United Nations, n.d.). Overall, entrepreneurs help tackle key global issues, such as climate change, pollution, and lack of equal access to education, healthcare, and financial resources (GEM, 2023). Purpose driven entrepreneurs are at the forefront of moving to more environmentally friendly and circular business models, with one in two business owners taking steps to reduce their environmental impact (GEM, 2023). However, most entrepreneurs operate with limited resources and have a high failure rate, especially in the first year of their business (Ewing Marion Kauffman Foundation, 2022). One of the challenges of resource-strapped entrepreneurs is to raise awareness for their business and purpose.

Social media platforms, such as Facebook, Instagram, LinkedIn, WeChat, Weibo, and X, give companies and their leaders the ability to engage with stakeholders directly, quickly, and often more cost-effectively (Pakura & Rudeloff, 2020). Using social networks supports building trusted relationships broadly within and outside the company, which is one of the five global leadership competencies defined by Stolz and Oldenziel Scherrer (2022). A growing number of studies are linking the role of the social media presence of the organization's leader to corporate reputation and organizational outcomes (Cottan-Nir, 2019; Marx et al., 2020; Venciute et al., 2024). A quantitative study by Tsai and Men (2017) on CEOs

use of X (formerly known as Twitter) concluded that the way CEOs communicate can enhance the trust in the leadership and the organization. This direct engagement with stakeholders in their region and globally can potentially level the playing field for entrepreneurs who compete against larger corporations with more resources (Genc & Öksüz, 2015). For example, female micro-entrepreneurs in Turkey used social media as a low-cost communication and networking channel and research tool (Genc & Öksüz, 2015). However, organizations of all sizes compete for attention on social media platforms (Genc & Öksüz, 2015), and it is difficult to build a large following on social media as a new company with a small marketing budget. Nevertheless, the smaller size and the ability to move more quickly with more personalized engagements on social media can become a competitive advantage for entrepreneurs. The type and size of an organization can determine the level of visibility a CEO wants for corporate reputation and risk management. In Spain, leaders of public organizations in regulated industries are less visible on social platforms due to higher compliance requirements and higher risk-aversity (Serrano et al., 2020). Furthermore, corporate leaders consider their own reputation when selecting policies, communications, and actions (Schnee, 2017) which can impact in which channels leaders communicate with stakeholders. Global leaders are more vulnerable on social media platforms where conversations are interactive and less controllable compared to corporate communications channels, such as the company's website or newsletter. Study results on the use of social networks by global leaders in different countries by Korzynski (2013) indicated that leaders with a participative and consultative leadership style benefitted from using social media, but global leaders with a directive leadership style less so. Some SMEs still underestimate the role and potential of social media (Belás et al., 2021). Especially in emerging economies, the adoption of social media to drive organizational and sustainability outcomes can be slow due to limited resources and technical knowledge (Ur Rahman et al., 2020).

The purpose of this paper is to discuss the role of social media for entrepreneurs to achieve their company's financial and sustainability goals. It is structured as follows. First, a literature review takes an interdisciplinary look at entrepreneurial marketing, global leadership, and brand building studies using a thematic approach. Themes cover the changing social media landscape, current applications of social media by entrepreneurs, and the connection between social media, entrepreneurship, and sustainable development goals. Second, a review of the findings and how they are connected to the emergence of founder-led social media marketing. Third, a discussion of the challenges and opportunities entrepreneurs are facing using social media. The paper will conclude with recommendations for future research based on identified research gaps.

Research Methodology: A Literature Review on How Entrepreneurs Use Social Media to Drive Financial and Sustainability Goals

The use of social media by organizational leaders to drive financial and sustainability goals falls under strategic communication as a global leadership skill (Bird, 2017; Cumberland et al., 2016), responsible and sustainable entrepreneurship (Vallaster et al., 2019), as well as startup marketing, small business marketing, and entrepreneurial marketing (Collinson & Shaw, 2001; Yang et al., 2023). To provide cross-disciplinary insights and perspectives as the foundation for future studies, the selected methodology is a literature review to capture consolidated insights from all these disciplines. The literature review is organized by topics (Rosch et al., 2023) to identify and analyze themes in research studies across different disciplines and identify research gaps (Depoy & Gitlin, 2020). The research was conducted by using databases, including EBSCO, Emerald Insight, Gale, JSTOR, ProQuest, Sage Journals, and ScienceDirect, as well as Google Scholar to identify relevant studies in peer-reviewed journals and books with a focus on English-language studies between 2018 and 2024, with some exceptions when earlier studies had relevant results. In addition, non-peer reviewed data sources were used from reputable industry expert sources, such as Statista, to provide the most recent data on the use of social media platforms and consider new developments in the discussion, such as existing and proposed TikTok bans by countries. Key search terms included corporate reputation, entrepreneurship, entrepreneurial marketing, global leadership communication, social media platforms, SME digital marketing, and sustainable development. The literature review is divided into three themes: the changing social and

digital media landscape, how entrepreneurs use social media to achieve business goals, and how entrepreneurs use social media to promote sustainable development goals.

Theme 1: Navigating a Changing Social and Digital Media Landscape

Entrepreneurs need to navigate a fast-evolving social and digital media landscape characterized by constantly new emerging channels, changing ownerships, and government bans which can turn established channels, such as TikTok, into risky choices for marketing (Hassan et al., 2024). In this paper, a digital network is defined as "a web-based platform that allows users to construct a personal or professional profile from which they can share news and data and connect and communicate with other users" (Digital Marketing Institute, n.d.). With more than three billion users Facebook remains the largest global social media network based on the number of active users (Dixon, 2024). Following on its heels are YouTube, WhatsApp, Instagram, TikTok, WeChat, Facebook Messenger, Telegram, Douyin, Snapchat, Kuaishou, X (formerly known as Twitter), Sina Weibo, QQ, and Pinterest (Dixon, 2024). When selecting social media channels for their business, entrepreneurs need to consider user preferences by region, industry, and lifestyle and how stable the social media channel is.

One challenge is the regional fragmentation of the social media landscape. Not all global networks are accessible in all countries, and some stakeholders prefer to engage on regional platforms (Ng & Taneja, 2023). For example, TikTok is currently banned in India and Nepal and on the phones of government employees in Australia, Britain, Canada, the EU, and New Zealand (Hassan et al., 2024). The Chinese-owned social network is also facing a potential ban or sale in the U.S. (Hassan et al., 2024). Similarly, Facebook, YouTube, X, and LinkedIn are not available in China due to government regulations (Gordon, 2023). The regulated social media landscape in China spurred the growth of domestic platforms, including Weibo and WeChat, which became key networks for Chinese speaking users across regions and are among the most used social media networks globally (Chen et al., 2017). Even in countries with no access restrictions to U.S.-owned social networks users often turn to local or regional channels. In Japan, more than 94 percent of people use the multifunctional app Line, and the app is being increasingly adopted by users in Taiwan, Thailand, and Indonesia (Statista, 2024; Steinberg, 2020).

A second challenge for entrepreneurs is understanding consumer behavior on social media channels. Social media users have varied reasons why they engage digitally and often use different networks, some for work, others for personal interests and interactions. Given the resource constraints, entrepreneurs need to select carefully on which social media platforms they engage in based on the online preferences of their key audiences. For example, LinkedIn is the preferred network for business-to-business (B2B) communications (Cortez et al., 2023). The video platform YouTube is the most used social media channel by U.S. adults (83 percent), followed by Facebook (68 percent), and Instagram (47 percent) according to data by the Pew Research Institute (Gottfried, 2024).

Theme 2: Using Social Media to Achieve Business Goals

The social media usage rate globally is at about 59 percent, with users spending more than 150 minutes per day on social media and messaging apps (Dixon, 2023). That is an opportunity for entrepreneurs to connect with prospects, customers, and other stakeholders to reach their organizational goals and communicate their sustainability vision. Following is a look at the diverse ways entrepreneurs in emerging and established markets use social media to meet financial goals from starting and financing the business to building a long-term reputation with stakeholder engagement.

Start the Businesses

Social media has given entrepreneurs the ability to start online businesses without geographic boundaries, broadening the opportunities for entrepreneurs from remote locations and disadvantaged industries. According to a study by Chaker & Zouaoui (2023) in Tunesia, Facebook opened the ability for female entrepreneurs to start e-commerce-based businesses. Social media helped women become entrepreneurs and positively impacted their entrepreneurial journey (Chaker & Zouaoui, 2023). For example, women in developing economies used social platforms, such as Facebook, to start a business in the tourism and hospitality sectors (Ditta-Apichai et al., 2024). Startups in Thailand that used social media

strategically perceived it as an important avenue to grow their business (Mumi, 2022). According to a study by Gbandi and Iyamu (2022) Facebook, Instagram, X (formerly known as Twitter), and YouTube all significantly contributed to the growth of SMEs in in Nigeria. Young entrepreneurs in emerging markets primarily used Instagram, Snapchat, and to some extent also YouTube, as promotional digital marketing channels and turned to WhatsApp to engage directly with customers (Bellaaj, 2021) based on their ease of use, cost-effectiveness, and preference by their local customers. Entrepreneurs combined social media with offline channels for three key activities - communication and promotion, customer transactions, and customer service, - to increase their brand visibility, grow sales, and strengthen customer relationships (Bellaaj, 2021). Entrepreneurs in more established markets recognized social media as a brand building and business development channel as well. In the United States, for example, approximately 30 percent of small business owners stated that Facebook delivered the highest return-on-investment (ROI) from all their marketing channels (Faria, 2023). In Germany, especially early-stage startups rely heavily on social media, such as Facebook, for social listening and environmental scanning, to build and refine their product for the market (Pakura & Rudeloff, 2020). The importance that entrepreneurs give to social media can vary by the development stage of their business. A study among a large group of German startups in different growth stages indicated that the adoption of social media was less important to more mature startups than to young startups (Pakura & Rudeloff, 2020).

Support Crowdfunding

Crowdfunding has become a common route for entrepreneurs to raise financial capital, create awareness, and gain validation for the business and products by using sites like GoFundMe, Indiegogo, Kickstarter, Mainvest, Patreon, StartEngine, and WeFunder (Junge et al., 2022). Raising funds from a larger number of individuals is especially attractive for SMEs that have less access to bank credits, loans, and other traditional types of funding, or operate in more risky markets (Stefanelli et al., 2022). Regardless in which country the business is located, social media are crucial to successfully implementing a crowdfunding campaign and enticing individuals at a large scale to financially contribute within a given time (Kaur & Gera, 2017). The typical length of a crowdsourcing campaign to launch or expand a business is 30-60 days. Crowdfunding sites encourage business owners to attract investors via email and social media channels, including YouTube, Facebook, Instagram, LinkedIn, and X (Sahaym et al., 2021). The success rate of crowdfunding campaigns on Kickstarter, for example, is 40 percent (Statista, 2024). An analysis of crowdfunding campaigns on Indiegogo concluded that using social media and engaging online communities, such as Facebook, is critical to generate word-of-mouth to reach the funding goal (Bernardino et al., 2021). Moreover, an entrepreneur's knowledge and attitude towards social media matters to a crowdfunding campaign's success (Sahaym et al., 2021). Recognizing the potential of social media can lead to a positive outcome of an SME's crowdfunding campaign whereas a lack of understanding can dampen its success (Sahaym et al., 2021).

Build Awareness and Reputation

There is a growing body of research that connects the social media use by organizations to the ability to build awareness and reputation (Chen et al., 2017; Haudi et al., 2022; Kim, 2020; Pakura & Rudeloff, 2020). This is especially for entrepreneurs with a global ambition (Tien, 2020). In China, startups' primary reasons to use social media is the need to build awareness by sharing information and creating word of mouth domestically and internationally (Chen et al., 2017). The Chinese startups also mentioned the need to build their reputation via stakeholder engagement (Chen et al., 2017). Entrepreneurs increasingly use a combination of their personal channels and their company's channels to create and engage a following on social media to build trust and brand loyalty (Haudi et al., 2022; Kim, 2020). Being approachable and authentic on social media as a leader can positively impact the trust that stakeholders have in the company While considered an intangible value, brand and reputation building is critical for a start-up's success as it lays the foundation for tangible assets, including revenue generation (Pakura & Rudeloff, 2020). Overall, there is a wide spectrum of how entrepreneurs use social media, ranging from slow adoption to embracing it fully and becoming a social media influencer, and in some cases social media celebrity. For example, as the face of her companies Fashion Valet and the dUck Group, founder Ivy

Yusof, created a strong personal brand on Instagram with a higher following than her corporate brand channels (Md Saad & Yaacob, 2021). Yusof's Instagram posts mixed insights into her personal life and professional life as a female startup founder with corporate and product updates (Md Saad & Yaacob, 2021). For example, an outfit-of-the day series featured clothing that is available on the e-commerce site, supporting online sales. Not all entrepreneurs are adept at using social media. A study in Central Europe concluded that some entrepreneurs do not sufficiently understand how social media can drive business growth and financial performance (Belás et al., 2021).

Theme 3: Using Social Media To Drive Sustainable Development Goals

An increasing number of entrepreneurs worldwide incorporate sustainable development goals into their business strategy and purpose (GEM, 2023). Driving sustainable development outcomes starts with nurturing sustainable socio-economic growth, such as with job creation. A study by Chen et al. (2018) in China connected entrepreneurship and social networking both as factors that foster regional economic growth. According to Mumi (2022), digital channels can positively impact corporate performance and organizational sustainability by building social capital. Similarly, Dvorský et al. (2023) identified a connection between sustainable development and corporate reputation management, which can be achieved by engaging stakeholders via social media channels. Their study among SMEs in four Central European countries – the Czech Republic, Hungary, Poland, and the Slovak Republic-, revealed a strong relationship between the owners' perceptions of the importance of corporate reputation and sustainable development (Dvorský et al., 2023). In Poland, entrepreneurs listed social media as the second most important channel to communicate corporate social responsibly goals, followed by the company's website (Stawicka & Paliszkiewicz, 2021). Globally, entrepreneurs used social media platforms, such as YouTube, to provide content on sustainability and promote a more sustainable behavior and lifestyle (Gregori et al., 2023). When looking at individual channels, TikTok has become a valuable social media channel for engaging audiences on global issues, such as climate change, with one caveat: scientific expertise needs to be delivered credibly within the platform's time and format constraints (Sun et al., 2024). However, the app is not available in all countries and some nations, including the U.S., consider banning it due to security and data privacy concerns (Hassan et al., 2024). Finally, not all entrepreneurs are equally savvy in engaging stakeholders about sustainability goals in social channels (Stawicka & Paliszkiewicz, 2021).

Findings

While social media is a marketing channel, the social media use by SMEs goes beyond marketing and sales lead generation. Entrepreneurs use social media to start a (digitally native) business, find alternative ways to finance a business, such as with crowdfunding, and to educate stakeholders on key issues, such as climate change and access to health. Overall, there is evidence that social media has emerged as a multi-functional platform for entrepreneurs in emerging and developed economies to start, finance, and grow a business and support sustainable development goals.

The adoption and use of social media varies by the type of business, industry, country, and technological competency of the entrepreneur and is shaped by a complex global context (Reiche et al., 2017). This includes the continuous rise and demise of social channels, which makes it challenging to maintain a sustainable social media strategy for long-term stakeholder engagement. The speed in which conversations happens on social networks can be challenging, compared to more traditional, more controlled communications channels. As a result, the lack of technological knowledge and social media expertise can slow down the adoption of social media by SMEs (Ahmad et al., 2018).

The consensus in the reviewed studies is that the benefits of social media outweigh the challenges for entrepreneurs. Moreover, the ability to attract a vast number of followers on social channels increased the visibility of entrepreneurs and their companies on the global stage and triggered the rise of founder-led brands (Cottan-Nir, 2019; Md Saad & Yaacob, 2021). Entrepreneurs discovered the role of social media to build thought-leadership (Chen et al., 2017). This is especially important for business-to-business organizations and for providing insights on key sustainable development issues. Across all reviewed studies that touched upon the use of social media to build businesses and drive sustainable development goals, the most frequently researched social media channels were Facebook, Instagram, X, WeChat,

Weibo, and YouTube. As four of the six social networks are US-owned, more research is needed on the use of other non-US owned networks that attract a large user base, such as Line, Douyin, Kuaishou, QQ, and Telegram.

Discussions and Conclusions

Social media has emerged as a recognized platform to build and grow businesses and support sustainable development goals. As social media users prefer to connect and engage with other humans, as opposed to companies, SMEs have an opportunity by using their founder's brand and channels to engage with stakeholders on social media (Cottan-Nir, 2019; Marx et al., 2020; Md Saad & Yaacob, 2021). Being the face of the company and building a large following on social media also has risks, if the founder's engagements do not align with the company's corporate values and mission. An example is Elon Musk, the CEO of Tesla, SpaceX, and X whose comments on X can sway product purchases and stock prices (Niburski & Niburski, 2023), but also draw criticism and the departure of customers due to offensive remarks. While entrepreneurs can be cheekier and candid on social media, they still should follow ethical communications guidelines, rooted in corporate and personal values to avoid miscommunication and repercussions on the corporate reputation and financial performance of their business.

Limitations and Directions for Future Studies

The study was facing several limitations. First, the literature review was based on studies that are available in English language. This limited the sample of analyzed research studies and the types of social networks and entrepreneurs that were surveyed. For example, four of the six networks that were most discussed in the research studies – Facebook, Instagram, and YouTube, and X (formerly known as Twitter), - are US-owned social media platforms. The other two – Weibo and WeChat – are key networks based in China. Considering the increasingly fragmented social media landscape, future research could look at how entrepreneurs use other non-US owned networks that attract a large user base, such as Line, Douyin, Kuaishou, QQ, and Telegram.

Second, studies included a wide-ranging mix of methodologies and types of organizations under the MSME umbrella – from micro-entrepreneurs in emerging markets to tech startups in established innovation hubs like China and Germany, which made it difficult to compare findings. As companies go through different growth phases (Pakura & Rudeloff, 2020), future studies could analyze SMEs in the same specific growth stage across regions to ensure a better comparability.

Third, to more deeply analyze the types of social media engagements that help entrepreneurs to achieve financial and sustainability goals, future studies could analyze how entrepreneurs with a sustainability mission engage stakeholders on social media using a mixed method approach that combines a content analysis of social media engagements with a stakeholder survey.

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Managerial approaches to blockchain technology adoption in the rail freight sector: An emerging market perspective

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Keywords
Africa, blockchain, intelligent systems, management, rail freight, supply chain management

Abstract

Modern supply chains demand adaptability driven by the globalization of production and markets, the fourth industrial revolution (4IR) and recent events such as the unexpected closure of the Suez Canal, the Russia-Ukraine war, and the Covid-19 pandemic. Investing in digital supply chain technologies boosts end-to-end visibility, mitigates risk, and improves the resilience of supply chains. Many disruptive technologies are currently changing the business landscape in Africa. However, Africa has traditionally been an adopter rather than a pioneer of technologies for business development. Although there has been an increase in the use of blockchain technology in various industries, there is still a challenge of understanding how the technology can be applied in the South African rail supply chain context. Thus, it is crucial to investigate how managers perceive the technology and how this understanding affects the decision to use the technology in the rail freight Container Corridor. A gap exists between the understanding, organizational support and benefits of the technology and its application within the corridor.

A case study approach was utilized to collect primary data obtained through a structured self-administered survey questionnaire. The main findings of the study were that the understanding of blockchain influenced managers perceptions and willingness to adopt the technology. While the railway operator was committed to implementing blockchain, other operational constraints and inefficiencies still present on the corridor were impediments to further investigation. Furthermore, potential benefits and challenges, costs and resources required as well as the impact on current operations and workings were highlighted by management as important decision-making factors.

The study provides valuable insights into disruptive technologies applications within the transport supply chains. It substantiates the significance of how managers view blockchain as a technology to address various challenges as well as enhance operations within the South African freight rail sector.

Introduction

The transportation sector in South Africa plays a fundamental role in economic development, contributing 6,5 percent to the country's Gross Domestic Product (GDP) in 2022 (Labour Research Service, 2022). The rail network in South Africa spans to around 31000 track kilometer (KM) and is primarily utilized for domestic passenger transportation, with an occasional usage for international connections (Transnet, 2021; African Development Bank, 2015). The South African rail system provides a vital link, connecting major cities and stands out as the most advanced and sophisticated rail network on the African continent (Zote, 2022).

An essential link between the economic hub of Gauteng to the port of Durban is the Container corridor, representing South Africa's largest rail corridor. The corridor facilitates the transportation of diverse commodities including fuel, containers, coal, and automotive products (Transnet, 2022). However, losses stemming from various inefficiencies such as limited processes and collaboration, inadequate rail infrastructure as well as continued security concerns favor the use of road transport as an alternative. These inefficiencies have resulted in losses of billions of Rands in various industries and threaten the country's regional and domestic trade (International Trade Administration, 2021)

A road-to-rail strategy proposed by Havenga, de Bod, Simpson, Swarts and Witthöft (2021), revealed the lack of reliable and timely services as a main issue with South Africa's intermodal rail freight terminal. Furthermore, various factors such as the spatial and modal interfaces influence the freight logistics networks interaction between the port and rail users (Pieterse, Farole, Odendaal & Steenkamp., 2016). Enhancing the efficiency and effectiveness of the Container corridor can be done by implementing new operating models at ports and terminals to manage increased cargo volume and offer improved services to their customers. Moreover, the deployment of technology can also be used to improve the daily operations of the corridor. The advent of fourth industrial revolution (4IR) technologies, such as Internet of Things (IoT), Artificial Intelligence (AI), Big Data and Blockchain has opened new possibilities for the operations and management of the railway industry (Veitch, 2022).

Blockchain is a technology that provides security, transparency, and immutability (Deshmukh and Saxena, 2023). Blockchain has emerged as a transformative solution in addressing the various challenges within the context of the Container Corridor. However, the successful implementation of these technologies demands considerable expertise and willingness. Several studies on blockchain across various industries including that of Almekhlafi and Al-Shaibany (2021), Jena (2022), and Shrestha, Vassileva and Deters (2020), emphasize that the users' willingness to adopt new technology plays a crucial role in the rate of adoption. Additionally, social influences which encompass support from superiors and colleagues has been identified as an important factor influencing blockchain adoption (Sharma, Sharma, Singh & Bhatia, 2023). As such, it is essential to examine managers' understanding of the technology and assess how their perception influences their decision to employ the technology in the rail freight Container corridor.

Literature Review

Rail Transport in Africa

Railway lines in Africa span approximately 70 000 kilometers, with an operational rate of around 84% in various regions (Bullock, 2009:4). Rail freight within Africa constitutes only 7% of the global total, while passenger rail contributes to a mere 2% (Wangai, Rohacs, & Boros, 2020). Although African governments have embarked on various initiatives to develop rail transport infrastructure, rail transport still suffers from neglect, marked by insufficient support systems, a lack of financial aid, inadequate strategic planning, and a disregard for the environmental impact (Wangai et al., 2020). Most railway lines in Sub-Saharan Africa are in a state of disrepair, though there are exceptions, such as those in Northern Africa and South Africa, which exhibit better performance (African Development Bank, 2015).

Despite the contribution of transport to the South African GDP, Venter (2022:1) states that sectors such as the iron-ore, coal, manganese mining and chrome sector experience yearly losses ranging between R39 billion and R50 billion in export earnings. The losses, in part, can be attributed to the failure of the South African freight rail system to transport larger volumes of these commodities to different ports. Moreover, as per Venter (2022:1), rail traffic volumes in South Africa have experienced a decline of around 2.9% compared to previous years, while road transport has witnessed an increase of 16.8%. In 2017, South Africa's primary railway operator transported over 230 million tons of cargo (Daniel, 2022:1). Subsequently, freight volumes have steadily declined year-on-year, reaching a record low of 179 million tons in 2021 (Daniel, 2022:1). This downward trajectory continued into early 2022, with a 4% volume decrease compared to the previous year, a trend partially attributed to the impacts of the COVID-19 pandemic and the gradual recovery of economies (Daniel, 2022:1; Grater & Chasomeris, 2022:2).

The diminishing freight volumes are exacerbated by factors such as the deterioration of the rail network and diminishing rail infrastructure (Daniel, 2022:1; (Venter, 2022:1). Consequently, inefficiencies in rail transport have prompted a noticeable shift towards road transport as the preferred modal choice (Daramola, 2022:62). This shift is underscored by the poor performance of the country's largest transport provider Transnet, which has contributed to a myriad of logistics inefficiencies and increased costs. The use of digital technologies to improve the efficiency of rail transport is essential (Popova et al., 2021). Currently, digital technology employed by the South African railway operator directly transmits information about train operations and communicates with drivers through a centralized system (van der Merwe, 2018). However, the centralized system has not addressed the ongoing challenges of the operator

such as increased theft, vandalism and sabotage of the network infrastructure and rolling stock, continued contractual disputes, poor cost recovery and increasing maintenance backlogs. Acknowledging the challenges mentioned, the South African railway operators are actively working on modernizing its rail infrastructure by embracing advanced technologies (Transnet, 2023).

Blockchain technology and its application in supply chains

Blockchain is "a type of distributed ledger which can record transactions securely and transparently" (IBM, 2020:1). Sherman, Javani, Zhang and Golaszewski (2018:1) stated that "blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network". Parizo, 2021; Iansiti & Lakhani (2017) confirm the technology as a shared and immutable structure while adding that it provides members with control over information and decision-making processes. It provides transparency, equity and trust while expediting essential information transfer and storage security, ultimately providing innovative solutions and increased interest from various industries (Sharif and Ghodoosi., 2022; Weking, Mandalenakis, Hein, Hermes, Bohm, & Krcmar., 2019).

The implementation of blockchain technology can significantly transform and improve supply chains by ensuring transparency, traceability, and security. This ultimately addresses inherent challenges in global supply chains (Saberi, Kouhizadeh, Sarkis, & Shen., 2018). Transparency and traceability within the supply chain can be achieved by the technology's ability to monitor and record social and environmental conditions across different tiers of the supply chain (Pournader, Shi, Seuring & Koh., 2019). Furthermore, the technology improves security in supply chains by enhancing information and transaction management (Wannenwetsch et al., 2023).

The initial application of blockchain technology was an electronic peer-to-peer payment system Bitcoin which enabled merchants to accept cryptocurrencies for transactional purposes (Hamukuaya, 2021). This paved the way for the integration of the technology across diverse industry sectors contributing to substantial business value (Iansiti & Lakhanil, 2017; Paliwal, Chandra, & Sharma, 2020). The use of blockchain technology within the financial sector has enhanced operational efficiency by expediting banking transactions and lowering costs (Chang, Baudier, Zhang, Xu, Zhang & Aramis, 2020). In the healthcare industry, blockchain technology is employed to securely transfer patient medical records (Jabbar, Lloyd, Hammoudeh, Adebisi & Raza, 2021), while its use in the pharmaceutical sector has the potential to track and trace serial numbers, aiming to reduce costs, enhance security, instill trust, and foster transparency across supply chains (Rayome, 2018).

Within the logistics sector, blockchain technology has been used to manage inventory, track shipments, secure and manage billing and payments, reduce counterfeit trade, and effectively govern contracts (Martynov, 2023). The incorporation of blockchain technology in the transport industry has enabled companies to enhance their payment and billing systems, reduce commissions, and accelerate transactions, while simultaneously facilitating real-time tracking of vehicle movement and providing more accurate trip information (Martynov, 2023). A notable example is that of IBM and A.P. Møller – Mærsk which together launched the TradeLens platform in 2018, aimed at assisting companies to enhancing their supply chain efficiency by providing users with real-time data on freight movement (Musienko, 2023). Similarly, Kuehne + Nagel has created a cloud-based platform, empowering partners to oversee their supply chains to minimize costs and enhance operational efficiency thereby addressing concerns related to fraud prevention and ensuring information security by mitigating errors and inconsistencies (Musienko, 2023).

Within the rail sector, operators such as the Russian Railways (RZD), Thailand's State Railway (STR) and Germany's Deutsche Bahn AG have created innovative applications that have the potential to augment efficiency of business operation (Zasiadko, 2020; Robinson., 2022). Despite many of these applications being in the experimental phase, Morant (2018) suggests, aim to address diverse railway systems management challenges, including signaling, passenger information systems, and ticketing.

The use of blockchain in railway transport

Blockchain technology has the potential to decentralize railway infrastructure management, enabling trains to autonomously make decisions and oversee their routes in a transparent and efficient manner

(Kuperberg, Kindler & Jeschke, 2020). Robinson (2022), highlighted Germany's application of blockchain technology in rail, illustrating how trains can automate their communication. This innovative approach eliminates the requirement for centralized control, empowering trains to make informed decisions autonomously. The implementation of blockchain-based railway control systems in Germany is aimed at not only improving safety but also enhancing operational efficiency, ultimately creating an automatic traffic management system (Kuperberg et al., 2020).

Furthermore, blockchain technology, coupled with sensors, promotes the adoption of predictive maintenance operations, enabling components to autonomously register their requirements (Dutta, Choi, Somani & Butala., 2020). An illustrative example is the ongoing testing of blockchain on locomotives by the Italian railway company Trenitalia (Perasole, 2020). The integration of blockchain and sensor technology empowers the company to improve operational efficiency and safety. Through the utilization of blockchain, the company can proactively safeguard its network against potential failures (Perasole, 2020). Further blockchain initiatives have been the creation of intelligent ticketing systems aimed at reducing reliance on paper tickets for passengers (RSSB, 2020). The United Kingdom (UK) is working on leveraging blockchain for the development of smart ticket system that seeks to be established universally by all train operators in the region (Preece & Easton, 2019).

International collaborations as seen in the partnership between China and Laos, aims to establish blockchain-based trade platforms to facilitate cross-border business transactions (Global Times, 2022). The objective of such an initiative is to offer a secure cost-effective means to engage in business transactions ultimately improving the country's transportation system. While blockchain technology is finding value in global rail industries, its development and utilization in the African and South African railway sectors are currently limited or nonexistent. Only Transnet, South Africa's leading transport operator, has initiated projects to pilot blockchain solutions (Mackenzie, 2018)

Drivers influencing the adoption of blockchain technology.

The most prevalent drivers in blockchain adoption have been technology innovation (Gaur & Gaiha., 2020; Kuperberg., 2021; Xie, Chen, Qu, Fan, Tang, Zhu & Wang., 2020), fraudulent transactions (Ye & Zeng., 2021; Saberi et al., 2018; Xu., 2016; Cai & Zu., 2016), pressure from customers (Lukrozo., 2020; Tan & Sundarakani., 2021; Sharedo, Patil & Madaan., 2020) and pressure from internal and external stakeholders (Geroni., 2021; Jardim, Pranto, Ruivo & Oliviera., 2021). Technological innovation has revolutionized the supply chain, optimizing goods delivery, financial access, traceability, and partner relationships (Gaur & Gaiha., 2020). Countries like China, Australia, and Russia are exploring blockchain to enhance railway systems, addressing issues from value transportation to administrative authentication (RSSB, 2020; OECD, 2018; Fraga-Lamas, Fernandez-Carames & Castedo., 2017; Kuperberg, 2021). The introduction of blockchain in railway freight transportation holds potential for modernization and improved stakeholder connectivity, addressing the industry's need for innovation (Xie et al., 2020).

The surge in fraudulent transactions amid increased digitization has fueled the adoption of blockchain technology across several sectors (Javaid, Haleem, Singh, Suman, Khan, 2022). Leveraging its immutability and security features, blockchain can effectively prevent unauthorized activities (Ye & Zeng, 2021; Saberi et al., 2018), offering a secure and transparent means for businesses to conduct transactions and combat fraudulent activities (Swan, 2015). While studies by Cai, et al., (2016) showcase blockchain's potential in preventing objective information fraud, research by Xu (2016) highlights the need for further research to address vulnerabilities.

The rail industry in South Africa boasts Mediterranean Shipping Company (MSC), Maersk, Ford Motor Company, Toyota Motor Corporation, Puma Energy, Shell Global, Total Energies and Engen Petroleum as some of its most valued customers (Transnet, 2022). However, its popularity amongst these and other customers has declined due to unreliable services (Lukrozo, 2020. The implementation of blockchain technology is driven by customers who demand competitiveness and sustainability in rail freight operations, providing transparent and flexible services to their business objectives (Tan & Sundarakani, 2021; Sharedo, et al., 2020). Railway operators often engage with a range of stakeholders, including the Government, employees, management, labor unions, suppliers, media, customers, and credit rating agencies, to respond promptly to concerns and to integrate stakeholder inputs into their

business plans. Jardim, et al., (2021) emphasize that blockchain technology's ability to track and trace company activities is a crucial incentive for implementation while Geroni (2021) highlights its potential for real-time asset tracking and executing smart contracts.

Toth, Padayachee, Mahlatji and Vilakazi (2022), reported that the industrial sector's acceptance of new technologies such as the blockchain, centers on factors such as reliability, certainty and economic value associated with the technology for its intended applications. This often prevents innovative advancements from realizing their full potential, primarily due to absences in skills, knowledge, market access, and a comprehensive understanding of the economic advantages the technology could bring (Chua, Wong and Yeong., 2017). Additionally, factors such as the maturity, relative advantage and organizational readiness is also considered in the decision-making process when it comes to adopting blockchain technology (Wang, Liu, Liu & Huang, 2022:1). Aside from the drivers and potential benefits to enhance the supply chain, blockchain adoption is also influenced by the actual user's perception of the technology. A study by Dehghani et al. (2022) indicated that while data quality and interoperability were drivers to adopting blockchain, technological volatility, regulatory uncertainty, standardization uncertainty and the perceived lack of technological knowledge were barriers.

The incorporation of blockchain technology into supply chain practices stands as a promising avenue for organizations to elevate their supply chain management (SCM). The utilization of blockchain-based systems for automating routine tasks empowers supply chain professionals to focus on critical aspects of their roles, fostering improved decision-making and overall performance (Oracle, 2022). To fully leverage the advantages of blockchain technology in SCM, organizations must develop a comprehensive understanding of the technology and its implementation in the organization's operational context. This research investigates how managers on the South African rail Container Corridor perceive the technology and how this understanding affects the decision to adopt blockchain technology.

Despite the transformative potential and indications to pilot blockchain solutions, no research exists on the actual implementation and impact of the technology on the Container corridor operations. The study aims to provide valuable insights to the South African rail transport industry, facilitating informed decision about blockchain technology to optimize supply chain operations and enhance overall competitiveness in the transport sector.

Research Methodology

A quantitative, exploratory case study approach was used to explore the understanding of blockchain technology by managers on the Container Corridor. Specifically, the study attempted to determine how the technology is understood in a fright rail context, what the planned and current use of the technology was and what drivers to adopt the technology could be identified. The respondent organization (name withheld due to confidentiality) is a multimodal transport operator in South Africa. The respondents were managers of different levels across various departments within the Container Corridor. Management work experience was important as their knowledge of issues and processes influence the implementation of innovative solutions. Cross-departmental analysis provided insight into the current and possible applications of blockchain technology while the level of management influenced their perception and willingness to adopt or further develop the technology. Data was collected using a closed-ended survey questionnaire, distributed to 115 managers during the first quarter of 2022 of which 100 responses were received. The sample size of 100 responses is justified by their representativeness and statistical power. A high response rate ensured in-depth exploration and analysis of blockchain technology adoption within context of the Container corridor. Furthermore, the large sample size provided statistical power for meaningful analysis to align with the study objectives. The survey instrument consisted of multiple 5-point Likert-scale items related to the understanding, utilization, and drivers of blockchain technology within the freight rail Container Corridor. The results of the study were analyzed using IBM SPSS Statistics 28.0. Various descriptive statistics were calculated such as means, standard deviations, frequency distribution, and reliability analysis. Mean scores and standard deviation were used to describe the level of understanding and planned utilization of blockchain technology along the corridor. By generating frequency distributions, the researchers were able to analyze the support initiatives and drivers influencing technology adoption. SPSS further assisted with a reliability analysis using Cronbach's

alpha which assesses the internal consistency of measurement scales within the questionnaire. As all constructs indicated values greater than or equal to 0.70, the internal consistency and reliability of measurement scales related to blockchain understanding and adoption are acceptable.

Findings and results

Managers perceived understanding of blockchain technology

How managers understand blockchain technology was deemed an important measure in their willingness to adopt or further develop the technology along the corridor. The results investigated the understanding as perceived by all other managers as well as executive managers only. Executives greatly influence the adoption of technology based on various attitudes, subjective norms and perceived control (Riemenschneider et al., 2003). From the results, there appears to be a high level of understanding of blockchain technology as a "software protocol" and "system of recording information" and this is indicative of the broader and basic understanding of the technology. Executive alone showed a slightly higher understanding of these definitions although in context of the operations of the Container Corridor, these are marginal.

Blockchain technology concerning its "enhancement to supply chain" (mean 4.06) and "providing all parties….with access to information" (mean 3.68) was less understood as the technology is usually associated with financial and cryptocurrency application which are not the core focus of operational activities on the Container Corridor. The difference between other managers and executive managers is marginal and may be attributed to the corridors ongoing commitment to implementing various technologies.

The degree of understanding of blockchain technology	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean – other managers	Mean score for executive managers
Blockchain is a software protocol for the secure transfer of unique instances of value (e.g., money, property, contracts, and identity credentials) via the internet without requiring a third-party intermediary such as a bank or government.	0%	0%	40%	30%	30%	3.90	4.53
Blockchain is a system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the system	0%	0%	19%	45%	36%	4.17	4.18
Blockchain technology enhances supply chain management through process tracking, regulatory compliance, and reporting.	0%	0%	18%	58%	24%	4.06	4.06
Blockchain is an unchangeable distributed digital ledger with many uses beyond cryptocurrencies	0%	8%	44%	20%	28%	3.68	4.06
Blockchain provides all parties within a respective supply chain with access to the same information, potentially reducing communication or transfer data errors.	0%	8%	22%	50%	20%	3.82	3.94

Table 4.1: Respondents understanding of blockchain technology.

Current use of blockchain technology on the Container Corridor

Table 4.2 indicates that 40% of all departments "are developing prototype applications" for the use of blockchain. Departments such as Infrastructure (73%), Operations (41%) and Risk and Safety (64%) were at the forefront of this development consistent with blockchains ability to automate processes, safeguard rail consignments, enhance transparency and address data and information management issues. A

further, 28% "expect to have blockchain applications in production within the next 12-24 months", while 12% indicated that they were "experimenting" or currently have "blockchain applications" in production. Interestingly 20% of respondents indicated that they "did not know". Most of the respondents were from departments that are not directly related to blockchain activities although this may also indicate that they do not understand how and where the technology is currently employed. This reinforces the need to properly and fully understand how the technology works in a specific operational context.

The use of blockchain	Operations (%)	Infrastructure (%)	Risk and Safety (%)	Strategic Projects (%)	Other (%)	Total Percentage
We are developing prototype applications.	41	73	64	26	20	40
We expect to have Blockchain applications in production within the next 12-24 months.	15	27	36	35	40	28
Do not know	35	0	0	12	40	20
We are currently experimenting with Blockchains	9	0	0	15	0	8
We now have blockchain applications in production	0	0	0	12	0	4

Table 4.**2**: Current use of blockchain technology (N = 100).

Following the current use of blockchain technology, respondents were asked about their planned implementation of the technology. Executive management believed blockchain implementation was inevitable while almost a quarter of other management were more reserved stating that it would not be adopted unless it proved beneficial (14%), that they did not need blockchain (5%) or that it was unlikely to be adopted (5%). Blockchain is a relatively new technology and has not been explored in all sectors and applications. The need to wait for the "right time and required capability" is driven by the technology meeting specific business requirements and the difficulty in switching to different technological infrastructure. The need to "clarify some queries and justify adopting blockchain" can be attributed to the various adoption drivers, both technical and non-technical, that influence management decisions. Furthermore, the "need to get solutions" could be explained by the poor performance of the railway operator and thus, a major hinderance to adopting blockchain technology.

Planned implementation of blockchain technology	Executive management (%)	Other management (%)
Will not adopt blockchain unless it proves beneficial for us.	0	14
Will wait for the right time and required capability to adopt blockchain.	24	23
Needs to clarify some queries and justify adopting blockchain.	24	29
Needs to get solutions for some of our complaints/objections before adopting blockchain.	53	24
Does not need blockchain.	0	5
Is unlikely to adopt blockchain in the near future.	0	5

Table 4.3: Planned implementation of blockchain technology (N = 100).

To explore the drivers of blockchain technology.

The drivers of blockchain technology	Not probable	Somewhat improbable	Neutral	Somewhat probable	Very probable	Mean
Technology innovation	0%	0%	24%	40%	36%	4.12
Pressure from external stakeholders	0%	8%	28%	36%	28%	3.84
Pressure from customers	4%	8%	24%	40%	24%	3.72
Fraudulent transactions	4%	12%	40%	36%	8%	3.32
Pressure from Railway operator internal stakeholders	8%	12%	36%	36%	8%	3.24

Table 4.4: Drivers for the implementation of blockchain technology on the Container Corridor (N = 100)

The most significant driver for adopting blockchain technology on the Container Corridor was "technology innovation" (mean 4.12). Blockchain can improve the decision-making process for cargo owners seeking increased volume demands. The use of smart sensors and drones to monitor railway tracks address cable theft, derailments and cargo theft which have been persistent problems along the corridor. Other significant drivers were "pressure from external stakeholders" (mean 3.84) and "corridor customers" (mean 3.72). External stakeholders and customers such as shipping lines and cargo owners from the mining and minerals, automotive and petroleum industries value improved tracking and tracing of shipments to ensure faster turnaround times and improve the efficiency of various automated processes. The supply chain visibility benefits that blockchain affords, could incentivise the movement of cargo from road to rail transport. "Fraudulent transactions" (mean 3.32) and "pressure from internal stakeholders" (mean 3.24) were less likely to drive blockchain adoption although in principle, these could address many of the inefficiencies of the railway operator.

The adoption of blockchain technology will enhance supply chain management practices	Extremely Unlikely	Unlikely	Neutral	Likely	Extremely Likely	Mean
Real-time information sharing	0%	0%	12%	36%	52%	4.40
Visibility	0%	0%	16%	36%	48%	4.32
Cyber security	0%	4%	12%	40%	44%	4.24
Transparency	0%	0%	28%	28%	44%	4.16
Reliability	0%	0%	12%	60%	28%	4.16
Traceability	0%	0%	16%	52%	32%	4.16

Table 4.5: The likelihood of blockchain to enhance supply chain practices.

Despite indicating less understanding of blockchain in a supply chain context (Table 4.1), respondents viewed all features of blockchain as 'likely to extremely likely" to enhance supply chain management practices. Each of these features addresses key strategic risks in the South African freight rail sector. Real-time information sharing drives predictive maintenance of infrastructure which ensures a reliable service and may increase the rail market share. Visibility can improve the financial sustainability of the railway operator and enhance contract management. Cyber security not only facilitates cargo security, but the overall lack of ICT infrastructure has been a major impediment to achieving the business objectives of the railway operator. Transparency was cited as an important factor for enhanced customer collaboration and partnerships. Reliability is strategically important as the railway operator as unavailability, underinvestment and obsolesce has continually affected the operator's capacity to meet customer demands. Lastly traceability mitigates the procurement risk as current procurement practices have hindered the efficiency of the operator.

Discussion and conclusions

Managers across various departments and experience level within the Container Corridor were targeted for this research due to their pivotal and influential role in decision-making. Table 4.1 highlights the various definition of blockchain technology with notable recognition for blockchain as a software protocol or a system of recording information. However, definitions related to the supply chain, such as blockchain enhancing supply chain management and providing information to all parties, were less understood particularly by executive managers. This lack of understanding may have influenced responses to other questions, and this was considered in the analysis of the data.

Consistent with studies by Falcone, Steelman, and Aloysius (2020), Saberi et al. (2018) and Wang, Han and Beynon-Davies (2019) managers' perceptions and willingness to adopt blockchain, play a significant role in its implementation, while a barrier to adoption in the supply chain is posed by a lack of knowledge and expertise; this knowledge gap can lead to misconceptions, impeding the technology's widespread

adoption. Despite the prevalent use of blockchain technology, supply chain managers, as highlighted by Saberi et al. (2018), remain unaware of its potential to enhance operations. This lack of awareness may hinder management on the Container Corridor from fully embracing the technology, indicating a necessity for increased training and education on blockchain use in the Container corridor. Such efforts could promote technology adoption and enhance the overall efficiency of the rail supply chain.

Pournader et al (2019), emphasised that blockchain adoption needs to be aligned with the organisational goals and objectives. Findings of this study indicated that various departments are in different stages of blockchain implementation along the corridor which is consistent with the respondent organization's goal to enhance technological capabilities. Surprisingly, some managers in the same department indicated different stages of blockchain development. While this emphasises the lack of understanding and use of the technology, its greater implication as suggested by McKenzie et al. (2011) is that knowledge management contributes to better decision making. Previous research by Gurcan (2021) and Broni and Owusu (2020) mentions that the adoption of blockchain technology is conditional and similar results were found in this study.

Technological innovation was stated as the most significant driver of adopting the technology, and this is related to research by Olnes, Ubacht, and Janssen (2017) and Jena (2022). "Pressure from railway operator internal and external stakeholders," was an important finding in this study and resonates with Balci and Surucu-Balci (2021) emphasis that stakeholders may influence blockchain technology adoption. Similarly, "Pressure from Container Corridor customers" aligns with Saberi et al.'s (2018) suggestion that customers demand transparency. The influence placed by stakeholders and customers highlights their significant role in shaping the functioning of the corridor, often leading to the adoption of new technologies. Blockchain may have a significant impact on supply chain management practices and comparable results were stated by Khurshid, Zahid, and Rehman (2023); Liu, Xiang, and Sun (2022); Osmani, El-Haddedeh, Hindi, Janssen, and Weerakkody (2020); Shafay, Ahmad, Salah, Yaqoob, Jayaraman, and Omar (2022); Polyviou, Velanas, and Soldatos (2019); Yu (2022); Kumar, Lahza, Sreenivasa, Shawly, and Alsheikhy (2023). This study aligns with previous findings that highlight the enhancement in supply chain practices with the adoption of blockchain technology. Since the study did not specifically address the use of blockchain technology on the Container Corridor, the impact and operational performance of the technology cannot be determined.

The research undertaken, highlights the diverse understanding of and adoption attitudes of blockchain technology amongst managers from various departments and experience level within the Container corridor. Managers influential role in decision making processes makes their perceptions and willingness to adopt blockchain crucial for successful implementation. This study further revealed the lack of understanding regarding blockchains application in the supply chain, such as enhancing supply chain management and providing information to all parties. This lack of awareness may have influenced responses to other questions and poses a potential barrier to the widespread adoption of blockchain technology within the Container Corridor.

Consistent with prior studies by Molla et al. (2016) and Riemenschneider et al. (2003), the success of blockchain implementation is underscored by the significance of managers perceptions and knowledge. A knowledge gap can lead to misconceptions and hinder the technology's adoption. Therefore, there is a clear need for increased training and education on blockchain use in the Container Corridor, aimed at enhancing the overall efficiency of the rail supply chain.

The study also highlighted that blockchain adoption should align with organizational goals and objectives. Various departments within the Container Corridor are at different stages of blockchain implementation, reflecting the organizations' goals to enhance technological capabilities. However, the disparity in stages of blockchain development within the same department emphasizes the need for better understanding and application of the technology.

Technological innovation emerged as a significant driver for adopting blockchain, with pressure from internal and external stakeholders, as well as customers, influencing the decision-making process. Stakeholders and customers play a crucial role in shaping the functioning of the corridor, highlighting the impact of their demands on the adoption of new technologies. Despite the study's alignment with previous findings by Pournader et al. (2020), Saberi et al. (2019) and Wannenwetsch et al. (2023) regarding

the positive impact of blockchain on supply chain practices, the ongoing deterioration of the railway operator's operational and financial performance remains and will remain the major obstacle to any technological advancement on the Container Corridor.

Limitations and directions for future research

As a singular case study limited to the Container corridor, the study's findings cannot be generalized and applied to the broader sector. The study did not consider the viewpoint of other key stakeholders such as customers, cargo owners, and freight forwarders which are key for understanding how the technology works and identifying future growth opportunities. Importantly, the study did not formulate a blockchain model that can be used as a framework for logistics development in the rail freight sector.

Future research should consider the use of other data and digital technologies within the railway industry and the influence this has on the potential adoption of blockchain technology. Research into the practical implications of blockchain adoption in specific context of the Container Corridor will provide a more comprehensive understanding of its effects on operational efficiency and supply chain management. While the current study focused on rail freight transport, there is greater potential for the application of the technology in passenger rail services. Lastly, there is a need to further understand the recurring challenges within the South African rail freight sector and explore how blockchain and other such technologies can mitigate the problem.

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Exploring the development of regulatory framework for crypto assets in South Africa

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Keywords
Regulatory frameworks, laws, investment, risk, crypto assets, South Africa.

Abstract

This paper explores the need for, and forms of regulatory framework and laws established to guide and control the growing number of individuals and firms investing and trading in crypto assets in South Africa.

The step taken to regulate crypto assets was necessitated by the 2021 report of the Paris-based intergovernmental organisation referred to as the Financial Action Task Force (FATF) which revealed that there is apparent lack of crypto assets regulation in South Africa. In rising to this challenge, the South African regulatory authority known as the Financial Sector Conduct Authority (FSCA) in October 2022 indicated that crypto assets are digital representation of value and therefore could be categorised as financial product which are to be subjected to FSCA regulations with reference to Section 1(h) of the Financial Advisory and Intermediary Services Act (FAIS). The method adopted was to review the regulatory framework and laws governing crypto assets in South Africa.

It was found that relevant regulatory framework and laws are needed to provide adequate protection for the investing public and to provide avenues for the sustainability and stability of the crypto assets business sector. The paper concludes that providing an efficient regulatory framework for crypto assets in South Africa will assist in limiting the risk of volatility and cyber-attacks to which individuals and firms trading and/or investing in crypto assets are exposed to. Moreover, an awareness of various regulatory controls and laws governing investments in crypto assets will ensure that individuals and firms in this sector tread in the path of caution.

Introduction

In various jurisdictions throughout the world, regulatory framework for crypto assets have been developed. The factors that have led to the development of fragments of regulatory instruments include the desire to promote innovation, the threats to the country's financial system; the level of development of the crypto assets ecosystem and the ability of regulatory agencies to develop regulatory instruments for crypto assets (Webforum, 2023).

The factors above including some jurisdiction-specific factors were responsible for the stance of various countries with respect to the regulation of crypto-assets. For example, Central African Republic and El-Salvador (El

Salvador and Cryptocurrency. Available at: https://freemanlaw.com/cryptocurrency/el-salvador/) have recognised Bitcoin as a legal tender while China completely banned the use of cryptocurrency in its jurisdiction (Webforum, 2023)

With respect to the regulation of crypto assets, three approaches are available for various jurisdictions across the world; these are:

Wait and learn: Some countries have decided to observe and monitor development on crypto assets before considering any form of intervention or regulation. A case in point is Ireland where the apex bank does not prohibit trading in crypto assets and at the same time does not issue any regulatory instrument on crypto assets.

Regulate: Countries in the European Union, the United States, Canada and Australia have backed up crypto assets with legal instruments through existing laws and financial regulations. These laws and

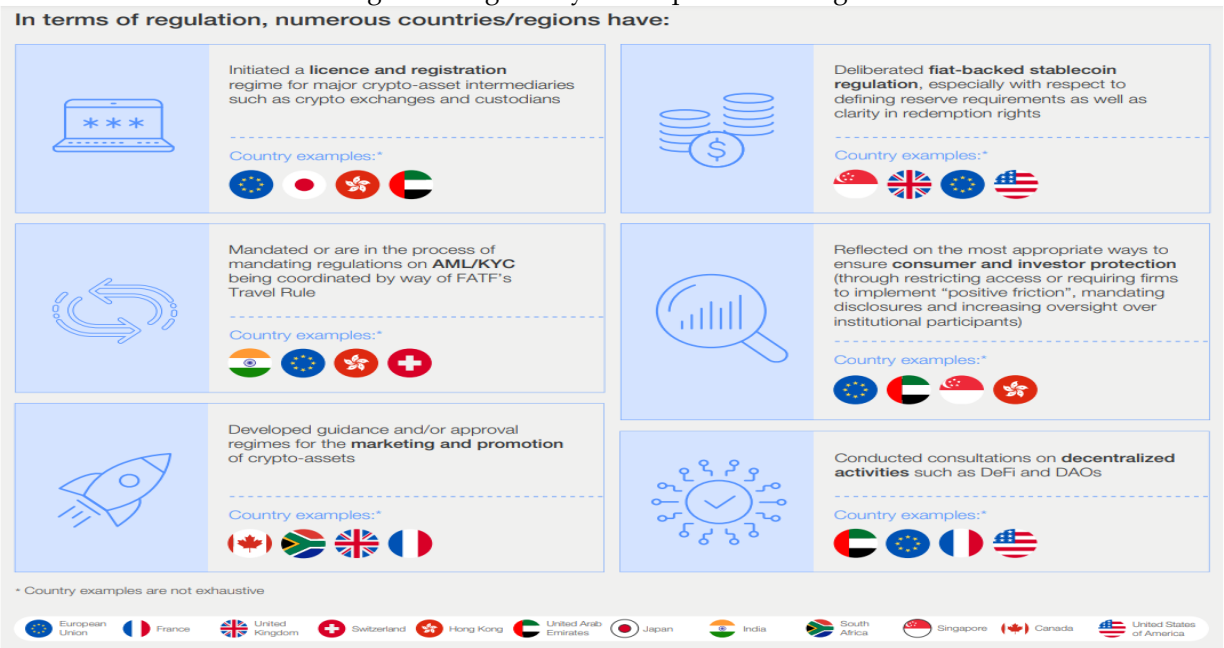
regulations include measures to prevent money laundering, scams, frauds, registration and licensing of crypto exchanges and operators.

Ban: Some countries such as Algeria, Bolivia, China and Egypt have banned completely the use of crypto assets (IFWG, 2021)

It has been noted that the crypto economy in the Sub-Saharan Africa is the smallest when compared with all other regions in the world. It accounted for 2.3% of the global volume of transaction in the period between July 2022 and June 2023 while the total on-chain value which the region attracted within the same period is about USD117.1 billion (Chainanalysis 2023). However, it was also noted that cryptocurrency has become popular in some countries in the Sub-Saharan Africa. For example, Nigeria was ranked as No. 2; Kenya ranked as No. 21; Ghana as No. 29 and South Africa as No. 31 on the 2023 Global Crypto Adoption Index by Chainanalysis (Chainanalysis, 2023). Another study indicated that 9.44% (5.8million) South Africans currently buy, sell or trade in crypto currencies with the expectation that this figure will increase to 43% by the year 2030 (Triple A, 2022).

In recent years, crypto assets have experienced rapid growth and are becoming more relevant within the financial system already being regulated in various countries. Crypto assets and the underlying blockchain technology have the potential to transform the financial landscape in these countries. In swift response to this development, regulators and governments are now considering ways and means of regulating the crypto assets ecosystem in order to protect the players from the increasing risks of fraud and scams as well as the challenges of illegal activities such as money laundering and terrorist financing.

Figure 1: Regulatory developments among countries



Source: Pathways to the Regulation of Crypto-Assets: A Global Approach (Webforum 2023)

In recent years, South Africa has shown interest in crypto assets. A good number of people are investing in crypto assets. Aside this, a good number of people engage in the development of blockchain while others engage in entrepreneurship through start-ups and tech-companies. The blockchain developers, entrepreneurs and banks are also exploring various ways by which blockchain technology operations could be improved to provide better satisfaction to the traders of crypto assets.

The main reason why crypto-assets ecosystem needed to be regulated was to protect the traders of crypto assets in view of the high risk involved in the trade. Again, the fall and death of crypto businesses including Futures Exchange (FTX) in the year 2022 necessitated the need for better regulatory framework for crypto assets in South Africa.

Theory of regulation

According to Morgan and Yeung (2007), a theory of regulation is a set of propositions or hypotheses about *why* regulation emerges, *which actors* contribute to that emergence and typical *patterns of interaction* between regulatory actors. These authors classified theories of regulation into two categories; theories "*that assume a relatively clear dividing line between public and private actors and institutions while others view the line as blurred both in theory and practice*" and other theories "*that focus mainly on economically defined goals, factors and influences, while others supplement this focus with attention to more broadly defined political goals, factors and influences*" (Morgan & Yeung, 2007).

However, Cary Coglianese (2017) stated that in view of the similarities in various regulations, the major differences between them can be understood within the context of four components. The first component is the regulator, the second is the target; the third is the type of command while the fourth is the type of consequences. According to this author, a good understanding of these four key components of any regulation "*can help decisionmakers select appropriate responses to problems requiring some kind of regulatory intervention". (Coglianese, 2017).*

A theory of regulation can therefore be said to be a set of propositions developed to understand the reasons for adopting the regulations and those who were instrumental to the adoption of those regulations as well as the forms of interactions expected between the various individuals or organisations within the regulatory system.

In South Africa, crypto currency is legal. This means that the use of crypto currencies by businesses and individuals is legal. This is why many trading platforms and cryptocurrency exchanges are currently operating in the country. However, it must be noted that the South African Reserve Bank has not declared cryptocurrencies as legal tender in the country although businesses and individuals can trade in cryptocurrencies through the registered platforms and exchanges. In other to protect investors in crypto assets from the risks such as scams, cybersecurity threats and market volatility, the government has established some regulatory frameworks.

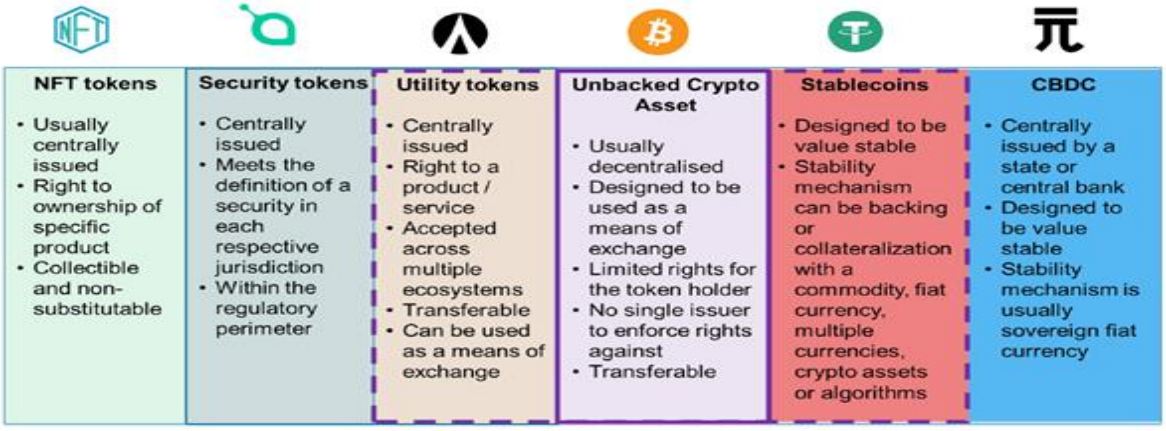
The IFWG CAR WG Position Paper defined Crypto Assets as:

i. *a digital representation of value that is not issued by a central bank, but is capable of being traded, transferred or stored electronically by natural and legal persons for the purpose of payment, investment and other forms of utility.*

ii. applies cryptographic techniques; and

iii. uses distributed ledger technology (DLT)

Figure 2: Crypto Assets Taxonomy



Source: Regulating the Crypto Ecosystem the Case of Unbacked Crypto Assets, IMF note 2022/007

According to the IFWG (2021) and IMF (2022) Crypto assets have been categorised as follows:

Non-Fungible Tokens (NFT) – A unique digital asset that represents ownership of a specific item or asset e.g. art, music, in-game items, videos, and more.

Security tokens - are tokens that provide the holder with rights like that of traditional security.

Utility tokens - are tokens which provide the holder with access to an existing or prospective product or service.

Unbacked crypto assets - These crypto assets are transferable, primarily designed to be used as a medium of exchange and are often decentralised.

Stablecoins - This type of crypto asset aims to have a stable price value. This objective is normally pursued by the crypto asset being linked to a single asset or a basket of assets, for example, fiat funds, commodities such as gold, or other crypto assets. Prominent examples include Tether, Binance USD, and USD Coin.

6.Central Bank Digital Currency (CBDC) - A CBDC can be defined as a form of money that is denominated in fiat currency (central bank money), in an electronic form (SARB)

Crypto assets functions and activities

The crypto asset market showcases a variety of roles and activities with some likened to those found in the traditional financial system. Some of these essential functions are summarised in the table below:

Table 1: Essential Functions and Activities in the Crypto Asset Ecosystem

Functions	Activities
Creation, issuance, distribution, redemption and underlying infrastructure	• Creating, issuing, and redeeming crypto-assets, distribution, underwriting, placement, market-making, marketing, and sales • Operating infrastructure and validating transactions
Wallets and custody	• Provision of custodial (hosted) wallet and custody services • Provision of non-custodial (unhosted) wallets
Transfer and transactions	• Payment for/of goods, services, gifts, and remittances. • Exchange between crypto-assets or against fiat currencies, clearing and settlement
Investment, leverage and risk management	• Use as collateral to borrow/purchase other crypto assets • Trading/borrowing/lending of crypto assets • Direct/outright exposures to crypto assets • Synthetic/derivative exposures to crypto assets

Source: FSB Regulation, Supervision and Oversight of Crypto-Asset Activities and Markets Consultive document 2022

Development of crypto assets regulatory framework in South Africa

In South Africa, the process of understanding and documenting issues relating to crypto assets was initiated in 2014 through a joint initiative of the South African Revenue Service (SARS); the South African Reserve Bank (SARB), the Financial Sector Conduct Authority (FSCA); the Financial Intelligence Centre (FIC) and the National Treasury. These bodies issued a statement to the public alerting them of the inherent risks of crypto assets.

The Intergovernmental Fintech Working Group (IFWG) was established in 2016 for the purpose of gaining the understanding of the ever-increasing role of fintechs and innovation in the financial sector of South Africa. The group was also established to explore how risks and opportunities can be assessed more proactively in both traditional financial and the crypto assets markets. The IFWG's Innovation Hub was established to foster collaborative efforts of the IFWG, through participation with other organisations such as the South African Reserve Bank (SARB), the Financial Sector Conduct Authority (FSCA); the Financial Intelligence Centre (FIC); the South African Revenue Service (SARS); the National Credit Regulator (NCR); the Competition Commission and the National Treasury.

The Crypto Assets Regulatory Working Group (CAR WG) of the Intergovernmental Fintech Working Group (IFWG) published the final Position Paper (CAR Paper) on crypto assets for South Africa in June 2021 termed the IFWG: CAR WG Position Paper on Crypto Asset. This position paper signified a regulatory and policy response to crypto assets activities in South Africa. The CAR-WG made 25 recommendations for crypto assets and related activities. These recommendations include the definition

of entities providing crypto assets services; amendment of FIC Act by adding CASPs to the list of accountable institutions; the Financial Intelligence Centre (FIC) will assume the supervisory role and duties to ensure compliance by those CASPs that would become accountable institutions with the requirements of the FIC Act; the CAR WG will continue monitoring the crypto asset ecosystem as well as defining and implementing monitoring programmes to track progress with the implementation of the recommendations; Crypto assets will remain without legal tender status and not be recognised as electronic money.

Crypto assets will not be allowed for settlement obligations in financial market infrastructures such as the South African Multiple Option Settlement (SAMOS) system; the Financial Surveillance Department of the South African Revenue Board (SARB) should assume the supervisory and regulatory responsibility for the monitoring of cross-border financial flows in respect of crypto asset services; Crypto Assets Trading Platforms (CATPs) should be required to report crypto asset transactions to the Financial Surveillance Department of the SARB; CASPs offering custodial services and/or digital wallet provisioning should be accommodated within the appropriate licensing activity under the CoFI Bill, and as a financial service as contemplated under section 3(1) of the FSR Act; the current stance that collective investment schemes and pension funds should not be allowed to have exposure to crypto assets should be maintained and many other policy recommendations

The CAR WG Paper also provides a roadmap for a regulatory framework for CASPs. The CAR Paper proposed the FSCA to be the regulatory authority to license, supervise and investigate Crypto Asset FSPs.

In November 2020, FSCA published a draft for public comments on the declaration of crypto assets as a financial product within the FAIS Act. This declaration was also aimed at providing a form of control for the CASPs and assist in mitigating the risks in the crypto assets sector. However, the proposed Conduct of Financial Institutions Bill (COFI) will become an instrument for achieving these objectives after the CAR WG had concluded discussions in this regard.

In October 2022, crypto assets referred to as a 'digital representation of value' was officially declared as a financial product in terms of the FAIS Act. Crypto assets were therefore subject to section 1(h) of the Financial Advisory and Intermediary Services Act (FAIS). All existing crypto assets service providers were also mandated to register with FAIS by the end of 2023. They were also expected to register with the Financial Intelligence Centre (FIC) as well as complying with Anti-Money Laundering (AML) and the Counter -Terrorist Financing (CTF) requirements. The effect of this declaration is that individuals and businesses acting as brokers or advisors in respect of crypto assets are expected to register as an FSP. The declaration also placed a significant regulatory controls and licensing regime under the oversight and supervision of FSCA. (FSCA FAIS Notice 90 of 2022; FAIS Act, 2002).

As a follow up to the declaration, an information was published by the FSCA through paragraph 3(2) of the FSCA FAIS notice of 2022 demanding that all Crypto Asset FSPs to provide information on their businesses and its operations.

It is envisaged that other relevant issues with respect to crypto assets will be addressed by COFI Bill as a form of legal framework governing the conduct of all financial institutions in South Africa. Broad regulations regarding financial activities in the crypto assets sector will be included in the licensing conditions to be specified in the COFI Bill beyond the scope of crypto assets activities which are currently under the scope of the Financial Advisory and Intermediary Services (FAIS) Act.

In South Africa, advertisements of crypto assets are now regulated by the South African Advertising Regulatory Board through its Code of Advertising Practice amended in January 2023 to accommodate new requirements for advertisement of crypto assets. These new requirements demand that advertisers of crypto assets must state that investments in crypto assets may lead to capital loss so that members of the public investing in crypto assets will exercise caution. In addition, professionals, influencers, and ambassadors operating in the crypto assets social media space must also comply with the rules in the social media code to avoid sending wrong and misleading messages to the public.

On taxation, the South African Revenue Service (SARS) classifies crypto assets as intangible assets. Therefore, any gains from trading in crypto assets are subject to tax on a rate depending on the trader's income tax bracket. However, the current maximum rate of 45%.

Conclusion

In view of the growing interest in crypto assets in some countries in Sub-Saharan Africa including South Africa, the need for crypto assets laws and regulations cannot be overemphasised. These laws and regulations are necessary to the protect the investing public from the cyber threats and volatility in the crypto assets market as well as ensuring the stability and growth of the crypto assets sector. South Africa is one of the countries that has taken the bull by its horns through the enactment of laws and the development of regulatory frameworks on crypto assets.

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The impact of Artificial Intelligence on E-commerce supply chain sector in achieving cost efficiency and economic growth: A business and economics perspective

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Keywords
Supply Chain Management (SCM), Artificial intelligence (AI), Machine Learning (ML), GenAI, predictive analytics, economies of scale

Abstract
The study aims to find how much cost effectiveness is achieved when e-commerce supply chain operations use automation and AI technologies. therefore,ing technology of AI and its models have essentially proved to be impactful in making data driven decisions by the organisations gaining leverage in productivity and profit sustainability in a way that the companies achieve competitive advantage therefore creating sustainable value propositions from business and economics perspective.
Aim/Purpose
The aim of the paper is to explore the positive relationship between AI technologies and productivity levels in the e-commerce supply chain sector through achieving cost effectiveness and economic growth.
Methodology/Approach
The study focussed on reviewing literature on how Artificial Intelligence driven technology can optimise various supply chain functions within e-commerce sector. Solow-Swan growth model has been applied to investigate the value AI creates in utilising capital, labour input to achieve output growth. Positivist approach that allowed for objective observation and independent conclusions has been adopted. For primary data, quantitative methodology is used through survey questionnaires to gather data from a sample of 206 employees, managers, data analysts in e-commerce supply chain sectors.
Findings
The findings from the secondary sources inform that the use of AI and automation in the e-commerce industry leads to a high rate of productivity in terms of reducing costs and promoting economic growth. The primary research methods, through survey questionnaires collects real-time data that helps achieve quantifiable and measurable values to conclude that AI-led technology can increase productivity and competitive advantage as it saves cost while increasing productivity and overall economic input. Descriptive statistics of measures of central tendency were used to present findings in simpler, presentable way followed by interpretations of the data in percentages.
Practical implications
Managers and decision-making directorial board members have important lessons to learn from these findings as the quantifiable values may give them an insight into how much capital investment should be allocated for AI technologies and how predictive analytics and data analysis can accelerate their service towards becoming customer centric. Significant strategic planning and implementation of resource management can lead to higher rates of productivity profitability and eventually higher economic growth.

Introduction

The past decade has seen the exponential growth of Artificial Intelligence, ML and data analytics that have impacted people's lives in several ways. However, the inclusion of this technology into business has caused major digital transformation with various algorithms in marketing, production, supply chain and

distribution functions of a business, where data can be gathered on customer preferences, then demand can be gauged and means to supply the need at an increased speed and accuracy is possible that can save time and cost. Robotic machinery with IoT functions allows investment on physical capital yield productivity and operational efficiency. AI-driven technology in Supply Chain functions of e-commerce businesses has become a key driver of efficiency, scalability, and financial growth.

The use of AI in e-commerce Supply Chain operations

The e-commerce Supply Chain Management (SCM) practices involve various functions around procurement of raw materials to logistics and distribution (Lee & Billington, 1995). All these functions require planning, end to end visibility, transparency, speed, resilience, accuracy and budget (IBM, 2023). The amount of time and cost spent on these functions become essential deciding factors when organisations want to achieve competitive advantage. To make these processes smarter and sustainable in terms of creating time and cost value, AI, with its mathematical programming, is becoming increasingly crucial as it can access and analyse data, predict demand and supply, enhance visibility of inventory and warehouse management, improve logistics and altogether meet customer expectations with speed and accuracy.

This is functionally proven in case of business to business (B2B) operations with a higher share of e-commerce market revenue which is expected to increase to $20.9 trillion by 2027 mainly because manufacturers are using online platforms creating a unique environment where buyers feel highly competent to use e-commerce platforms (Research and Markets, 2020). Therefore, the supply chain practices face the requirement of being data driven in the functions of operational management and the use of AI in this regard becomes essential.

More importantly, integration of AI led technology gives cost advantage through various innovative interventions and automation and helps achieve economies of scale (CFI, 2023) and further substantiates the fact that the economics of AI networks can help businesses achieve market dominance (Wagner, 2020), This business and economic perspective aligns with Schumpeter's definition of innovation as it carries out business activities in a way it affects the realm of economic life positively (Sweezy, 1943). Solow-Swan growth model can also be adapted to consider the positive effects of yielding high productivity levels in the e-commerce supply chain sector with the inclusion of AI technology combined with capital, labour input.

The following section studies how AI-led technology provides businesses a leverage to increase profits by using predictive analytics, big data, data analytics in demand and supply planning, automated and robotic operations in warehouses, using generative AI and chatbots in customer relationship management and smart technologies and routing softwares in logistics. It also focuses on cost effectiveness in various SCM practices and how AI drives productivity growth in this direction.

Literature Review

Reducing costs through AI-enabled Demand and Supply planning

The advances of AI tools such as intelligent automation, data analytics, supply chain analytics and predictive analytics have allowed businesses to make strategic data driven decisions by planning according to the demand in the market and supplying as per the demand. Forecasting of demand ahead of time by studying market trends in a certain period enables organisations to achieve higher visibility, accuracy and speed in making timely decisions (Min, 2015, pp 89-96) and therefore increase cost effectiveness. With the use of comprehensive predictive models, e-commerce companies such as Amazon and Ebay are able to gauge future demand to make informed decisions which is then shared to their partners in supply chain to put in team effort to deal with demand competently, streamline operations and consequently increase time value (Forbes, 2021). When these processes are digitised, the data shared between suppliers can yield reliable and productive outcomes (Financial Times, 2022). Cognitive intelligence by AI can predict peak and non-peak times of the year so that businesses can set their priorities in functioning accordingly therefore allowing strategic decisions for real time order-sourcing and inventory optimisation (Financial Times, 2022). Such practices can save time and cost for the SCM operations. From economic perspective, the use of AI in e-commerce SCM sector has potential to create an

economy of $13 trillion (Liu & Lin, 2020) because the demand and supply functions indicate that the inclusion of AI increases the effectiveness of personalisation that yields higher rates of customer satisfaction and leads to increased demand for goods at a given price. For example, Amazon uses ML aggregation to predict customer behaviour regarding a product, analyse demand for it and showed that such a practice in product-demand forecasting increased its productivity rate by 15 times (Forbes, 2021).

Saving costs in Inventory management

Besides empowering SCMs with improved connectivity, visibility, and responsiveness with its predictive analytics in demand forecasting, AI has also been delivering impactful results through Machine Learning (ML) and robotics in the functions of inventory management to automate repetitive tasks, analyse data and promote communication among staff, reduce costs and boost overall performance of the organisation (Alotaibi, 2022). Most e-commerce companies such as Amazon, Alibaba and Ebay use robotics and Big Data to optimise inventory, maintain stockouts and overstock situations by making accurate predictions of the existing stock through the enhanced visibility provided by AI models. Inventory replenishment using real time data increases sales velocity and determines where and when the products should be made available (AWS, 2023). Automated Machine Learning (AutoML) is another modern method that aims to improve performance on time-consuming and iterative tasks by automating them. (AutoML, 2022). ML and ANN-enabled sensors can anticipate machine maintenance issues, identify quality issues, and detect data inconsistencies, resulting in improved performance and predicting potential disruptions. (Silva et al., 2017). This leads most business experts to believe that these smart applications may automate 40% of repetitive work in the sectors such as e-commerce divisions of marketing and hospitality in the next fifteen years (Loebbecke et al., 2020).

In case of packaging and item sorting, AI powered robotic machines reduce human labour and improve operational communication by offering feedback for self-correction and helps achieve almost 99% accuracy at packaging lines (Forbes, 2020). Added to this are the AI-led cameras which use rule-based analytics to read the bar codes, record and classify packages and move along the distribution process while administering quality checks and locate inherent issues thus reducing marginal costs and creating economic value (Forbes, 2020).

Robotic Process Automation (RPA) utilises machine learning and robotics to automate repetitive tasks like data recording, tracking orders, and invoices, making the processes time and cost effective and allowing businesses like Amazon to focus on demand forecasting and customer needs. Amazon successfully utilises robotics and AI in processing nearly 75% of its customer orders. (Tolba, 2023). Robotic technology and machine learning algorithms minimise the downtime so that the use of time and resources is optimised. For example, Amazon's Proteus robot, equipped with ML capabilities for perception and navigation, assists employees in lifting, moving wheeled transports, and packages, unlocking time value. (Amazon, 2023). Also, the AR ID (Amazon Robotics Identification) replaces the need for handheld scanners with its advanced camera system, allows employees to have better mobility, work with both hands and complete their tasks within the given time schedule (Amazon, 2023).

Such inclusion of AI tools helps optimise Lean, Agile and data-driven approaches to make the business achieve greater competitive edge (Michigan State University, 2023). These approaches fundamentally aim at reducing costs and making effective timely decisions that can be profitable to the companies.

Cost effectiveness in Customer Relations Management

Most e-commerce SCMs include in their operations the task of automating CRM by collecting data of customer preferences based on past purchases and analyse their tastes and habits to produce items according to the demand (Zhu, 2022). For example, Amazon uses its in-house cloud-based system, Sales Force through AWS, to track its customers and their interactions so that it can make recommendations, making it a smooth and easy-to-use interface that enhances customer buying experiences with easy access to order history, tracking product software, and automatic returns policy (AWS, 2023). AI inclusion in CRM has significantly boosted its sales that in the fourth quarter of 2022, it reported $149,204 billion in revenue which is a 9% increase from the previous year (Expert Market, 2023). The advent of AI and

Generative content involving chatbots and algorithms such as ChatGPT have created increasing demand for personalised content so that businesses can use them as channels to reach customers without much human intervention. This market size has the ability to reach $16.8 billion by 2030 (Forbes 2023). In 2022, B2B and B2C supply chains of up to 58% used chatbots while nearly 88% of online customers had a conversation with a chatbot of which 69% were satisfied (Hostinger, 2022). The AI-driven chatbots serve the purpose as a customer service application which is economical as it offers round the clock customer service.

AI chatbots with their customer-facing application reduce costs in the functions of customer service. Most humanoid bots such as My Assistant tool by Walmart write up drafts and sum up large documents with data similar to Ebay using TCG Player to enhance its collectibles market (Retail Dive, 2023)

AI anomaly detection models make the administrative tasks such as payment transactions more accurate as the systems are trained to detect fraudulent practices involved with credit cards, improper claims by using artificial discretion. Through this model, organisations could save up to $2.6 billion in 2018 by gaining four dollars for every dollar used (Bullocks, Yang & Wang, 2020).

Logistics and distribution

In the retail logistics and e-commerce domain, order picking from the warehouses to delivering the finished product to the customer is a labour and cost intensive activity (Klumpp and Loske, 2021). The advanced AI-led routing algorithms help decide delivery routes which predict traffic jams, traffic times, delivery times, and vehicle capabilities therefore reducing time spent in traffic and the cost of delivery. Radio Frequency Identification (RFID) technology with IoT inclusion, helps cut down delivery times, monitor goods and track vehicles for routing to achieve better visibility (Financial Times, 2022). These systems increase value for operational retail managers as they find efficiency rates increasing in the order pickers as entrance hurdles as well as costs involved with time to invest are lowered (Klumpp and Loske, 2021). The quick deliveries provided by the ecommerce chains have become successful in planning, packing, distributing and physically dispatching on the same day and sometimes the same hour only because of AI technologies. Amazon's application called 'Flex' calculates the number of drivers and vehicles, the number of shipments and decides the sizes of containers into a vehicle (AWS, 2023) directly increasing the customer satisfaction levels and customer loyalty towards the company which in turn boosts sales. In the e-commerce age, poor routing and late deliveries can increase costs and time by 50% when the customers prefer one-day and one-hour deliveries, necessitating the use of standard routing software for faster delivery options. (AWS, 2023). Amazon has benefited from the inclusion of smart technology in terms of creating time value (time to invest) for those operational managers who preferred order pickers' efficiency while at the same time reduced transaction costs of entrance hurdles of securing a qualification – a transaction cost that relates to scientific management approach (Klumpp and Loske, 2021)

AI productivity in reducing costs and promoting economic growth

The core of AI is to increase productivity; therefore, it is directly linked to economics and predictions in the economy because of which experts think that AI could hike the global economy to $15.7 trillion by 2030 (Forbes, 2020). AI, using machine learning and deep learning, offers economic advantages by utilising digital economies of scale, reducing marginal costs and allowing for asset reuse (Forbes, 2020). AI is crucial in supply chain operations as machine learning and deep learning algorithms enhance customer value and help businesses achieve their economic objectives.

Statista records that nearly 51% of their survey respondents opined that the integration of AI can lower operation costs by over 20% which may be due to the fact that fraud could be detected more efficiently, market demand could be predicted, and sales could be monitored (Hostinger, 2022). For example, the combination of ML, deep learning and computer vision have enabled Amazon to measure the packaging exactly fit for each product since the technology has a smart automated mechanism to save cost and has reduced shipment packaging by 36% and eliminated 2 billion shipping boxes in 2021 (Amazon, 2023). Furthermore, the Digital age of e-business induced more efficiency within processes of an organisation with e-signatures, e-invoice, e-payments, mobile banking and altogether creating an e-commerce environment that cuts costs and boosts financial growth.

As a result, the amount of data is increasing at a high rate that AI systems are inevitably gaining prominence in the business world especially through the future trends in banking and financial services paving the way for new opportunities to reduce costs and increase revenues. (Dirican, 2015) as mentioned by Porter about value creation and competitive advantage theory where profitability and sustainability occur when costs are minimised or value is maximised (Porter, 1985).

Theoretical frameworks

Economies of scale

Technology can help businesses become more flexible and adaptable, lower expenses and errors, make the best use of their assets, and speed up operations and communications (Amazon, 2023). AI-enabled SCM operations offer potential for economies of scale, and a combination of technology and expert skills can create a productive AI ecosystem, allowing employees to be liberated from monotonous jobs. (Dive News, 2020). Reduction in promotional costs, reduction in logistics, cheaper capital and the fact that it spreads risk allows AI technology to achieve economies of scale (CFI, 2023). Supply-chain technologies cannot accomplish their business goals unless the appropriate solutions are used in this area to achieve economies of scale. (Financial Times, 2022). Economies of scale occur when long-term costs decrease and output increases, enabling companies to predict demand leading to bulk buy raw material, use advanced machinery, and aim at target specific markets for advertising. (CFI, 2023).

Solow-Swan growth model

The levels of productivity gained through AI incorporated systems in e-commerce supply chain functions can be applied to Solow-Swan neoclassical exogenous growth model by the economists Robert Solow and Trevor Swan in the 1980s who proposed that long term growth is the outcome of more capital, labour and innovative technology. The aggregate production function is achieved when output i.e., higher rate of national income is a direct outcome of higher labour input, higher capital investment and the rate of technological progress or innovative ideas. In the case of the current study, AI is the factor affecting productivity and technology drives this productivity further to accelerate economic growth through reducing costs and increasing profits. This is exactly what is observed in the use of AI in e-commerce supply chain where automation, robotics in inventory and warehouse environments as well as predictive analytics and data analytics in demand and supply planning and use of chatbots and generative AI in improving customer relationships bring an equilibrium between the input of human capital, physical capital, and innovative technology. This equilibrium achieves productive growth and valuable output of more profits, therefore more GDP overall.

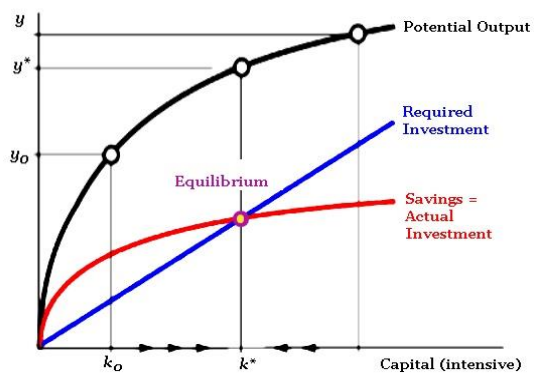


Fig.1 Solow-Swan exogenous growth model
Source: Adapted from Solow-Swan (1956)

Research methodology

The research investigates how AI and automation affect e-commerce supply chain management (SCM) in terms of cost effectiveness. It employs a positivist approach using quantitative methods to independently draw conclusions. The study utilizes both primary and secondary data, employing descriptive non-experimental research and subjective analysis to gain valid insights and analyze AI's

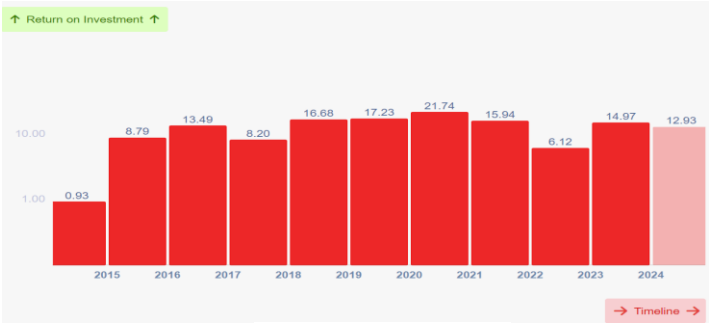
implications on businesses. Employing a deductive research approach, the study examines cost reduction and uses standardized protocols to collect data from income statements and annual reports of e-commerce companies, steering clear of set beliefs and assumptions. Random sampling is used for cluster sampling, targeting various professionals in e-commerce SCM environments. Questionnaires were administered to collect data from groups directly involved in AI-led work environments. The study ensures validity through descriptive statistical tools and neutral data, preventing bias through random sampling. It also provides examples from e-commerce platforms like Alibaba and Amazon to enhance the generalization of AI's impacts on SCM operations.

Findings and Analysis

Secondary data findings:

Secondary data shows that businesses incorporating AI technology in their supply chain management have significantly increased their net profits. Amazon, for example, saw a 741% increase in net profit over the past decade (Statista, 2023), demonstrating the productivity growth rate in these sectors through cost savings.

ROI of Amazon Inc



Source: Statista (2023)

The graph shows Amazon's ROI (Return on Investment) where it is evident that the company could receive benefits from the investment in made. The data shown in the graph above indicates the steady returns for the past 10 years and have not been affected by changes in the market. The ROI metric is important as it shows how Amazon gained profits from the investment it made. It is also significant as it allows companies to make strategic decisions on investments in the future. The table below shows Amazon's investment on Technology and infrastructure and gross profit in billions of USD.

Technological investment

Year	Technology expenses (billions USD)	Gross profit (billions USD)
2022	73213	225,152
2021	33,364	197,478
2020	21,331	152,757
2019	11,588	114,986
2018	10,073	93,731
2017	3,033	65,932
2016	2,371	47,722

Table 1. Technological investment over 7 years in Amazon Inc. Source: Macrotrends (2023)

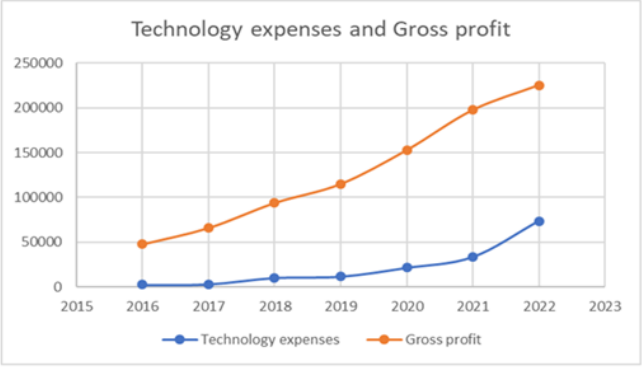


Fig 2. Graphical representation of information in Table 1

This data shows the relationship between the investments and profit gained during a period and indicates that decision to make investment in technology leads the company on growth trajectory. Since Amazon invested in Research and Development for AI technology, the steady returns gained point to the fact that inclusion of AI machinery and technology can ultimately earn profits for the businesses and overall economic growth for the nation.

Primary data findings and analysis:

Supply chain management practices are the performance indicators in this data study, and the primary data was gathered from 206 respondents to investigate the potential benefits of AI-led technology on these practices. Productivity is measured by cost effectiveness through savings on days in inventory, forecast accuracy, on-time delivery, and cost value gained through customer preference predictions and customer service via AI. The main data findings validated the data found in the literature study by providing a measurable percentage-value to know how much productivity is attained through cost savings. Percentage values alongside metrics generated by measures of central tendency of descriptive statistics are used in this analysis, and conclusions are derived from them with ramifications for the other SCM procedures.

The data gathered from the responses given in the survey questionnaire is summarised in the table below considering costs reduced on effective stock prediction, overall operational costs, packaging, robotics, labour and legal compliances, deliveries and distribution, use of chatbots and consumer preferences prediction. From the survey results gathered from 206 respondents, only category (2) i.e >40 and category (3) i.e >50 is considered in the table below. Those who chose under the value of <40 (category 1) was not considered as they were less than 20% of the sample.

Cost efficiency with AI in e-commerce SCM practices – no. of responses			
Cost reduction on	**<4 0%**	**> 40%**	**> 50%**
stock prediction	82	70	54
operational costs	80	69	57
packaging	77	75	54
robotics	68	88	50
labour & legal compliances	84	69	53
deliveries & distribution	75	70	61
customer service through chatbots	79	78	49
e-payments, e-receipts, e-bills	81	61	64
customer focussed e-commerce	75	70	61
consumer preference prediction	93	64	49

Table 2. SCM practices and cost efficiency of AI

The research explores the impact of AI models on supply chain management (SCM) practices in e-commerce companies and found that AI reduced time on stockouts and overstocks by 40% therefore avoiding unnecessary costs and increasing profits. Additionally, it revealed a correlation between investment on technology and profitability, highlighting the importance of operational excellence and timely delivery. Nearly 42% of respondents agreed that AI models such as predictive analytics, supply chain analytics, Big Data, Robotics, Machine Learning are used in the major e-commerce settings to produce impressive results of more than 40% gain in cost effectiveness. The research also revealed a significant increase in customer satisfaction rates to 59.73%, indicating operational excellence and therefore increasing productivity rates by 39%. It also explored the use of AI-led systems in supply chain operations, showing that predictive analytics, Gen AI models, robotics, and routing software significantly reduce cost by more than 40%, leading to increased profits. The primary data collected shows that 70% of respondents found the technology reliable, especially for faster service like Prime Now therefore increasing the number of sales. The efficiency rate on packaging is more than 50%, and real-time productivity is 63%.

The values presented in the table above are calculated using descriptive statistics as shown in the table below.

> 40%		***> 50%***	
Mean	71.4	Mean	55.2
Standard Error	2.3860706 89	Standard Error	1.69836 523
Standard Deviation	7.5454180 36	Standard Deviation	5.37070 242
Minimum	61	Minimum	49
Maximum	88	Maximum	64

Table 3. Measures of central tendency values based on Table 2

From the data presented, it is evident that the inclusion of AI technology into SCM sectors can enhance the capability of overall productivity in e-commerce companies. The average mean of over 71.4 for >40% and 55.2 for >50% with a standard deviation of only 7.5 and 5.3 indicate that there is high rate of consensus on the fact that this technology can be productive in yielding profits by more than 40% showing a positive relationship between AI technology and productivity and ultimately profits and economic growth. The graph below is a visual representation of the descriptive statistical values shown in Table3.

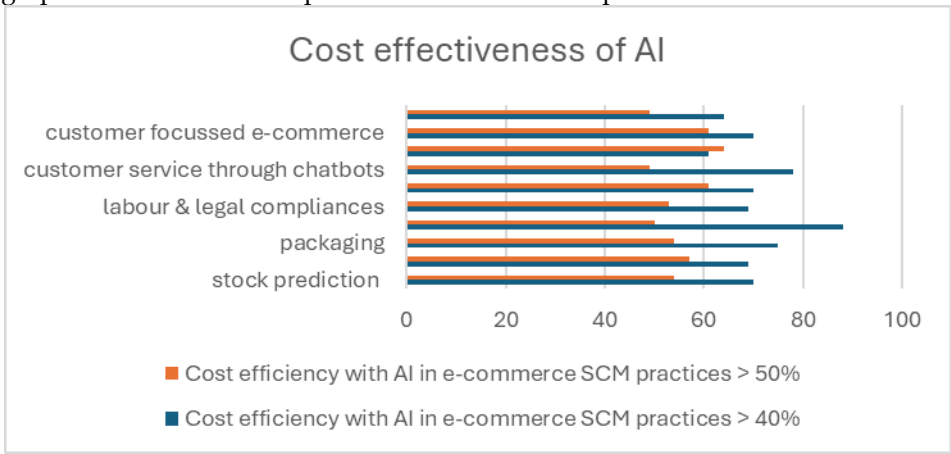


Fig 3. Graphical representation of cost effectiveness of SCM practices through AI

The data shows that there is a gain of more than 40% from the time saved on the repetitive chores around the warehouse which means that the time that is saved can be productively used to carry out

further jobs therefore allowing the companies to produce more and ultimately promote overall growth. Predictive analytics model of AI, with its high rate of accuracy in predicting customer preferences, is evolving to be a lucrative tool for companies to manage supply and demand effectively. Inclusion of robotics and machine learning have considerably reduced the cost on labour and legal compliances which means that the company can invest its funds on training employees to achieve higher skills in managing AI modelled machines. Furthermore, if a company can save up to 50% on overall operational costs on e-receipts, e-bills, chatbots and humanoids in the place of a live employee, GenAI for generating content, it amounts to considerably high profits which indicates that the capital invested on the projects has yielded good results. The amounts saved on one task can be reinvested on another so that there is growth in multiple areas. The high percentage values shown for customer engagement and customer satisfaction rates present a case that inclusion of AI through generative apps and chatbots have been motivating customers towards the business. Added to this is the efficiency growth rates in sourcing and distribution, deliveries which got quicker and therefore increased customer satisfaction rates. If the customers are satisfied, the customer base will increase, and this eventually grows the market share for the company and sustainability in profits will lead to overall economic growth of the nation. One of the key principles of economic growth, which is efficiency, is achieved through incorporating AI systems into work environment. Economic growth of a nation is a key indicator of gross national income as the personal consumption expenditures will grow leading to growth in workforce and eventually growth in productivity and increased per capita GDP.

Practical implications and recommendations for the managers at SCM operations

AI has a major impact on SCM operations, accelerating productivity and profitability growth. Managers in this sector can learn vital lessons. First, effective demand and supply planning enables managers to make critical decisions about product life cycle, promotions, trend analysis, pricing, and consumer preferences. Given the pressing requirement for accurate forecasting and regular updates of cutting-edge techniques, artificial intelligence (AI) may be essential to these procedures. The frequency with which customers attempt to purchase or look for a product online is used to measure demand. These processes can speed up production lines, supply lines and increase productivity levels and eventually have a positive effect on overall economic growth. Therefore, the data provided by AI tools in about customer demand is essential for the managers to make quick and effective decisions.

AI technology can increase the likelihood that moving, loading, and unloading times can be cut by 50% through warehouse automation within the logistics component of supply chain management procedures. By determining the optimal path, the routing apps save money and time spent in traffic. This enables deliveries to reach customers faster and at a lower cost, with time efficiency exceeding 70% and cost efficiency more than 40%, improving productivity and giving businesses a competitive edge. Managers and data analysts have important lessons to learn here as the input obtained from this data points to the immediate need for not only investments in AI technology but also on training and development for the employees to cope with this inclusion. The ultimate goal of any organisation is to obtain a significant market share, and this can be achieved when capital investments in AI machinery increase, and operational costs reduced which eventually boosts profits and contributes to national income and overall economic growth. Hence, when managers and directors make key business decisions it is essential to consider the benefits of AI-led investments into their businesses.

Limitations

Much of the data used in the primary research came from survey questionnaires. The analysis was quantitative, and interviews were not possible because of data protection and security regulations with e-commerce companies. Because the primary source of data for this study was survey questionnaire responses, it is quite narrowly focused. Research on how AI technology contributes to competitive advantage did not allow comparisons between different companies because there are very few e-commerce companies that have adopted AI enabled systems in their supply chain management (SCMs). Thirdly, the likelihood of bias in respondents' data combined with the lack of precision and end-to-end visibility in the data could be another constraint. Fourthly, the shortened duration restricted the ability of

researchers to conduct in-depth research. Ultimately, the financial and operational risks associated with implementing advanced AI systems may prevent certain organisations from implementing the research findings.

Conclusion and Recommendations for further study

The study's goal was to find out how using cutting-edge AI devices and systems may give SCM operations a long-term, cost-effective competitive advantage. The current study demonstrates that there is a significant amount of room for profit maximisation and cost and time efficiency achieved by e-commerce businesses through the integration of AI-led technologies into their supply chain management (SCM) systems. While recognising the limitations of this study , it can be concluded that the intended research objectives have been met, and the hypotheses that there is a positive relationship between investment on AI technology and productivity and economic growth. In the future research, it is recommended that more information is drawn on how much each of the e-commerce companies invest on AI technology per year. This information may bring more clarity on the trajectory of the economic benefits that AI may yield. Also, it is recommended that qualitative research methods should be used to obtain more reliable data from the employees and managers within SCM sectors.

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Advancing Work-Life Equilibrium through Employee Engagement and Innovation

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Keywords
Information Technology, Innovation, Leadership, Employee Engagement, Job Satisfaction, Human Resource Professionals.

Abstract

The importance of employee engagement and work happiness cannot be overstated in the context of organisational success, especially within the highly competitive Information Technology (IT) industry. This abstract presents a comprehensive study that examines the complex correlation between employee engagement and job satisfaction as well as the employee innovation and job satisfaction within the IT industry. The research utilises quantitative surveys and a standardised questionnaire to collect data from information technology workers across different job positions as well as the stages of expertise. The study evaluates the employee engagement influences, employee innovation, job satisfaction and identifies the reasons that impede all engagement, innovation and satisfaction levels. SPSS-22 is employed for doing descriptive analysis and regression analysis.

The study's primary findings indicate a robust and favourable association between employee involvement and job satisfaction specifically within the IT industry. Employees are enthusiastically involved in their work have been found to experience higher levels of job satisfaction, enhanced productivity, and a stronger sense of dedication towards their respective organisations. The study additionally finds several factors that contribute to involvement within the IT business, including but not limited to possibilities for enhancing skills, acknowledgment of achievements, and the congruence between personal and organisational ideals. In contrast, the research emphasises the obstacles that could hinder the level of IT employee engagement and job satisfaction. These issues encompass an overwhelming workload, an absence of equilibrium between work and personal life, and a scarcity of prospects for career progression. This link is further examined by considering factors such as leadership quality and communication within organisations, which are seen as influential variables.

The research highlights the importance of cultivating employee engagement and employee innovation as a strategic necessity for IT organisations aiming to augment job satisfaction, retain exceptional personnel, and attain sustained success. This publication offers pragmatic insights and suggestions for human resources professionals and organisational leaders to enhance levels of engagement, foster job happiness, and ultimately optimise the performance and well-being of information technology personnel. In summary, this research provides significant contributions to investigate the composite relationship between employee engagement as well as employee innovation on work satisfaction within the information technology industry. This statement underscores the belief that organisations functioning within this industry consider a motivated and engaged staff to be a crucial asset. Furthermore, it suggests that endeavours aimed at improving employee engagement can significantly influence job satisfaction, organisational performance, and employee retention.

Introduction

The evolution of human resource management has witnessed a continuous transformation, marked by evolving expectations from both employees and employers. Organizations have shifted from a paternalistic approach to one focused on guiding and mentoring, eventually fostering a nurturing and growth-oriented environment that encourages employees to make dynamic decisions. Performance management has evolved from mere assessments to fostering a more symbiotic relationship between employees and employers. It's about creating an environment where employees feel valued, supported, and motivated to contribute their best while aligning their goals with the organization's objectives. This

shift involves continuous feedback, coaching, and development opportunities rather than just annual reviews. It's about establishing clear communication channels, setting achievable goals, and providing the necessary resources for employees to thrive. When organizations prioritize this relationship, they often see increased engagement, productivity, and overall satisfaction among their workforces.

The persistent adverse effects of the ongoing COVID-19 pandemic have led to deteriorating working conditions for employees, increased psychological stress, and concerns about job security (Jin et al., 2022). In such challenging business environments, organizations are compelled to adopt innovative processes and strategies to ensure adaptability and sustainability. Organizational innovation encompasses a broad spectrum, including research and development (R&D), marketing, processes, products, and managerial innovation. Recognizing the pivotal role of employees, particularly in service industries, our focus is primarily on Innovative Work Behaviors (IWBs).

The importance of IWB is well-established in the literature on organization and human resources management. For instance, Li et al., (2019) stressed its importance in building organizational sustainability and gaining a competitive edge, while Anderson et al. (2014) argued that understanding the factors that enhance employees' IWB is critical for organizational success. Earlier research by Scott & Bruce (1994) highlighted the connection between IWB and the strategic survival of organizations in various social and economic contexts, emphasizing the need for further exploration of the individual and organizational factors that facilitate IWB. Similarly, IWB is crucial not only for innovation-based companies or roles but for all members of an organization. Recognizing the prominence of driving IWBs, researchers have increasingly focused on understanding its prerequisites and predictors (Tian et al., 2021).

In their endeavor to stimulate and promote IWBs among employees, managers encounter various challenges, such as gauging employees' readiness for innovation, addressing disparities in the work environment, and overcoming potential hindrances rooted in organizational culture (Tan et al., 2021). In this context, we propose that employee engagement (EE) has the potential to facilitate employees' IWBs. The concept of EE has gained widespread recognition among academics and practitioners in current time period (Saks and Gruman, 2014; Bakker and Albrecht, 2018; Sahni, 2021). While a substantial body of research on work engagement and creativity exists, it has predominantly been conducted within Western contexts (Hui et al., 2020). Mansoor et al. (2021) argued that organizational innovation and competitiveness hinge on the presence of an engaged and innovative workforce (Sahni, 2021).

According to Bakker and Albrecht (2018), highly engaged employees make significant contributions to productivity and maintain high levels of satisfaction, citizenship behavior, and performance. Schaufeli et al. (2002) defined work engagement as an employee's positive, fulfilling, work-related state of mind characterized by dedication, vigor, and absorption. Existing literature lacks consensus on the antecedents and outcomes of employee engagement (Saks and Gruman, 2014; Bailey et al., 2017). In a meta-analysis of 130 studies, Borst et al. (2020) indicated that EE is positively related to two key attitudinal outcomes: commitment and job satisfaction, while it is negatively associated with two behavioral outcomes: turnover intentions and workaholic.

Our research extends the learning of IWBs as a consequence of EE among the workforce in the Indian IT industry. In this research, we aim to address the question of whether EE facilitates both IWB and Work-Life Balance (WLB) among IT sector employees. Additionally, we aim to investigate the potential role of WLB as mediator in the relationship between EE and IWBs. Thus, our research contributes valuable insights into how service companies can stimulate the IWB of their employees to navigate the rapidly evolving business landscape in the post-COVID-19 era. Specifically, our study underscores the importance of EE in promoting WLB and driving employees' IWB, and it suggests that EE and IWB relationship is mediated by WLB.

Theoretical background and hypothesis development

Employee Engagement

There exists a positive association in employee engagement and factors such as happiness, satisfaction, and productivity. However, it is important that the presence of happiness and satisfaction in an employee does not guarantee their level of engagement. The disappearance of these concerns occurs through a telephone conversation initiated by a consultant, who presents an enticing salary increase to an

employee, who subsequently expresses contentment by accepting the offer. Engagement is commonly perceived as a mindset or conduct that encompasses being actively occupied with, deeply immersed in, captivated by, dedicated to, retained within, and firmly attached to our professional endeavours or organisational affiliations. Engaged employees are characterised by their manifestation of satisfaction, pride, and self-motivation in the workplace, as well as their inclination to integrate their personal identities into their professional endeavours (Kahn, 1990). According to Gallup, there exist three distinct categories of employees. (i) Engaged personnel demonstrate a strong sense of passion and establish a deep emotional connection with their organisation. One sort of employees that significantly contribute to organisational progress is those who drive innovation and propel the organisation forward. Another type of employees is those who are not engaged in their work. There are three distinct categories of employees based on their level of engagement at work: (i) The first category comprises those who exhibit a passive disengagement, as they go through their work day without investing much energy or enthusiasm into their tasks; (ii) The second category includes those who are actively disengaged, meaning they are not content with their work and express their dissatisfaction through their actions; and (iii) The third category consists of individuals who are actively disengaged, although they do not experience misery at work, but rather channel their discontent via their behaviour. On a daily basis, these employees undercut the achievements of their colleagues who are actively involved in their work. According to Kahn (1990), it is said that employees are more likely to exhibit engagement when they perceive their role as meaningful and experience a sense of security in fulfilling their duties.

Work-Life Balance (WLB)

Transformation in social organisation, characterised by women's equitable participation in the economic advancement of their families and communities, has resulted in heightened mobility for both couples. The organisational culture and policy extend beyond individual employees to include the families of those who are employed (Kanter, 1977). It is imperative for organisations to recognise that their focus should not solely be on the quantity of employee output, but also on the quality of said output. The primary focus should be on assessing the level of employee satisfaction during the task execution. If an employee at their place of work is preoccupied with concerns for their unwell spouse or child, elderly parents, creche arrangements or their child's open house event at school, it raises questions about their level of engagement as an employee. Likewise, the inverse scenario may also occur, wherein an individual contemplates professional matters while in the confines of their home environment. Instances such as the one described can potentially give rise to intrapersonal conflict, since the employee may encounter challenges in determining the specific function he is expected to fulfil. The work-life balance refers to the principle by which employees are able to effectively integrate their personal lives and community engagement with their own individual interests and broader societal concerns (Heery & Noon, 2008).

Innovative Work Behavior

Scholars have shown a growing interest in comprehending the antecedents and motivational elements of Interactive Whiteboards (IWB) in order to gain a deeper understanding of individual-level innovativeness, as it is considered crucial for organisational success (Wu et al., 2014). Grossan and Apaydin (2010) have categorised the elements that impact interactive whiteboards (IWBs) into two main categories: organisational (or environmental) factors and individual aspects. The present study utilises work-life balance (WLB) and perceived organisational support (POS) as organisational factors, and employee engagement (EE) as an individual component, in order to examine the relationship with innovative work behaviours (IWBs) among millennials working in the IT industry. For the significant impact of employees in demonstrating innovative work behaviour (IWB) by surpassing established organisational routines, discovering novel approaches to job duties, and using contemporary technologies argued (De and Den, 2010). According to Afsar et al. (2018), employees who are responsible for the maintenance of interactive whiteboards (IWBs) possess the ability to effectively and rapidly analyse and comprehend developing work conditions, and then offer innovative suggestions to enhance the quality of products and services. There is a scarcity of comprehensive and cohesive research on the use of interactive whiteboards (IWB) among millennials in the Chinese environment. Hui et al. (2020) posited that the

inclination of Chinese millennials towards innovative work behaviour (IWB) is influenced positively by their sense of organisational identification, with work engagement serving as a constructive mediating factor. Tian et al. (2021) discovered a positive correlation in employee creativity and prosocial motivation. According to Zhu et al. (2018), individuals belonging to the millennial generation possess the capacity to embrace novel concepts and demonstrate increased dedication towards fostering creativity and acquiring additional knowledge and skills in the face of adversity. Therefore, we suggest that creative individuals from the millennial generation possess the necessary self-assurance and skills to provide inventive resolutions to nascent challenges in the workplace. Millennials, a term coined to describe individuals born between 1980 and 1994 (Levenson, 2010), are closely linked to the era of the millennium and the advancements in digital technology. According to Kong et al. (2016), millennials exhibit elevated levels of self-confidence and prioritise job autonomy within a flexible working environment as a means to efficiently complete their jobs.

Employee Engagement and Innovative Work Behavior

The research in the field of EE has yielded a range of positive outcomes, including job satisfaction, organisational citizenship behaviour, organisational commitment, knowledge sharing (Bailey et al., 2017) employee performance (Khusanova et al., 2021). According to the study conducted by Mansoor et al. (2020), it was posited that environmental engagement (EE) has a direct influence on innovative work behaviours (IWBs), as well as a noteworthy mediation effect on the association between inclusive leadership and IWBs within the context of IT professionals in Singapore. Previous studies have demonstrated that employee engagement (EE) has a notable and beneficial impact on employees' innovative work behaviour (IWB) (Arifin et al., 2021). The study conducted by Inam et al. (2021) establishes a clear correlation between employee engagement (EE) and the level of creativity exhibited by marketing staff in Pakistan. According to Svensson et al. (2021), there is a positive correlation between environmental education (EE) and individuals' intention to engage in pro-environmental behaviours (IWB).

Environmental education (EE) is considered a crucial precursor to the development and implementation of inquiry-based learning (IWB) methodologies, as highlighted by Miller and Miller (2020). It seems like the studies you've mentioned delve into the correlations between employee engagement and various aspects of work behavior, particularly innovative work behavior (IWB) and task performance. Al-Ajlouni (2021) found a positive correlation between employee job engagement and the likelihood of displaying innovative work behavior. Similarly, Gemeda and Lee (2020) demonstrated a favorable relationship between work engagement and both task performance and innovative work behavior. Kahn's (1990) definition of employee engagement as the holistic commitment of employees to their job responsibilities, encompassing physical, cognitive, and emotional attention, forms a foundational aspect of this discourse. The terminology used to refer to this engagement construct varies among scholars, including work engagement, employee engagement, role engagement, and job engagement. Schaufeli and Bakker (2010) differentiate between "work engagement" and "employee engagement." While employee engagement explores the connection between an individual, their work, and the organization, work engagement specifically assesses the relationship between an employee and their work alone.

Hypothesis 1: Employee engagement is positively related with innovative work behaviour

Employee Engagement and Work-Life Balance

Scholars have posited that the implementation of EE holds promise in promoting employees' work-life balance. For example, a study conducted by Halbesleben et al. (2009) revealed that employees who are highly engaged tend to have less interference between their work and family domains. Similarly, Culbertson et al. (2012) shown that employee engagement has a beneficial effect on family life by promoting favourable work-to-family relationships. According to the findings of Karatepe and Demir (2014), individuals who exhibit elevated levels of work engagement demonstrate a greater capacity to effectively harmonise their work-related responsibilities and familial obligations. Previous research conducted by Marais et al. (2014) and Qing and Zhou (2017) have demonstrated that work-family enrichment is strongly influenced by emotional exhaustion (EE).

Chen and Huang (2016) emphasised the close association between employee engagement (EE) and the prediction of employees' innovative work behaviours (IWBs). According to Qing and Zhou (2017), in the Chinese context, it has been suggested that EE plays a significant role as a precursor to work-family enrichment. Ilies et al. (2017) conducted a study examining the level of engagement among employees in the Chinese banking sector. Their findings revealed that employee engagement (EE) has a good effect on the utilisation of work–family interpersonal connections. This, in turn, contributes to increased family happiness and the attainment of a harmonious work-life balance.

Wood et al. (2020) highlighted a reciprocal relationship between work engagement and work-life balance (WLB) through empirical research. This study aims to expand the existing research, emphasizing work engagement as a precursor to achieving a balanced professional and personal life. We propose that actively engaged employees are more likely to strike a harmonious equilibrium between their work and personal spheres. Building upon Wood et al.'s (2020) work, our study empirically examines how employee engagement (EE) affects both work-life balance (WLB) and in-role work behaviors (IWBs). Additionally, we explore how work-life balance (WLB) might mediate the relationship between emotional exhaustion (EE) and innovative work behaviors (IWBs).

Hypothesis 2: Engagement of employees positively influence the work life balance

Work-Life Balance and Innovative Work Behavior

Given the extensive research on work-life balance (WLB) and its positive implications for employees, including improved job performance, psychological well-being, and reduced turnover intentions, it's evident that maintaining WLB is crucial. Pieterse et al. (2010) emphasize the importance of employees having an internally focused mindset and active involvement in work activities like interactive whiteboard (IWB) sessions. Highly engaged employees, as highlighted by Aryee et al. (2012), display traits like enthusiasm, sustained focus, and increased energy, enabling them to engage in innovative behaviors (Eva et al., 2019), ultimately contributing to their professional success. Clarke et al. (2004) define work-life balance (WLB) as the subjective satisfaction individuals feel in managing their personal and professional responsibilities. Kim and Yun's (2019) study in the Chinese hotel industry found a positive correlation between employees' work-life balance (WLB) and their individual work benefits (IWBs).

Based on this existing research, we propose a hypothesis suggesting a positive relationship between employees who maintain work-life balance (WLB) and their likelihood of displaying innovative work behaviors (IWBs). To reinforce this hypothesis, we predict that.

Hypothesis 3: Employee work-life balance has a positive impact on IWBs.

Mediating Effect of Work–Life Balance

Scholars and professionals emphasise the significant impact of work-life balance (WLB) in organisational aspects for enhancing organisational performance (Stankeviˇciene et al., 2021). According to the study conducted by Haar (2013), there is evidence to suggest that the relationship between family conflict and enrichment, and the subsequent effects on employees' success and wellbeing outcomes, can be explained by the mediating role of work-life balance (WLB). According to Au and Ahmed (2014), there is a positive correlation between work-life balance (WLB) and various aspects of organisational effectiveness, including employees' attitudes, behaviours, and overall welfare. According to Lawson et al. (2013), employees who experience an imbalance between their work and personal lives, often owing to family issues or an overwhelming workload, tend to experience high levels of stress in the workplace. This, in turn, leads to the development of negative work attitudes and ultimately contributes to burnout. According to the research conducted by Nabawanuka and Ekmekcioglu (2021), it was posited that work-life balance (WLB) plays a crucial role in influencing the overall wellbeing of millennials. Furthermore, the study suggests that WLB acts as a mediator in the association between perceived supervisor support and employee wellbeing. According to Rashmi and Kataria (2021), there exists a positive relationship between work-life balance (WLB) and job satisfaction among nursing professionals. Additionally, WLB was found to partially mediate the relationship between two job resources, namely job autonomy and supervisor support, and job satisfaction.

The study establishes a mutual relationship between employee engagement (EE) and work-life balance (WLB) due to the substantial demands posed by work and family responsibilities, consuming considerable energy, time, and emotional resources (Halbesleben, 2010; Timms et al., 2015). Organizations emphasizing work-life balance empower employees to efficiently manage their performance, effectively allocating their working hours. Existing literature lacks exploration into how work-life balance (WLB) might influence the link between emotional exhaustion (EE) and the intention to withdraw from an organization (IWB). However, based on this research, it's suggested that work-life balance (WLB) can act as a mediator in the relationship between employee engagement (EE) and innovative work behavior (IWB). Hence, this leads to the subsequent research hypothesis.

Hypothesis 4: WLB has a mediating effect on the relationship between EE and IWB.

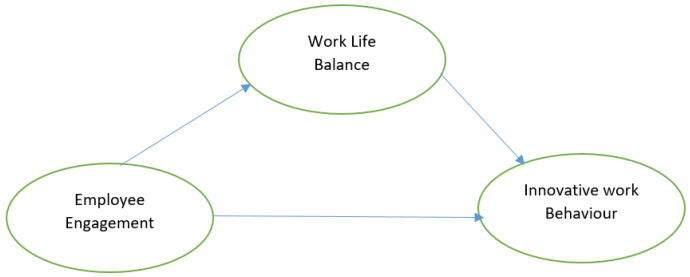

Figure:1 Hypothesized Model

Research method

Methods

Our study's targeted populations were employees working in IT, companies located in four main cities. Such industries are frequently employed as the research context for service industry research (Zhou et al., 2018; Khan et al., 2021b; Sahni, 2021; Tian et al., 2021). In addition, employees working in such service industries need to possess the skills and capabilities to exhibit IWB through interaction with customers.

Recognizing their proactive inclinations, millennials exhibit a greater degree of innovative behavior in comparison to the previous generation, as noted in the work of Giebels et al. (2016). This trend is particularly pronounced in knowledge-based economies, as highlighted by Hui et al. (2020). Millennials tend to be open to novel ideas, make substantial efforts to acquire new skills and knowledge, and are often willing to take risks in pursuit of short-term gains, as observed by Zhu et al. (2018). In the context of the Indian workforce, millennials constitute a significant majority and have the potential to play a pivotal role in fostering organizational innovation and enhancing competitiveness, as suggested by Zhao (2018), Asif et al. (2019), and Hui et al. (2020). Notably, the Indian IT workforce places a higher value on factors like remuneration and flexibility when compared to generations X and Y, as indicated by Lin et al. (2015).

Therefore, it is incumbent upon leaders to invest in the training and empowerment of their millennial workforce to encourage the manifestation of Innovative Work Behaviors (IWBs) and maintain a competitive edge, particularly within the IT industry. To select the study sample, we employed a random sampling approach focusing on major and large-sized branches of target service companies. Following the data collection procedure outlined by Tian et al. (2021), we initiated contact with branch managers through the respective organizations' service centers. Subsequently, we explained the purpose of our study and requested either a face-to-face meeting or personal contact details of the branch managers. After gaining their consent, we engaged in telephonic or face-to-face interviews to facilitate the data collection process.

After extensive communication with the managers, we successfully secured the cooperation of 39 out of a total of 46 branch managers for data collection. We established three specific sampling criteria and provided detailed explanations to the branch managers: employees should have been born between 1981 and 2000, hold senior positions, and possess the capabilities to exhibit innovative behaviors in the

execution of their job tasks. The distribution and collection of questionnaires took place between January 2023 and August 2023.

To encourage respondents to complete the questionnaires, we employed printed and self-administered survey forms. We also enlisted the assistance of two local individuals to ensure a seamless and efficient data collection process. These individuals were briefed on the study's purpose, identified the target companies and branches, and received training on questionnaire administration and collection. Symbolic incentives were provided to managers to motivate their employees to complete the survey questionnaires promptly. Respondents were allotted a two-week period to fill out the questionnaires, and we utilized email, WhatsApp, or in-person visits to communicate with and follow up on the respondents.

In total, we distributed 578 questionnaires, with 327 of them being deemed complete and valid for analysis, representing a response rate of 53%. It's worth noting that this moderate response rate is in line with the specific sampling criteria required for the study. Nevertheless, it's important to recognize that previous literature has acknowledged and accepted response rates as low as 41% (Sahni, 2021), 34% (Culbertson et al., 2012), and 31% (Gemeda and Lee, 2020). The demographic profile of the respondents is shared in the table-1

Table 1 Demographic profile of respondents (Sample size 327)

Category	Group	Frequency	Percentage
Gender	Male	195	60
	Female	132	40
Age of Respondents	23-28	16	4
	29-36	287	88
	>36	24	8
Year of Experience	Less than 5 years	244	75
	5-10 years	65	20
	More than 10 years	18	5
Education	PG	229	70
	PG+ Certification	70	22
	Pursuing Higher Education	28	8

Source: Research Output

Measures

The present investigation employed measurement scales that have been well recognised and validated in previous research. The study employed a five-point Likert scale, with response options ranging from 1 (strongly disagree) to 5 (strongly agree), to evaluate the accepted measures. Cronbach alpha values were computed to determine the reliability of the constructs. The variable of interest, employee engagement, was assessed using a set of nine items created by Schaufeli et al. (2006), who reported a reliability coefficient of $\alpha = 0.885$. IWB, as a multifaceted concept, encompasses the actions of employees that contribute to the improvement of innovative processes (De Jong and Hartog, 2007; Saeed et al., 2019). The measurement of innovative work behaviour was conducted via the scale developed by Ma Prieto and Pérez-Santana (2014). The measuring scale in question consists of four items, as reported by Mishra et al. (2019), who found strong reliability values of $\alpha = 0.810$ and $\alpha = 0.93$. The variable of work-life balance was assessed through the utilisation of four items that were produced by Hayman (2005). The utilisation of control variables was implemented in order to obtain a comprehensive elucidation of research outcomes, encompassing factors such as the gender, age, educational attainment, and length of service within the organisation of the employees.

Results

Table 1 summarizes the descriptive information of the research participants. It is evident from the above table that the gender of the respondents has been categorized into male and female, which comprises of 60% and 40%, respectively. The age of the respondents has been characterized into three

categories. The categories are 17-22, 23-28, and more than 28 years of age. These age categories are 4, 88, and 8 percent, respectively. Respondents are categorized into three categories of job experience: less than 5 years, 5-10 years, more than 10 years. The percentage of these categories are 75, 20 and 5 respectively. The Educational details of the respondents are categorized into three categories P.G., P.G. + Certification, and pursuing higher education. The percentage of these categories are 70, 22, and 8%, respectively.

Measures

The robustness of the measures can be verified from the values of the factor loading, Cronbach's alpha (C.A.), and rho-A. Further, the validity and reliability of the measurement model can be confirmed through composite reliability and convergent and Discriminant validity of the constructs. Table no. 1 ensures the adequacy of the factor loading, which is above 0.7 for each statement (Fornell & Larcker, 1981; Hair et al., 2014).

Table 2: Factor Loading

Statements	Innovative work behaviour	Employee engagement	Work life Balance
IWB1	0.868		
IWB 2	0.701		
IWB 3	0.855		
IWB 4	0.840		
EE 1		0.736	
EE 2		0.786	
EE 3		0.711	
EE 4		0.845	
EE 5		0.843	
EE 6		0.699	
EE 7		0.771	
EE 8		0.777	
EE 9		0.762	
WLB1			0.748
WLB 2			0.813
WLB 3			0.806
WLB 4			0.857

Internal Consistency Reliability

Table 3 confirms the presence of adequate internal consistency for each construct through the values of Cronbach's alpha (C.A.) and Rho-A. Here, all the values are above 0.70, which is sufficient to establish internal consistency. Further, the construct's reliability is found to be satisfactory as all the values of composite reliability (C.R.) for each construct are above 0.60 (Hair, Hult, Ringle, & Sarstedt, 2014). In addition to this, Fornell & Larcker, 1981 suggested the use of rho-A as additional criteria to confirm the reliability. The results of the rho-A test are satisfactory as all the values are above 0.6. All the values mentioned above lead to the confirmation of the internal consistency and reliability of the constructs.

Convergent and Discriminant validity

This can be found in table 3 that all the AVE values are more than 0.5, which is a necessary condition to establish convergent validity. Moreover, the value of AVE for each construct is more than the corresponding values of MSV (Gaskin & Lim, 2016). In addition to this, it can be observed that the square

root of the AVE is higher than the corresponding correlation value for other relationships. Therefore, discriminant validity is also established.

	CR	AVE	MSV	MaxR(H)	EE	WLB	IWB
EE	0.850	0.534	0.090	0.859	**0.731**		
WLB	0.891	0.673	0.075	0.896	0.273	**0.820**	
IWB	0.927	0.681	0.084	0.932	0.290	0.322	**0.807**

Model Fitness Table:

Measures	Values
CMIN/df	2.917
NFI	0.918
CFI	0.893
TLI	0.862
RFI	0.930
RMSEA	0.064

From the table we call see that the value of SMIN/Df is within the range of less than three which is acceptable and good also in case of social science model.

Structural equation Model results:

	EE	WLB	IWB
EE	1		
WLB	.381**	1	
IWB	.381**	.313**	1

Table 6. Regression Analysis of variables

variable	B	se	t	Sig	Hypothesis
EE→WLB (R^2=0.292)	0.612	0.079	4.564	.000	Supported
EE→IWB (R^2=0.452)	0.523	0.236	11.16	.000	Supported
WLB→IWB(R^2=0.303)	0.497	0.142	6.084	.000	Supported

Mediation Test

Construct/variables	Direct	Indirect	Boot LLCI	BootULCI	Mediation
EE<->WLB<->IBV	0.1120	0.1662	0.0418	0.1732	Full Mediation

Discussion:

The research results have validated our initial premise that there exists a positive correlation between employee engagement (EE) and Innovative Work Behaviours (IWB) within the IT industry. The findings presented in this study are consistent with the extant scholarly literature, as evidenced by the research conducted by Mansoor et al. (2020), Arifin et al. (2021), Inam et al. (2021), and Svensson et al. (2021).

Furthermore, Al-Ajlouni (2021) and Gemeda and Lee (2020) arrived at comparable findings, underscoring the significance of employee engagement in facilitating employees' innovative work behaviours (IWBs).

Additionally, our research has provided empirical evidence to support the existence of a causal connection between employee engagement (EE) and work-life balance (WLB). Furthermore, our findings indicate that EE plays a crucial role as a primary determinant of WLB. This discovery aligns with the existing body of literature, as demonstrated by the research conducted by Halbesleben et al. (2009) and Culbertson et al. (2012), which indicated that employees who are highly engaged are more capable of maintaining a satisfactory work-life balance. Karatepe and Demir (2014), Marais et al. (2014), and Qing and Zhou (2017) expressed comparable viewpoints, contending that individuals who are actively involved in their work had the ability to effectively balance their professional and familial obligations. Nevertheless, it is important to acknowledge that several research have suggested that EE may potentially result in work-family conflict. Chen and Huang (2016) proposed that there exists a positive correlation between high emotional exhaustion (EE) and both burnout and increased work-family conflict. The study conducted by Bakker et al. (2014) demonstrated that engagement in work can have a beneficial impact on the facilitation of work-family balance, leading to increased levels of satisfaction among both employees and their families.

The empirical findings of our study also support the notion that work-life balance (WLB) has a significant and direct influence on innovative work behaviours (IWBs), which aligns with the findings of previous research undertaken by Pieterse et al. (2010), Aryee et al. (2012), Eva et al. (2019), and Kim and Yun (2019). Furthermore, our investigation revealed that work-life balance (WLB) serves as a partial mediator between employee engagement (EE) and innovative work behaviour (IWB). This suggests that there is a positive relationship between the level of employee engagement and the achievement of an acceptable work-life balance, leading to an increase in their innovative work behaviours. The utilisation of work-life balance (WLB) as a mediating variable has been a common practise in the existing academic literature. This is evident in studies conducted by Lawson et al. (2013), Nabawanuka and Ekmekcioglu (2021), and Rashmi and Kataria (2021).

To the utmost extent of our understanding, this research endeavour serves as a first attempt to empirically validate the mediating function of work-life balance (WLB) in the association between emotional exhaustion (EE) and innovative work behaviour (IWB). Based on our research findings, it can be concluded that work-life balance (WLB) effectively serves as a mediator in the relationship between emotional exhaustion (EE) and innovative work behaviours (IWBs). This suggests that work-life balance (WLB) has a direct effect on employees' innovative work behaviours (IWBs) and also has an indirect influence on IWBs through its impact on their degree of job engagement.

Managerial Implications

Our research findings highlight the crucial role of Employee Engagement (EE) in fostering Innovative Work Behaviors (IWB). This suggests that engaged employees are more likely to inspire IWBs. Consequently, employers should promote EE by implementing relevant policies and programs aimed at stimulating IWBs. It's essential for leaders to recognize the significant impact of EE on driving their employees' IWBs. As a result, identifying and implementing effective EE practices is crucial for encouraging employees to demonstrate IWBs. Our research findings also suggest that leaders in service industries should prioritize the effective engagement of millennial employees. Servant leadership, as discussed by Khan et al. (2021a), has been found to have a positive influence on employees' sense of meaning in their work and work engagement. This, in turn, mediates the relationship between servant leadership and work engagement among employees in the service sector in Pakistan.

In light of our research, it is imperative for leaders to focus on EE practices to enhance employees' Work-Life Balance (WLB). Creating a conducive work environment that allows employees to strike a balance between work and personal life is of paramount importance. This can be achieved by offering flexible work hours and supporting employees in managing their family and work responsibilities. Furthermore, Anderson et al. (2014) have called for additional research to integrate the findings from innovation research, which can significantly contribute to the field of innovativeness. Given the observed reciprocal relationship between work engagement and WLB factors, as highlighted by Babic et al. (2017)

and Timms et al. (2015), further longitudinal studies are necessary to gain a more comprehensive understanding of their interconnections.

Limitations

Participants in this study who fell under the age bracket of millennial employees were asked to provide their birth years between 1981 and 2000. Given that the current study concentrated mostly on millennials working in the IT industry within the context of India, it is possible that the findings cannot be generalised to a broader population. For the most part, our research relied solely on data acquired from the points of view of employees. As a result, subsequent studies might incorporate the viewpoints of both employees and managers in order to investigate the effect that EE has on IWB. In addition, in order to generalise the results of the research study, additional research may make use of a bigger sample size conducted in a variety of settings. Because of India's cultural values and varied perspectives, such as large power distance and collectivism (Chen et al., 2020), it may be difficult to generalise the findings of our empirical research. Consequently, subsequent research may investigate the applicability of our model and attempt to broaden its reach by using it in a variety of scenarios with larger samples and making use of qualitative investigations. The empirical findings of our study contribute to the expanding body of research on EE and IWBs; this is the case despite the limitations of the research that have been highlighted above.

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Freight logistics in Africa: information and technology as beacons

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Keywords
Freight logistics; Africa; Sub-Saharan Africa; technology; information; scoping literature review

Abstract

Movement of freight globally is complex due to the vast distances between countries, the in-transit perils, high costs, and challenges in meeting customer delivery timelines. Freight logistics within Africa is even more complex given the limited logistics infrastructure, varied regulations between countries, poor security and the high cost of transport. The purpose of this paper is to explore the status of academic literature on freight logistics in Africa and examine the potential of advanced information technologies in enhancing the logistics sector. The paper utilised the scoping literature review technique to select relevant documents. The freight logistics sector in Africa can be termed as struggling, it is among the least efficient globally. The lack of valid data on the various logistics components makes it difficult for stakeholders to plan for efficiency and effectiveness.

The need for country specific technologies to address its unique challenges is emphasized. The smooth flow of goods across countries can only be achieved through collaboration among countries and investments in logistics infrastructure as well as technology. The study underscores the need for data-driven decision-making, context-specific technologies, and collaboration to improve Africa's freight logistics. The current study has explored the freight logistics literature focusing on Africa, not only to unearth the challenges, but also propose likely solutions. While the current study is limited to published literature, further research should empirically explore impactful technologies, compare countries' situations, and involve policymakers for comprehensive solutions.

Introduction

Background on freight logistics in Africa, challenges/opportunities

Freight logistics is a complex process that aims to ensure the smooth and efficient movement of goods from origin to destination, minimizing costs, time, and environmental impact while maximizing safety and compliance. This efficiency and effectiveness require adequate infrastructure and relevant equipment, skilled personnel, and appropriate technologies. The performance of most industries (such as healthcare, fashion, retail, and agriculture) now, more than ever, depends on efficient logistics, particularly for the supply and distribution of products to support business operations (Ambe, 2014). In a modern business environment, efficient and effective logistics operations require the adoption of freight transport technologies such as artificial intelligence (AI), the internet of things (IoT), and transport management systems (TMS). High logistics performance has the potential to stimulate activities within an economy due to efficient flow of goods and related information (Kuteyi and Winkler, 2022). Despite the importance of logistics in the development of economies, the African continent still lags behind on all the measures in the Logistics Performance Index (LPI)(World Bank, 2023), with aspects such as the timeliness of shipments, efficiency of customs clearance, and ability to track and trace shipments performing at significantly lower levels than other areas of the world. This suggests that African economies are not currently providing the level of logistics services that can impact the economy.

Freight logistics in Africa is characterised by fragmentation of modes, thus not offering integrated multimodal transport services. By implication, shippers need to source, negotiate, and procure transport

services for each individual leg of the freight journey, resulting in increased cost (and time) of logistics. Logistics firms operating in Africa encounter challenges related to poor road surfaces and network, lack of security, fragmented supply chains, unfavourable taxation policies, varying labour laws, unpredictable road closures, inadequate information and low levels of appropriate competencies, causing huge delays in shipments. Generally, freight transport by road in sub-Saharan Africa (SSA) can be summarised as overloaded vehicles, under-utilised resources over time, high maintenance costs, long transit times caused by unnecessary delays, lack of skilled manpower, freight imbalances, cumbersome border crossing procedures, and therefore high freight transport costs to shippers (Burl, 2019). Given the myriad of issues facing logistics operations in Africa, the question is raised as to whether technology can mitigate some these challenges, without the need for huge infrastructural investments.

Some of the technologies applied to freight logistics include mobile apps that promote on-demand trucking services such as GIGGo App in Nigeria, Lori Systems in East Africa, Flexstock in North Africa, Tripplo in Southern Africa, and Sendy in Kenya (Technext, 2023). These technologies offer various benefits including real-time end-to-end tracking of freight, automated invoicing and payments, easy estimation of freight costs, facilitating logistics outsourcing, and optimising truck operations (Technext, 2023), thus alleviating some of the key issues raised by the LPI.

There are numerous issues facing logistics operators in Africa. Many of these issues can be alleviated through infrastructure investments, streamlining cross-border movements, reducing bureaucratic documentary requirements, eliminating corruption, and creating enabling economic and regulatory environments, amongst others. Where these are not forthcoming, logistics service providers need to consider other avenues to create efficiencies that will allow them to remain competitive in a global logistics environment. This research asserts that logistics performance can be enhanced through the use of technologies such as digitisation, logistics platforms, artificial intelligence, blockchain, IoT, and other recent technological developments. Freight logistics in developed countries and regions such as Europe, North America and Australia is well known and its current focus is on climate change and reducing CO2 emissions (Macharis and Bontekoning, 2004; Ambra, Caris and Macharis, 2019), while freight logistics in Africa is lacking both in literature and infrastructure. The paper explores the current freight logistics challenges and makes a bold statement by proposing solutions that are relevant to the African context. This research therefore seeks to determine whether technologies can enhance the performance of freight transport operations in Africa.

The rest of this paper covers the literature review, methods, discussion, and conclusion in that order.

Literature review

Freight logistics in Africa

Africa is a continent with the largest number of countries in the world; 54 countries. Most of the countries in Africa fall under the least developed countries category, where access to transportation is cited amongst some of the most critical challenges that citizens face (Wale-Oshinowo *et al.*, 2020). Specifically, SSA has the least developed road transport network in the world (Burl, 2019). Intra-African freight logistics is faced with major challenges including long transit times due to port and border procedures and delays, low quality transport infrastructure, poor vehicle maintenance, corruption, and high logistics costs compared to developed countries (Burl, 2019; Kuteyi and Winkler, 2022). Road freight transport in SSA is characterised by poor rural and urban roads, extreme weather conditions, lack of harmonisation in road freight regulations, such as axle load limits, and, resultantly, lengthy delivery lead-times. Freight is also transported by air, water and rail in Africa. Rail freight is usually limited between countries due to an inadequate supply of rail tracks in neighbouring countries or differences in rail track gauges. Poor port and air infrastructure, inadequate cargo handling facilities and a lack of intermodal handling facilities all contribute to high costs and lengthy logistics procedures.

In terms of regional highlights, West Africa has about eight busy corridors linking about 11 countries to seaports. However, these corridors have poor logistics infrastructure, prone to inefficiency, corruption, and bureaucratic processes, which cause bottlenecks. This negatively impacts the export competitiveness of the region. South Africa has among the best logistics infrastructure in Africa, thus servicing all its neighbouring countries. However, South Africa grapples with logistics skills shortages, corruption, and

fragmented transport services. East African regional corridors to and from the ports of Mombasa and Dar salaam are faced with traffic gridlock, corruption, suboptimal processes, and lack of transparency in pricing. Therefore, SSA logistics challenges can be summarised as gateway, trucking, and customs inefficiencies (Kuteyi and Winkler, 2022).

Despite the logistics challenges, SSA has huge trade potential, given its market size in terms of population size and the presence of minerals, arable agricultural land, and other. Intra-African trade is limited, however, with the current promotion of African Continent Free Trade Area (AfCTA) (African Union, 2023) there is massive potential for more trade activities and, therefore, the need for more freight transport movements. A wide variety of cargo types are transported from and within Africa to support trade activities. It is important to highlight that most of the freight from African countries is shipped to former colonial masters in Europe. China is also a major trading partner. The cargo shipped includes raw materials from agricultural areas; of which, most is transported from rural areas over vast distances by road to seaports; these include cocoa, tea, coffee, flowers, cashew nuts, maize, fresh fruits and livestock. Crude oil is also another product transported from Africa; most of it via pipelines to seaports and then loaded on to ocean tankers (Adewole, 2019). It is also important to highlight that most of the African countries import refined oil products for internal consumption and this represents one of the most transported products across Africa, especially from seaports to the rural areas of both land-locked and coastal countries (Adewole, 2019). Minerals and ores such as gold, diamonds, platinum, iron ore, copper and manganese are key bulk exports (Goldring and Juckes, 2001). Agricultural food items are also usually traded amongst neighbouring countries in Africa, thus generating a lot of freight logistics activities across the borders.

Despite the critical role played by logistics in an economy, many of the African countries have not put sufficient effort in improving or modernising their logistics sectors, especially from an infrastructure perspective. In fact, Adewole (2019) argued that while African economies are rising coupled with rapid urbanisation, logistics infrastructure is still inadequate, making Africa uncompetitive as a source market globally due to the associated high logistics costs (over 40% of the price of imported products). Africa still lacks a trans-African highway that offers East-West or North-South linkages for ease flow of goods and services across the continent. Despite the challenges aforementioned, many of the countries are making some significant strides to improve road networks and rail, and seaports infrastructure. However, new infrastructure developments are expensive and, with limited funding, might take long to complete. Hence, the question is whether African countries can leverage on technology to leapfrog towards more efficient freight logistics.

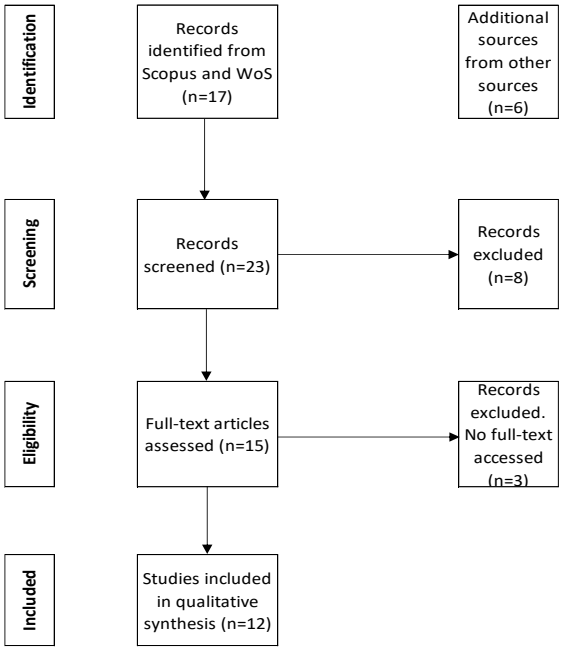
The adoption of freight logistics technologies is rather fragmented across the African continent owing to the varying levels of telecommunications infrastructure from one country to another. Some countries such as Nigeria, Kenya, and South Africa have advanced internet and telecommunication infrastructure, thus driving down the cost of data. This implies that the adoption of logistics technologies is likely to be higher in those countries with developed telecommunication infrastructure as well as high internet penetration such as Morrocco (Galal, 2024).

Prior research has focused on logistics challenges (Kuteyi and Winkler, 2022), the road versus rail debate (Van Der Mescht, 2006), adoption of ICT and other smart technologies in road freight (Tob-Ogu, Kumar and Cullen, 2018; Farquharson, Mageto and Makan, 2021), and intermodal logistics systems (Govender and Mbhele, 2014). Many of these studies have a narrow focus on specific country contexts without regional or African perspectives, thus making difficult to expose the labyrinth that is African freight logistics. We argue that, by addressing the identified challenges and harnessing IT technologies, Africa can chart a course towards a brighter future, where efficient and sustainable logistics unlock economic growth and societal well-being through reduced costs of products. Therefore, this study sought to answer the following questions: (1) what are the major freight logistics issues in Africa? (2) How can technology be utilised to mitigate the most pressing freight logistics problems in Africa?

Methods

A scoping review of literature was conducted to establish the nature of the freight logistics sector in Africa. The aim was to establish prior research that has examined the interplay between freight logistics

and technology within the African continent. The scoping review helped to identify the knowledge gaps within the area of study, as also claimed by Tricco *et al.* (2016). They argued that scoping reviews are useful in providing a broad synopsis of an emerging research topic, thus fit for exploring freight logistics and technology in Africa. The procedure and processes followed to search, identify and select articles for analysis is presented in Figure 1.



Source: Adapted from Iwu et al. (2019)
Figure 1: Scoping review process

Searches were conducted using the Scopus and Web of Science core collections. The following search string was used in both databases *("freight logistics" OR "sea freight" OR "rail freight" OR "cargo logistics" OR "road freight" OR "air freight" OR "ocean freight" OR "train freight") AND technolog* AND Africa).* Only 23 documents were extracted signifying limited academic literature on technological applications in freight logistics in Africa. After removing duplicates and checking for relevance by reading the abstracts, 12 documents were retained. These are the published studies on freight logistics and technology in the African context. The results are presented in Table 1.

Table 1: Key findings of selected studies

Authors	Mode	Technologies	Research Approach	Role players	Context	Key findings
Kuteyi and Winkler (2022)	All	Telecommunications	Mixed methods	Government, shippers and operators	Sub-Saharan Africa	Logistics in SSA is characterised by poor infrastructure, limited skills, lack of transparency in pricing, and bureaucratic processes. Poor logistics negatively affects export competitiveness of SSA.
Van Der Mescht (2006)	Road versus rail	Road freight technologies	Qualitative - review	Government, shippers, rail operators and truck operators	South Africa	Road freight is a dominant mode. Rail carries less than 35% of freight. Both rail and road infrastructure are deteriorating due to underinvestment.
Burl (2019)	Road freight	Electronic data interchange, ICT	Qualitative - review	Multi-agencies	Sub-Saharan Africa	Freight vehicles are older, overloaded per trip but underutillised over a period. Huge delays at transit points. There is need for developing professional road haulage firms that can benefit from modern freight logistics technologies. Adoption of ICT systems will offer a strategic value to SSA as a source market globally
Tob-Ogu et al. (2018)	Road	ICT, SAP, ORACLE,AQUILA	Qualitative - Case study	ICT developers, road transport sector	Nigeria	Road freight challenges include poor infrastructure, accidents, theft, environmental and operational challenges. ICT can promote operational efficiencies and sustainable solutions. ICT adoption is driven by accident prevention, inventory and process efficiencies, route optimisations, and training. ICT results in visibility, transparency, safety, and integration.
Havenga et al. (2015)	Not mentioned	None	Quantitative: gravity-oriented freight flow model	Government through policy	South Africa	Freight transport costs likely to continue increasing driven by oil prices. Inconsistent classification of commodities. Lack of accurate data sources for informed decision making. Current modal configuration has negative environmental impact to society.
Govender and Mbhele (2014)	Road and containerisation. multimodal	RFID, real-time tracking, scanners, X-rays, electronic seal, intermodal logistics systems	Quantitative	Seaport operators, truckers, container operations	South Africa	Application of relevant technology can streamline container terminal operation to facilitate intermodal transportation.
Farquharson et al. (2021)	Road	Internet of things (IoT)	Quantitative	road freight operators and trucking technology firms	South Africa	IoT promotes operational effectiveness, improved decision making, real-time tracking and information sharing in road freight operations.

de Saxe et al. (2023)	Road	Not mentioned	Quantitative	Electricity generation firms and government	South Africa	Huge volumes of coal transportation via road. Need to adopt high-capacity vehicles to improve productivity. Need for decarbonisation in future
Ambe (2014)	All modes; supply chain	IT, supply chain technology, forecasting technologies	Mixed methods	Vehicle manufacturers	South Africa	SSA logistics challenges can be classified as technological, infrastructure, cost, market/service, relationship and production and skills challenges. Also, port delays, rail unreliability, high fuel costs, high operating costs and high port charges
Adenigbo et al. (2023)	Air	4IR, RFID, and emerging technologies	Quantitative	Air cargo agents	South Africa	Adoption of 4IR, RFID and other smart technologies promotes efficient air cargo operations and improves customer satisfaction.
Nguyen and Mogaji (2022)	All	Smart mobility, intelligent transport systems, internet of things, artificial intelligence, use of chatbots	Review	Tech developers, Transporters, Transport Tech start-ups and Travellers	Africa	Technology helps to optimise multimodal freight transport efficiency. Digitisation of freight transport is likely to improve efficiency, effectiveness and minimise cost of maintaining logistics infrastructure. Technology adoption in the transportation sector in Africa should be country centric. Selected technologies should improve access to freight services by sharing real-time information.
Fourie and Malan (2021)	Rail	Integration technologies	Review	Government, rail operators and stakeholders	South Africa	Rail subsector is lagging when it comes to technology adoption hampering its competitiveness. Inadequate skills are also limiting its growth. An intermodal strategy is required that supports rail transport especially for heavy freight and over long distance. Rail is expected to promote sustainability in freight movement.

Discussion

The African continent faces a wide variety of problems in the transportation of freight. This includes long travel distances (given the remote locations of resources and distance to ports), lack of a common currency, poor infrastructure and freight facilities, lack of harmonisation in transportation laws, policies and regulations, inconsistent law enforcement, uncertain and bureaucratic documentation and border procedures, ageing equipment, high accident rates, and security issues, especially in the Central African region, although southern Africa also faces high rates of crime and corruption in freight transport. Therefore, the continent has a burden of logistics inefficiency stemming from the dominance of road freight, coupled with aging infrastructure and limited rail connections and utilisation. This inefficiency translates to ever increasing costs, delayed shipments, and ultimately, low export competitiveness for SSA countries. Therefore, freight logistics challenges can be categorised into technological, infrastructural, regulatory, competencies, and socio-economic, implying a need for multi-facetted solutions.

This review also highlights the potential of ICT and related smart technologies to illuminate the labyrinth that is African logistics. From an operational efficiency perspective, ICT can be used to optimise routes and schedules, improve tracking and tracing of shipments (a critical issue highlighted by the LPI for SSA), and provide better levels of visibility and transparency. Technology can facilitate the integration of different logistics functional areas and organisations. In particular, technology allows for modal integration, which is regarded as a fundamental stumbling block in achieving freight logistics efficiencies in Africa. Road safety and environmental sustainability are also potential areas in which efficiencies can be gained. The level of technology adoption in Africa varies considerably from country to country, thus freight transport technologies should be country centric, to address pertinent local issues (Nguyen and Mogaji, 2022). Country-specific needs and contexts must be considered when adopting technologies like 4IR or RFID in air, rail, or road cargo operations. Nonetheless, minimum ICT requirements need to be identified and adopted, given that the lack of harmonisation of infrastructure, policy, and equipment remains a major impediment to intra-African trade and cross border freight logistics. Whilst ICT policies need to take current technological conditions into account, broader considerations must include the ability to collaborate (from a technological perspective) across organisational, regional and international boundaries. The adoption of logistics freight technologies is likely to minimise freight transport costs, enhance maintenance of logistics infrastructure, improve visibility of freight and freight vehicles, and improve customer service (Nguyen and Mogaji, 2022). In addition, the emphasis on real-time information sharing through technology points towards the importance of collaboration. This requires governments, shippers, transporters, research institutions, regional economic communities, and communities, working together to unlock the full potential of technology and build a more efficient, sustainable, and competitive logistics sector in SSA.

The key stakeholders in freight transport and technology are identified as governments, through providing favourable laws and regulations, and regional economic communities to facilitate harmonisation in infrastructure standards, and transport policies and regulations. Tech developers are critical to ensure the technology is relevant to the specific country in Africa, with due recognition of the need for cross border collaboration, given the differences and the need for collaboration between countries. Transporters must be willing to adopt technologies to minimise fuel and maintenance costs, improve communication, promote transparency and visibility, and improve customer service levels. Transport technology start-ups across the African continent are likely to play a critical role in ensuring that they work with local operators to ensure that the solutions are affordable and relevant.

The study furthermore highlights the lack of accurate data on freight logistics in Africa, which makes it difficult to provide relevant and objective decisions. From a policy perspective, freight data provides information on the movement of goods, volumes and types. Without such information, infrastructure investment decisions and policy formulation are constrained, resulting in less-than-optimal resource allocation. From a service provision perspective, uncertainty on road conditions, commodity classification, lead-times of shipments, documents required for border crossings, and lack of information on border delays impede the provision of a globally competitive logistics service, thus increasing the total landed costs of imports and exports, and therefore the ability to trade. The provision of reliable and cost-effective logistics services in Africa face major impediments. The adoption of appropriate technologies enhances

visibility, thus allowing for more timeous decision-making when faced with supply chain disruption. Addressing the data gap is crucial for effective policy interventions and technology implementation in the logistics sector.

Whilst most of the studies focus on the use of technology to overcome the issues faced in logistics on the continent, and improve efficiencies, another area that received attention was the need for the implementation of sustainable solutions. Much of Africa's logistics issues are cost-related, with delays and inefficiencies leading to increased costs. Although technology can be applied to solve some of the immediate issues, it is critical that long term solutions are sought. Any technology investment or application should thus seek to inform resource allocation and investment decisions, both from a service provision and policy formulation perspective. Sustainability must therefore be considered as fundamental to any technological decisions.

Conclusion

This study considers the role of technology in freight logistics in Africa. The logistics issues on the continent are well documented and verified by the low scores in most categories of the World Bank's Logistics Performance Index for sub-Saharan Africa. Freight logistics problems in Africa can be considered from private and public sector perspectives. For policy makers, decisions on regulation / deregulation and infrastructure investment need to be data-driven. Critical information requirements include volumes, directions and commodity movements. Decision-making on resource allocation needs to be informed by up-to-date freight movement data, driven by clear data collection protocols and methods. For logistics service providers, similar information is required in real-time, enabling better planning, but also resilience and flexibility in decision-making, particularly when faced with potential disruptions. Against this background is however the recognition that many African countries lag in technological development, and it is difficult to obtain relevant and reliable information and data.

Technologies for the freight industry thus need to take into consideration the existing environment, implying fit-for-purpose technology rather than state-of-the art. Cogniscance also needs to be taken of the varying levels of data collection capabilities and availability. Whilst the need for environment-specific solutions is recognised, connectivity across organisational boundaries, across borders and internationally, is recognised as a crucial component to the collaboration that enables logistics and supply chain efficiencies. Visibility throughout the transport process is critical to the ability to plan and react to adverse situations. Technologies thus need to be considered that enhance visibility and collaboration.

The study investigated the main freight logistics issues in Africa and considered the role of technology in alleviating some of the most severe problems. Data availability is a key issue for regulators and policy makers, whilst logistics service providers require affordable technologies that provide freight visibility, to enable better resource allocation and enhanced efficiencies. Future research directions should seek to identify road freight technologies that are likely to provide the greatest impact to logistics operations, given the constraints of data availability, affordability, and contextual issues, such as wifi connectivity. As the latter differs considerably across the various African countries, an environmental scan is required, to determine and compare the policies and regulations, connectivity, and required competencies to enable appropriate technology solutions across the various countries. A key limitation to this study is the lack of relevant research into freight logistics and technologies in Africa. Future research may expand the search to popular as well as grey literature and broader search terms to capture specific technology applications and the lived experiences of implementation, thus enabling the understanding of benefits achieved and challenges faced in technology implementations. Finally, policy makers need to be considered, to determine their data requirements for efficient decision-making and resource allocation. It is suggested that the results be compared across countries, to determine synergies and data gaps, as well as facilitate cross-border collaboration and the facilitation on intra-African trade.

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Satisfaction of academics with leadership, creativity, innovation and organisational performance at a university 5.0 work environment

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Keywords
University 5.0, innovation, creativity, technology revolution, competitiveness

Abstract

Just like in industries, university and other higher educational institutions are facing novel working contexts arising from their present technological transitions. As a result, known factors that influence organisational success require new assessments to establish how they have been affected by the disruptions. The objectives of this study were to: (1) explore the satisfaction of academics with leadership, creativity, innovation and organisational performance at university 5.0 work environments (2) assess the relationship between transformational leadership and organisational performance within the university 5.0 context and (3) assess the relationship between innovation and organisational performance within the university 5.0 context. To attain the stated objectives, 200 academics from a university that is a leader in the adoption of education 5.0 transitions completed a questionnaire and the data was analysed. The study found that the academics were satisfied with the leadership, creativity, innovation and organisational performance associated with the university 5.0 contexts. It appears that the adoption of university 5.0 practices was favourable for creativity, innovation and performance. Future studies may have to follow comparative designs that factor in the relevance of sector specific mediators in the realisation of innovativeness, creativity and productivity of university 5.0.

Introduction

At present the business environment is being transformed by technological systems (Icela, ,Soledad & Antonio, 2023; Hirschi, 2018) thereby calling for studies in worker satisfaction with the new work context. Such studies allow for better appreciation of the new transformations and how to ensure organisational competitiveness remain optimal. Traditional work patterns have been disrupted and business models transformed. Consequently, previously established knowledge systems are being challenged (Mukhuty, Upadhyay & Rothwell, 2022). Of interest to this study is how leadership, employee creativity, innovation and organisational performance are relating to each other given the shift to education 5.0 in South Africa. Higher education is witnessing increased digitalisation, automation, information load, analytics, connectivity, and transparency (Sudibjo, Idawati & Harsanti, 2019). The dependent variables of interest were employee creativity, innovation and transformational leadership behaviours and organisational performance while the independent variable was the work environment associated with higher education 5.0. It was important in this study to determine the strength of the relationship between the independent variables and the dependent variables so as to inform higher educational institutions on how they can better take the technological environment to solve problems in society 5.0

Literature review

As reported by the Presidential Commision on the Fourth Industrial Revolution (2020) and also explained in Schwab (2016), digitalization as a result of the 4IR has created smart industries which are to be managed through smart management practices involving interconnected systems. At a time when most organizations were working on ensuring that they adapt to the new management models, the Covid-19 pandemic resulted in lock downs and closure of businesses resulting in forced need to digitalise.

Higher education (and education in general) has evolved from education 1.0 (9th-15th century) which was teacher centered to education 2.0 (15th to 18th century) which was knowledge and exam centered

through education 3.0 (18th-20th century) which was student centered up to education 4.0 (20th-21th century) which was outcome or action based (Nikum, 2022). In the view of Nikum (2022), education 5.0 is more about people and the realisation of their creativity in the use of technological systems. Usmaedi (2021) support this view and explains that education 5.0 seeks to ensure that humans are at the centre of innovation based on the use of technology to improve the quality of life, social status, and general welfare of people. In their study of higher education 5.0, Aviva, Adiputra, Wibowo, Anshori and Safrizal (2023), averred that society 5.0 and education 5.0 is haunted by the challenge of creating educationist and academics who digitally competent, innovate and creative to meet new demands. Additionally, higher education has to respond to the progression to society 5.0 and this responsiveness require appropriate transformational leadership, innovativeness, and creativity (Susanto, Pritikana & Utama, 2024).

Earlier studies like that of Alharbi (2023) have explored the implementation of education 5.0 in developing and developed countries and recommended further studies to understand the challenges and opportunities of implementation of education 5.0. The present study focuses on satisfaction with leadership, creativity, innovation, and organisational performance at university 5.0 environments. Previous studies (Gumusluoglu & Ilsev, 2009) have established that there is a positive relationship between leadership and employee creativity and innovation, and this finally leads to better performance. This study will consider this relationship at a university 5.0 environment which is characterized by widespread automation and digitalization given the Fourth Industrial Revolution (4IR). There is no adequate knowledge on how the restructuring, disruption of previously established management models and adoption of smart digital management practices affect project goal attainment (Mminele, 2018). Dhanpat, Buthelezi, Joe, Maphela & Shongwe (2020) asserted that some sectors have found this as a positive development in improving management effectiveness, specific studies on the influence of digital management practices on construction projects undertaken by the Cape Construction are still little. As a result, the effective ways in which digital management practices influence project goal attainment is still lacking (Gastrow, 2020).

Methodology

The study was quantitative and based on the collection of questionnaire data from one two hundred (200) academics at a selected university in South Africa and enquiring on their satisfaction with leadership, innovation, organisational performance and creativity. The university was purposively selected because of its status as a recognised leader in the implementation of higher education 5.0. Purposive sampling involves selecting a case based on its suitability for a certain purpose of a study (Christensen, Johnson & Turner, 2015; Creswell & Creswell, 2018). Academics were approached to seek their willingness to participateThe majority (53.5%) of the 200 respondents were males while 46,5% of them were females. It can, however, be argued that the sample was quite gender representative given that there was a small difference between numbers of males and female respondents in the study. Participants with working experience less than 5 years were 58 which is 29% , those with 5 -10 years of experience were 117 which is 58.5% and those with 10-15 years were 25 which is 12.5%. The education level of the respondents showed that 22 had diploma which is 11%, 58 had degrees which is 29% , 51 had master's which is 25.5%, 62 respondents had PhDs which is 31% and others were 7 which is 3.5% . The questionnaire was based on Likert scale items which were coded as follows: Strongly Disagree (SD) =1, Disagree (D)=2, Neutral (N)=3, Agree (A)=4 and Strongly Agree (SA)=5

Findings

For the analysis presented in this section, data was coded as follows - TL:Transformational leadership, OP: organisational performance, EC= Employee creativity , OI=Organisational Performance. Mean less than 2.4 indicates a lower level of agreement and a mean of 2,5 and above indicates a high level of agreement. To achieve the objectives that have been stated for this study, a normality test was performed to the data set so as to establish whether the data was normally distributed. The Tests for normality yielded the results displayed in the next section

Table 1: Normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TL	.172	200	.000	.937	200	.000
PS	.124	200	.000	.974	200	.001
IM	.217	200	.000	.777	200	.000
EM	.184	200	.000	.913	200	.000
IS	.228	200	.000	.891	200	.000
EC	.218	200	.000	.919	200	.000
OI	.228	200	.000	.898	200	.000
OP	.184	200	.000	.936	200	.000

a. Lilliefors Significance Correction

(TL – Transformational Leadership, PS – Perception of support, IM – intrinsic motivation, EM-Empowerment assertions, IS –Intellectual Stimulation, EC - Employee Creativity, OI-Organisational Innovation, OP- Organisational Performance).

As shown in Table 4 All variables did not follow a normal distribution (for TL, p=0,000<0.005, for PS=0.001<0.005, for IM =0.000<0.001, for EM=0.000<0.005, for IS=0.000<0.005, for EC=0.000<0.005, for OI=0.000<0.005, for OP=0.000<0.005.

Since the variables did not follow a normal distribution, the appropriate analysis that were adopted were spearman's rho as were as ordinal regression analysis analysis it was appropriate to perform correlation analysis to establish how the variables related to one another and to attain the study objectives. Table 2 provides a summary of the Results of Spearman's rho correlation analysis correlations of all the variables considered in the analysis, individual based analysis for each variable is treated in the next section.

Table 2: Summary of correlations between the variables

			OP	TL	PS	IM	EM	IS	EC	OI
Spearman's rho	OP	Correlation Coefficient	1.000	.766**	.676**	.140*	.293**	.800**	.689**	.866**
		Sig. (2-tailed)	.	.000	.000	.048	.000	.000	.000	.000
		N	200	200	200	200	200	200	200	200
	TL	Correlation Coefficient	.766**	1.000	.754**	.209**	.240**	.816**	.659**	.771**
		Sig. (2-tailed)	.000	.	.000	.003	.001	.000	.000	.000
		N	200	200	200	200	200	200	200	200
	PS	Correlation Coefficient	.676**	.754**	1.000	.228**	.300**	.731**	.576**	.662**
		Sig. (2-tailed)	.000	.000	.	.001	.000	.000	.000	.000
		N	200	200	200	200	200	200	200	200
	IM	Correlation Coefficient	.140*	.209**	.228**	1.000	.366**	.160*	.271**	.161*
		Sig. (2-tailed)	.048	.003	.001	.	.000	.023	.000	.023
		N	200	200	200	200	200	200	200	200
	EM	Correlation Coefficient	.293**	.240**	.300**	.366**	1.000	.281**	.425**	.286**
		Sig. (2-tailed)	.000	.001	.000	.000	.	.000	.000	.000
		N	200	200	200	200	200	200	200	200
	IS	Correlation Coefficient	.800**	.816**	.731**	.160*	.281**	1.000	.668**	.817**
		Sig. (2-tailed)	.000	.000	.000	.023	.000	.	.000	.000
		N	200	200	200	200	200	200	200	200

	EC	Correlation Coefficient	.689**	.659**	.576**	.271**	.425**	.668**	1.000	.660**
		Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000
		N	200	200	200	200	200	200	200	200
	OI	Correlation Coefficient	.866**	.771**	.662**	.161*	.286**	.817**	.660**	1.000
		Sig. (2-tailed)	.000	.000	.000	.023	.000	.000	.000	.
		N	200	200	200	200	200	200	200	200

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

TL: **Transformational** leadership, OP: organisational performance, EC= Employee creativity , OI=Organisational Performance,IS= Intellectual stimulation ,EM= Empowerment, IM= Intrinsic motivation, PS= Perception for support

Employee creativity

Table 3 provides views provided by respondents in respect of employee creativity in the organisation

Table 3: Descriptive Statistics for Employee creativity

	N	Minimum	Maximum	Mean	Std. Deviation
1. I am encouraged to suggest new ways to achieve goals	200	1	5	2.48	.987
2. I am motivated to come up with new or practical ideas to improve performance	200	1	5	2.42	.989
3. Constructive criticisms are accepted and encouraged	200	1	5	2.77	1.142
4. My suggestions are sometimes taken into account	200	1	5	2.61	1.031
Valid N (listwise)	200				

In interpreting the means above: the highest agreement was that constructive criticisms are accepted and encouraged (mean=2.77,:Sd=1.142); my suggestions are sometimes taken into account (Mean=2.61, SD=1.031): 1. I am encouraged to suggest new ways to achieve goals (Mean=2.48,:SD=.989) and I am motivated to come up with new or practical ideas to improve performance (Mean=2.42,: SD=.989)

The strength and direction of the correlation between employee creativity and organisational performance is shown in Table 4

Table 4: correlation coefficient for assessing the relationship between organisational performance and employee creativity

			OP	EC
Spearman's rho	OP	Correlation Coefficient	1.000	.689**
		Sig. (2-tailed)	.	.000
		N	200	200
	EC	Correlation Coefficient	.689**	1.000
		Sig. (2-tailed)	.000	.
		N	200	200

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

Table 4 shows a strong positive correlation (r=0.689) for the relationship between organisational performance and employee creativity. This correlation was significant (p=0.0001<0.005). Implication of this result is that improvement in employee creativity can result in improvement in organisational performance. This is evidence that the organisation need to boost the creativity of employees as this has a positive effect on organisational performance.

The relationship between Transformational Leadership and organisational performance.

Table 5 provides views provided by respondents in respect of transformational leadership in the organisation

Table 5: Descriptive Statistics for transformational

	N	Minimum	Maximum	Mean	Std. Deviation
1.There is an instilled sense of fulfilment in employees in this organisation	200	1	5	2.65	1.151
2. Leadership goes beyond self-interest for the good of the employees	200	1	5	2.68	1.244
3. In this organisation, people are enthusiastic about what needs to be accomplished	200	1	5	2.60	1.116
4. Leadership articulates compelling vision in this organisation	200	1	5	2.48	1.032
5.Leadership considers the moral and ethical consequences of decisions	200	1	5	2.62	1.163
Valid N (listwise)	200				

In interpreting the means above: the highest agreement was that leadership in the organisation goes beyond self-interest for the good of the employees (Mean =2.68: SD=), Other statements with a better tendency for agreement were there is an instilled sense of fulfilment in employees in this organisation (Mean=2.65,SD=1.151). Followed by Leadership considers the moral and ethical consequences of decisions (Mean =2.62,SD =1.163). In this organisation, people are enthusiastic about what needs to be accomplished (Mean=2.60,SD=1.116).The lowest agreement was Leadership articulates compelling vision in this organisation with a (Mean=2.48,SD=1.032). Correlation analysis was then performed to establish how the statements on transformational leadership were related to organisational performance. The results of the spearman's correlation analysis were as presented in Table 6

Table 6: Correlation coefficient for assessing the relationship between organisational performance and transformational leadership

			OP	TL
Spearman's rho	OP	Correlation Coefficient	1.000	.766**
		Sig. (2-tailed)	.	.000
		N	200	200
	TL	Correlation Coefficient	.766**	1.000
		Sig. (2-tailed)	.000	.
		N	200	200

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

Table 6 shows a strong positive correlation (r=0.766) for the relationship between organisational performance and transformational leadership. This correlation was significant (p=0.0001<0.005). Implication of this result is that improvement in transformational leadership can result in improvement in organisational performance. This is evidence that the organisation need to boost the transformational leadership as this has a positive effect on organisational performance.

The relationship between organisational innovation and organisational performance

The relationship between organisational innovation and organisational performance was as as presented in Table 7

Table 7: Descriptive Statistics for organisational innovation

		Minimum	Maximum	Mean	Std. Deviation
The rate of introduction of new services into the organisation has grown rapidly	00	1	5	2.83	1.063
The rate of introduction of new methods of delivery of services into the organisation has grown rapidly.	00	1	5	2.80	1.062
The rate of introduction of new markets services into the organisation has grown rapidly	00	1	5	2.81	1.050

The rate of introduction of new systems for strategic planning and control into the organisation has grown	00	1	5	2 .82	.991
The rate of introduction of new systems for training and development or promoting managers into the organisation has grown rapidly	00	1	5	2 .96	1.088
6.The organisation develop new competencies supporting innovation in the organisation	00	1	5	2 .87	1.062
Valid N (listwise)	00				

The results provided by respondents on organisational innovation were characterized by a high-level agreement to the statements that: The rate of introduction of new systems for training and development or promoting managers into the organisation has grown rapidly (Mean=2.96,:SD=1.088): The organisation develop new competencies supporting innovation in the organisation with a (Mean=2.87,: SD=1.062): The rate of introduction of new services into the organisation has grown rapidly (Mean=2.83,:SD=1.063). Followed by the statement: The rate of introduction of new systems for strategic planning and control into the organisation has grown with (Mean=2.82,:SD=.991) : The rate of introduction of new markets services into the organisation has grown rapidly with a(Mean=2.81,:SD=1.050) and the lower response was: The rate of introduction of new methods of delivery of services into the organisation has grown rapidly with a (Mean =2.80,:SD=1.062

Table 8 shows correlation coefficient for assessing the relationship between organisational performance and organisational innovation

Correlations

			OP	OI
Spearman's rho	OP	Correlation Coefficient	1.000	.866**
		Sig. (2-tailed)	.	.000
		N	200	200
	OI	Correlation Coefficient	.866**	1.000
		Sig. (2-tailed)	.000	.
		N	200	200

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

Table 8 shows a strong positive correlation (r=0.866) for the relationship between organisational performance and organisational innovation. This correlation was significant (p=0.0001<0.005). Implication of this result is that improvement in organisational innovation can result in improvement in organisational performance. This is evidence that the organisation need to boost organisational innovation as this has a positive effect on organisational performance.

Regression analysis

Given that this data was not consistency with the normal distribution the test for regression that was appropriate was either ordinal logistic regression or multinomial logistic regression.

Ordinal logistic regression was first attempted, and the parallel test was as shown in Table 9

Table 9: Test of Parallel Lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	881.306			
General	.000[b]	881.306	87	.000

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value is practically zero. There may be a complete separation in the data. The maximum likelihood estimates do not exist.

The Test of parallel lines in Table 9 was violated (p=0.0001<0.005) thereby making the ordinal logistics model inappropriate for the analysis. In order to use the ordinal logistics model, the test of parallel should provide a p value that is more than 0.05. Given this violation, the multinomial logistic regression model became appropriate for the study

A multinomial logistic regression was performed to assess the relationship between, employee creativity, transformational leadership and organisational performance. The traditional of 0.05 criteria of statistically significant was employed for all tests. The result was as follows x(90, N=200) =434.319, Nagelkerke R=.888, p<.001. The Tables below provides the model fitting information

Table 10: Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	f	ig.
Intercept Only	1152.913			
Final	718.594	434.319	0	000

Since the p value was less than 0.05 the model fits the data significantly than a dull model

Table 11: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	2296.730	4200	1.000
Deviance	699.071	4200	1.000

Table 12: Pseudo R-Square

Cox and Snell	.886
Nagelkerke	.888
McFadden	.365

Given that the P value for Pearson was 1.000(P>0.05) the model adopted is not statistically significant meaning that it the model fits the data set well and also the value of p value for Deviance is p=1.000 which is greater than 0.05 means that it is not statistically significant, so the model fits the data set very well. Table 13 provides the likelihood Ration Tests

Table 13: Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	993.307	274.713	30	.000
OI	872.611	154.017	30	.000
TL	778.512	59.918	30	.001
EC	776.348[a]	57.754	30	.002

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. unexpected singularities in the Hessian matrix are encountered. This indicates that either some predictor variables should be excluded, or some categories should be merged.

The results of the likelihood ratio test presented above shows organisational innovation (OI) significantly has an effect on organisational performance (p=0.0001<0.05), transformational leadership significantly has an effect on organisational performance (p=0.001<0.05), employee creativity significantly has an effect on organisational performance (p=0.002<0.05)

Other variables influencing organisational performance

The independent variable for this study was organisational performance (OP). Given that OP is affected by many variables, some of them were analysed in this study, it was important to consider descriptive statistics for OP from the data. The other variables that are described in this section were not specifically mentioned in the objectives but may directly affect OP or they may mediate the relation between OP and the other variables which were of interest in this study. Findings in relation to OP for this study are shown in Table 14

Table 14: Descriptive Statistics for organisational performance

	N	Minimum	Maximum	Mean	Std. Deviation
1. The quality of our products and services has been improved	200	1	6	2.66	.944
This organisation Employee education and training has increased	200	1	5	2.91	1.124
. The employees' satisfaction has increased in this organization	200	1	5	3.09	1.120
Customer satisfaction has increased in this organisation	200	1	5	2.82	1.011
. We continuously try to strengthen innovation skills in key areas where we have no prior experiences	200	1	6	2.71	1.045
The organisation is constantly exploring new/different ways to understand the expectations and requirements of key stakeholders	200	1	5	2.60	.972
The business processes are flexible allowing us to achieve high levels of responsiveness towards key stakeholder needs and demands	200	1	6	2.85	1.080
Customer complaints has decreased in this organisation	200	1	5	2.82	1.061
Valid N (listwise)	200				

The results for organisational performance indicate strong agreement on the statement that: . The employees' satisfaction has increased in this organization with a (Mean =3.09,SD=1.120). Followed by the statement that: This organisation Employee education and training has increased with (Mean =2.91,SD=1.124), The business processes are flexible allowing us to achieve high levels of responsiveness towards key stakeholder needs and demands had (Mean=2.85,SD=1.080). Customer satisfaction has increased in this organisation (Mean =2.82,SD=1.011) the statement that: Customer complaints has decreased in this organisation had a (Mean=2.82,SD=1.061) The statement that: We continuously try to strengthen innovation skills in key areas where we have no prior experiences had a (Mean =2.71,SD=1.045). The statement with low agreement were : The quality of our products and services has been improved with (Mean =2.60,SD=.972) and the statement : The organisation is constantly exploring new/different ways to understand the expectations and requirements of key stakeholders with a (Mean =2.60,SD=.972)

Perception for support

Statements for employee support in the organisation resulted in the descripted statistics shown on the table 15

Table 15: Descriptive Statistics on Perception for support

	N	Minimum	Maximum	Mean	Std. Deviation
1. Leadership always encourages people to come up innovative ideas	200	1	5	2.28	1.032
2. In my organisation, people are encouraged to solve the same problems using different ways	200	1	5	2.48	.935
3. This organisation is flexible and continually adapting to change	200	1	6	2.69	1.167
4. This organisation seems to be more concerned with the status quo than with change	200	1	5	2.94	1.279
5. This organisation publicly recognises those who are creative and innovative	200	1	5	2.88	1.230
Valid N (listwise)	200				

The results for perception for support indicates the high agreement on the statement that: This organisation seems to be more concerned with the status quo than with change with a (,Mean =2.94,:SD=1,279)This organisation publicly recognises those who are creative and innovative with a (Mean =2.88,:SD=1.230) .Followed by the statement that : This organisation is flexible and continually adapting to change with a (Mean =2.69,:SD=1.167) The statement with a lower agreement rate were In my organisation, people are encouraged to solve the same problems using different ways with a (Mean=2.48,:SD=.935) and .Leadership always encourages people to come up innovative ideas with a (Mean=2.28,:SD=1.032)

Table 16: provides views provided by respondents in respect of intrinsic motivation

Descriptive Statistics for intrinsic motivation

	N	Minimum	Maximum	Mean	Std. Deviation
1. I enjoy finding solutions to complex problems	200	1	6	1.70	.745
2. I enjoy engaging in analytical thinking	200	1	5	1.68	.648
3. I enjoy creating new procedures for work tasks	200	1	5	1.68	.665
4. I enjoy improving existing processes or products	200	1	5	1.67	.675
Valid N (listwise)	200				

The results provided by the respondents indicates a lower agreement with the statement that **:** . I enjoy finding solutions to complex problems with a (Mean=1.70,SD=.745). Followed by the statement that . I enjoy engaging in analytical thinking with a (Mean=1.68,SD=.648) and I enjoy creating new procedures for work tasks with a (Mean=1.68,SD=.665).

Table 17: Provides views provided by respondents in respect of empowerment

Empowerment

	N	Minimum	Maximum	Mean	Std. Deviation
1. I have significant autonomy in determining how I do my tasks	200	1	5	2.21	1.010
2. I have considerable freedom on how I carry out my tasks	200	1	5	2.21	1.014
3. The work I do is very important to me	200	1	5	1.61	.701
4. My job activities are meaningful to me	200	1	5	1.78	.798
5. I am confident about my ability to do my tasks	200	1	5	1.50	.665
Valid N (listwise)	200				

The results show low agreement that autonomy determines how tasks are done (Mean =2.21,SD=1.010). Respondents that considerable freedom on how I carry out my tasks (Mean=2.21,: SD=1.014), The statement that: My job activities are meaningful to me had a (Mean=1.78,:SD=.798) and the lowest agreement were as follows : The work I do is very important to me with a (Mean=1.61,:SD.701) : I am confident about my ability to do my tasks with a (Mean=1.50,:SD=.665)

Table 18 provides views provided by respondents in respect of intrinsic motivation Intellectual stimulation

Descriptive Statistics for intellectual stimulation					
	N	Minimum	Maximum	Mean	Std. Deviation
1. Leadership spends time mentoring and coaching	200	1	5	3.01	1.188
2. Leadership considers each individual as having different needs, abilities and aspirations.	200	1	5	2.89	1.181
3. Leadership inspires employees to look at problems from different angles	200	1	5	2.85	1.117
4. Leadership solicits differing perspectives when solving problems	200	1	5	2.87	1.106
5. Leadership helps employees to develop their capabilities	200	1	5	2.86	1.207
Valid N (listwise)	200				

The results provided by the respondents indicates a high agreement starting with the statement that: Leadership spends time mentoring and coaching with a (Mean=3,01,SD=1.188).The second high agreement is: Leadership considers each individual as having different needs, abilities and aspirations with (Mean =2.89,SD=1.181). The third highest response is: Leadership solicits differing perspectives when solving problems with a (Mean=2.87,SD=1.106) . Followed by the statement that : . Leadership helps employees to develop their capabilities (Mean=2.86,SD=1.207) and the last statement :Leadership solicits differing perspectives when solving problems with a (Mean=2.85,SD=1.106)

Conclusion

In conclusion the respondents indicate high satisfaction with employment creativity with a (mean=3.4312, sd=.89314), transformational leadership had a mean of (mean=3.3980, sd= .99768). Satisfaction that organisational performance has improved was also high (mean =3.2031, sd=89522) and Organisational innovation had a (mean=3.1542, mean=.97182). The findings of the study suggest that there is strong positive correlation (r=0.689) for the relationship between organisational performance and employee creativity. This correlation was significant (p=0.0001<0.005). Implication of this result is that improvement in employee creativity can result in improvement in organisational performance. This is evidence that the organisation needs to boost the creativity of employees as this has a positive effect on organisational performance. There also shows a strong positive correlation (r=0.766) for the relationship between organisational performance and transformational leadership. This correlation was significant (p=0.0001<0.005). Implication of this result is that improvement in transformational leadership can result in improvement in organisational performance. This is evidence that the organisation needs to boost the transformational leadership as this has a positive effect on organisational performance. The results also show a strong positive correlation (r=0.866) for the relationship between organisational performance and organisational innovation. This correlation was significant (p=0.0001<0.005). Implication of this result is that improvement in organisational innovation can result in improvement in organisational performance. This is evidence that the organisation needs to boost the organisational innovation as this has a positive effect on organisational performance.

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Using business analytics tools to boost Saudi business performance

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Keywords
business analytics tools, business performance, Saudi Arabian businesses

Abstract

This research studies the adoption of business analytics tools to improve business performance and operational efficiency in Saudi Arabia. The sample size considered includes 50 companies of different sizes and operating in different business sectors (consulting, manufacturing, food and beverages, retail, etc). The regression analysis confirms the positive correlation between the use of business analytics tools and enhancing business performance in the Saudi market. This finding supports the pervasive spread of business analytics in the business sector.

Introduction

In the age of digitalization, data has become a significant asset of modern businesses. Today, the use of traditional methods to analyze data is insufficient and ineffective (Niu et al., 2021). Traditional methods have failed to achieve competitive advantage for businesses. According to Uriona Maldonado et al., 2020, 89% of worldwide businesses believe they would experience losses if they do not use business analytics (BA) tools to make better decisions by improving their business processes. As a result, there is a rising demand for a new generation of technology, such as data analytics, and visualization tools, to aid businesses with enormous data administration, analysis, and decision-making (Chen & Lin, 2021).

There are a myriad of modern business analytic tools such as data mining, artificial intelligence (AI), machine learning (ML) and business intelligence (BI) that are beneficial for business performance and operations (Chae et al., 2014). A herald of research articles has been published on the use of BA and its significance. Prior studies have mainly focused on supply chain (Adaileh et al., 2022) and health sector (Alharthi, 2018) of the Kingdom of Saudi Arabia (KSA) while studying the impact of BA on business performance. However, in this study an inclusive approach has been taken in terms of industrial sector.

Advances in BA are rampant and studies on its benefits are in its early stages. This study attempts to broaden the theoretical concept of BA adoption and its benefits in the business sector of the Kingdom of Saudi Arabia (KSA) in terms of data visualization, business performance improvement, operational efficiency, and decision making via predictive analysis. There is a myriad of scholarly articles on impact of BA on the health sector in KSA. However, this study doesn't target a single sector, but data has been collected from different industrial sectors to explore the status of BA adoption and its perceived benefits in KSA. Moreover, an attempt has been made to find out the challenges companies are facing in adoption of BA using content analysis deductive approach. This study uses both qualitative and quantitative methods to unearth the impact of BA on business performance, and it provides evidence of the successful implementation of BA in businesses leading numerous operational and performance benefits.

Literature review

Operational efficiency, cost-reduction, and business performance are some of the critical needs of businesses in contemporary times. It is necessary for organizations to unrelentingly execute newer methods and processes that allow efficiency and promote innovativeness (Asare et al., 2020). By carefully monitoring costs, organizations can also ensure that they survive even in hostile markets, as they can maintain profitability without necessarily transferring the burden to the consumers (Khder et al., 2021).

Indeed, business analytic tools promise commendable business performance because, other than enhancing operations, they can also help detect abnormal business trends and allow effective redresses and improvements where weaknesses are identified (Rustagi & Goel, 2022). Chen et al., 2022 demonstrated a significant relation between the adoption of the business analytic tool and business performance. (Henrys, 2021) showed that in the 20th century, businesses that upheld predictive analytics remarkably attained proficiency. Therefore, this research project considers hypothesis (H1) stated as "*The adoption of BA (AdBA) has a significant impact on Business Performance (BP) and operational efficiency*". The hypothesis is teste in the Saudi market in different business sectors.

Research methodology

The methodology has been divided into two parts, qualitative and quantitative. In the quantitative context, a semi-structured self-administered questionnaire has been used to collect data from 50 companies operating in different business sectors, as shown in Figure 1. A self-administered five-point likert scale has been used to measure two variables, the adoption of business analytics (AdBA) and the business performance (BP). In addition, a coded question regarding the challenges faced by companies while adopting BA is also added to the survey. A convenient sampling technique was adopted in this study to determine the status of adoption of BA in KSA.

The AdBA is measured on a 5-point likert scale comprising two items determining if the company has adopted BA. The reliability of the construct is 0.68. However, the other variable BP is also a five-point likert scale based on 4 items. The cronbach's alpha of BP is 0.92. The BP items used in the questionnaire are the use of BA has *"increased efficiency and productivity"*, *"Improved decision making"*, *"Enhanced data visualization and reporting"*, *"Better understanding of customer behavior and preferences"* and *"Increased revenue and profitability"*. These items have been used as a comprehensive approach to measure the overall improvement in business performance resulting from cost reduction, operational efficiency and predicting customer behavior, leading to improved business performance.

Quantitative analysis

The data analysis was conducted using SPSS, using a linear regression model to test the hypothesis. The descriptive statistics were calculated to get an overview of the data. Figure 1 and table 1 summarize the characteristics of the tested sample. Moreover, the data analysis shows that 9 companies out of 50 are not using any smart business analytical tool. A Pearson correlation has been used to determine if there is a significant relationship between AdBA and BP. Moreover, the ANOVA test is conducted to determine if there is a significant difference between the BP of the company's using BA and the ones that are not using BA. The values confirm that the companies with BA have a higher level of business performance than the ones who have not adopted BA.

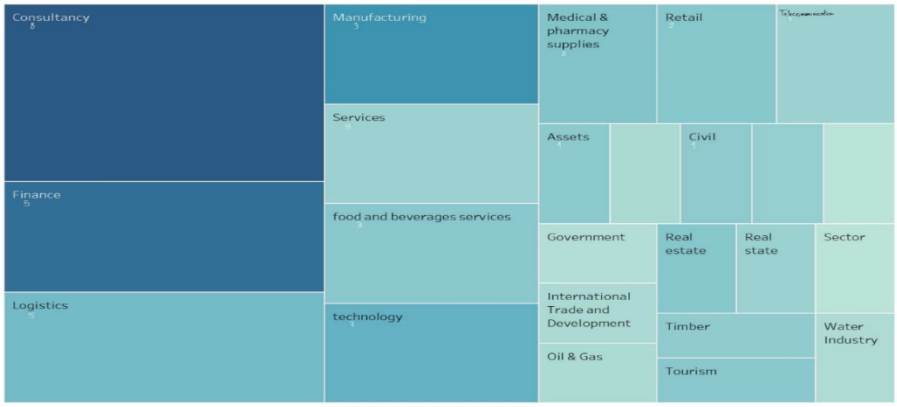

Figure 1. Companies Sectors where dark blue cells represent large companies and light green cells represent SMEs

Industry Sector	Number	# of employees	Number
Logistics	5	Less than 500	4

Consultancy	8	Less than 1000	7
Food	3	Less than 10000	8
Banking and Finance	5	Less than 20000	12
Retail	2	More than 20000	19
Technology	6		
Real Estate	2		
Manufacturing	7		
Others	12		

Table 1. Descriptive statistics

Moreover, companies were asked to select the challenges they faced during the implementation of business analytics. The challenges were *"lack of budget/resources"*, *"lack of skilled employees"*, *"difficulty integrating analytics tools with the existing system"* and "*others*". The results show that 25% of firms faced difficulty due to lack of skilled labor, 23.5% firms faced issue of funds deficiency and 23.5% firms faced difficulty during the integration of analytical tools with the existing system.

Qualitative analysis

A deductive content analysis approach has been used to answer the second research question stating, "Successful implementation of business analytics in your company". A semi structured questionnaire with open-ended questions were used to collect data. Analysis is done using thematic approach. Analysis revealed that several factors are required for a successful implementation of BA and there is a number of successful implementations across businesses.

The respondents' responses revealed that AI is a significant BA tool as it plays a vital role in prediction analysis in manufacturing, supply chain, quality control, marketing campaigns, and other sectors while ensuring customer satisfaction and operational efficiency. Predictive analysis helps business to make informed decisions as it identifies problems before they occur.

Findings

The linear regression has been applied as shown in Table 2. The dependent variable BP was regressed by the independent variable AdBA. The regression results show that ADBA significantly impact on BP, $F(1, 48) = 6.065$, $P<0.05$. It indicates that the variables under study have significant relation. Moreover, the R square equaling 0.441, depicts that the AdBA brings 44.1% variance in the BP.

The Pearson correlation shows a significant positive correlation between adoption of BA and BP where the value of beta is 0.335 and p value is 0.017. This shows that the adoption of BA improves business performance. Moreover, the ANOVA shows that there is a significant difference between the business performance levels of the companies that are not using BA with 0.017 significance level. Overall, the statistical results confirm the significant relation between the AdBA and BP which validates H1.

Hypothesis	Paths	Beta value	t	P-value	Results
H1	AbBA→ BP	.335	2.463	0.017<0.05	Supported
R 0.441 F (1,48) 6.065					

Table 2. Hypothesis testing

Furthermore, the direct relationship between AdBA and BF shows that the companies must adopt BA. Moreover, the data shows that in the sample of 50, 41 companies are already using BA to some extent. It shows the pervasive spread of BA in the business sector. The status of BA in the KSA is high and majority of the companies are using BA.

Limitation and future endeavors

The study provides an impetus to the companies to adopt BA to improve their performance. It proposes practical implications in the form of highlighting the issues companies facing during deployment of BA. While this study adopted convenient sampling, future studies can be done while adopting a specific sector with the specific level of employees. Moreover, this study used a single predictor of BP, and a comprehensive approach was taken in the name of BA. Future studies can be done using a different business analytical tool separately. Future studies can be performed while adding a moderating and mediation variable like business processing system to further signify the relation and enrich the literature.

Conclusion

The use of business analytics tools has expedited the process of improving corporate operations and performance. Despite the fact that business analytics has been utilized for many years, there is still a number of unresolved problems and barriers that must be addressed in order to increase company performance and efficiency for both individuals and businesses. Moreover, further studies must conduct in-depth analysis of the challenges companies are facing while adopting BA.

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The Digital Evolution- need to adapt education for a Tech-Savvy Generation

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Key words
Digital evolution, Education technology, digital classrooms, online, e-learning, real time education, digital literacy, technological shift, student engagement.

Abstract
Technology and innovation have impacted all industries and education is not exempt from this change. Organizations in different industries are constantly re-inventing their competencies and capabilities based on the technological upgrades that are being introduced into the markets; however, the change in education has not seen a drastic shift as it should. The current generation of scholars are exposed to technology from an early age (Manchanda, & Arora, 2023) and are equipped with tech-savvy devices that they are capable of using efficiently; can education leverage this skill in students to impart knowledge and improve their capabilities. This study aims to understand the gap in digitalization of education and propose various mediums and methods to adapt curriculum to engage students. Recent literature will also be reviewed as part of the study to gather evidence regarding empirical studies that have identified the need for technological adaptations, the benefits derived, and process followed to accomplish the same. There are a multitude of factors that must be considered to transform the education system through digitalization; as it certainly is not a simple process; the need to implement technology, students' expectations, alignment between course content and technology, instructors' ability to adapt to the change are some key factors that will impact this digital evolution in education. A vital purpose for conducting the study is also to evaluate the need for the suggested changes in education as current students are the future workforce who must be aware of technology, as it makes them employable in organizations; a digitally enables study environment trains students to utilize their technological skills so they can be transferred to organizations when they graduate and seek job opportunities (Murniarti, Simbolon, Purwoko, Fatmawati, & Hariyanto, 2023).

Introduction

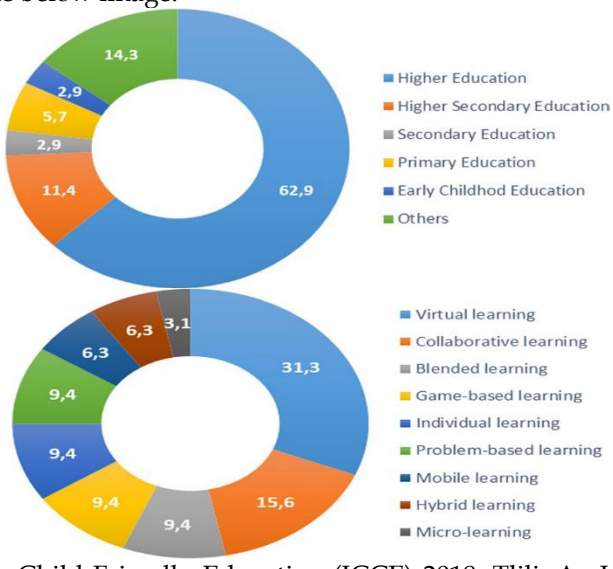
The current generation of students, namely Gen Z's (born between 1996 to 2010) and Gen Alpha (born between 2010 and 2025) have a unique set of skills in terms of technological acumen. They are introduced to technology at a very young age, technological devices like mobile phones, I-pads, laptops, and gaming consoles have become an integral part of their life. The adeptness of using digital media to communicate, being members on a multitude of online forums and constantly upskilling themselves to stay connected to the digital world are all unique characteristics of the current generation of students. These extreme changes that have taken place in recent decades have created a gap between the students and the education system, as contemporary curriculums and ways of learnings do not challenge and engage the students of recent generations. Although education systems have updated themselves to cater to the rising demands of the current generation students, there still seems to be a gap when compared to other industries that have adopted digitalization. Digitalization of education can be viewed as a multifold approach of updating the course content based on technological advances, adapting newer teaching methods, and implementing online classroom models so the students are equipped to transition smoothly into the workforce after they graduate. For the purpose of the current study, secondary research was conducted by reviewing empirical literature from recent years to identify the need for learning systems to

implement digital technology and primary research was conducted by interviewing students from different backgrounds of academics, varied age groups, pursuing their education in different levels; the data was collected, segregated, and analyzed to compute our findings that support the research.

Literature Review

Ahmed et al discusses the prominence of the implications of metaverse, and how educators can utilize technology to engage with the present generation of students. The multitude of available technologies included in the metaverse are listed as virtual reality, mirror world, embodied internet, post-reality simulator, digital virtuality, artificial intelligence, and lifelogging (Tlili, Huang, Shehata, Liu, Zhao, Metwally, ... & Burgos, 2022). Various keywords were strategically searched for, to comprehend the use of metaverse in educational research and the trend was observed as increasing over the recent years. E-learning, virtual reality, avatars that appear in simulations to interact with students, and interactive computer graphics all create a unique experience for learners. These interactive and immersive experiences ensure that students stay connected to the sessions, while tailoring content according to individual needs, interacting to receive real-time feedback, imparting knowledge relating to the course content as well as knowledge related to technology. The study reaffirms that using metaverse for educational purposes; as it expertly intertwines virtual world with physical classrooms and creates astonishing new possibilities for cooperative, collaborative, problem-solving learning possibilities (Araya, & Avila, 2018). These blended learning platforms do not eliminate the traditional lectures and training but suggest complementing these sessions with technology-based experiences like game-based scenarios for learning created and monitored by teachers.

The different levels of education and types of digital learning options that have been found in recent literature are depicted in the below image.



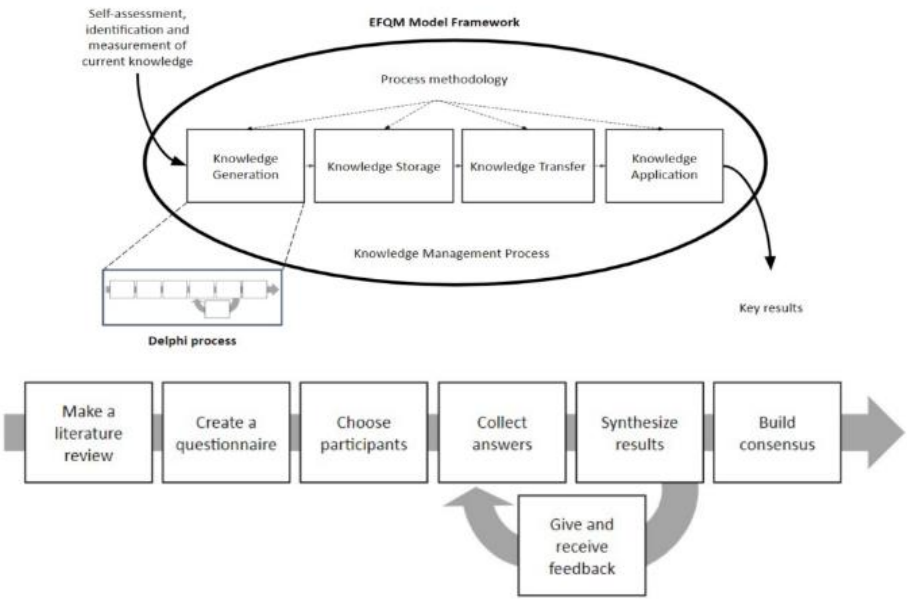
Source: Conference On Child-Friendly Education (ICCE) 2018. Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., ... & Burgos, D. (2022). Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis. Smart Learning Environments, 9(1), 1-31.

The authors discuss the learning process and habits of present generation students like Generation Z and Generation Alpha (at schools in Indonesia) and the importance of updating the learning system to make it more appealing and interesting to students. Key take aways from the paper are the need to create an attractive classroom with digital technology, opening up positive digital technology utilities for students and moving up the benchmark for learning success using technology. The authors have studied the nature and habits of the newer generation, which are tech-dependent, multi-tasking, and the keenness to always stay connected and have access to abundance of information online (Hariadi, Bambang, and Pantjawati, 2016). Globalization has revived many industries and education is not exempt from this radical change; as the users have updated themselves with technological advances, it is vital for the education system to keep up by updating the methods with web technologies to ensure improvement

in quality of education and the ability to bridge the gap between education and employability. The implementation of digital classrooms and online learning can improve the standard of education, help teachers and students to advance, and lead to cost reduction by introducing flexibility in learning.

The advantages of adopting digital education systems have been elaborately researched by the authors Van et al. and these are specifically gained by the implementation of technology in learning organizations. The importance of knowledge management and transfer, intellectual property gathering and processing, and creating digital scholars are explored in this paper. Enormous amounts of data are generated for the purpose of education, the data is compiled of learning materials, course content, student-teacher interactions, student progress, outcomes of the learning, future needs for improvement in the content and feedback from students; with the application of digitalization in education, this data can be gathered, stored, and processed for a multitude of benefits for the organizations, teachers, and students. Digital education can also assist in improving research, provides input for scholars, and knowledge can be converted into a capital asset.

Higher education institutions (HEI) are in dire need to manage knowledge in order to bridge the gap present in the transition phase of students into workers. Efforts including automation, augmentation and digitalization of learning systems have been adopted by institutions (Argôlo, Miranda, Pagliusi, Lima, Santos, Barbosa, & Souza, 2022). The future of the students who complete higher education needs to be taken into consideration by universities and organizations while designing the curriculum and the knowledge imparted to students in HEI must be capable to being transferred to the jobs in the future. The learning model developed must ensure all these checkpoints are met successfully, to establish success criteria for students. It is crucial for institutions to keep up with the demands of organizations in terms of the skillset developed by students, the trends that are adopted by organizations, so students are up to date when they are onboarded to their first jobs and transferring educational knowledge into practical situations and problems.



Source : Calvo-Mora, A., Navarro-García, A., & Periañez-Cristobal, R. (2015). Project to improve knowledge management and key business results through the EFQM excellence model. International Journal of Project Management, 33(8), 1638-1651.

The above image depicts the EFQM (European Foundation for Quality Management) model described by Calvo-Mora et al. as a framework to implement for quality management, this model can also be applied to education systems to manage the standard of curriculum, improve the same to ensure adherence to market standards of employability and guide educators through the knowledge management process efficiently (Calvo, Navarro, & Periañez, 2015).

Technology-Enabled Learning in Action

According to Amirian, (2007) learning principles transcend specific technologies. However as per Amirian, (2007), when carefully designed and thoughtfully applied, technology has the potential to accelerate, amplify, and expand the impact of powerful principles of learning.

This concept of technology-enabled learning encompasses a range of skills and literacies that can include internet safety, privacy and security, cyberbullying, online reputation management, communication skills, information literacy, and creative credit and copyright Amirian, (2007).

According to Hsu, P., & Sharma, (2008) few ways technology can improve and enhance learning, both in formal learning and in informal settings.

1.Technology can enable personalized learning or experiences that are more engaging and relevant. Mindful of the learning objectives, educators might design learning experiences that allow students in a class to choose from a menu of learning experiences—writing essays, producing media, building websites, collaborating with experts across the globe in data collection—assessed via a common rubric to demonstrate their learning. Such technology-enabled learning experiences can be more engaging and relevant to learners.

2.Technology can help organize learning around real-world challenges and project-based learning – using a wide variety of digital learning devices and resources to show competency with complex concepts and content. Rather than writing a research report to be read only by her biology teacher and a small group of classmates, a student might publish her findings online where she receives feedback from researchers and other members of communities of practice around the country. In an attempt to understand the construction of persuasive arguments, another student might draft, produce, and share a public service announcement via online video streaming sites, asking his audience for constructive feedback every step of the way.

Statistical Data

Participants

A total of 59 students completed the questionnaire via Survey Monkey after qualifying for participation in the study. The age range of the students who participated in the study is 18 to 28. The data were collected from undergraduate 33% of the students who were freshmen, 32% sophomores, 20% juniors, 10% seniors and 4% were graduate students or post-graduates More females than males answered the questionnaire, (28% male and 72% female). The majority of students were Americans (99%), and 1% international students.

Materials

The survey used for this study was based on the "Experience with technology" survey (Kennedy, Krause, Judd, Churchward, and Gray, 2006) This survey used the same three sections as Kennedy, Krause, Judd, Churchward, and Gray's (2006) survey. The first block asked students about their access to technology; the second block presented questions about computer use. The third section asked students' experience with computer technology in university as per Kennedy, Krause, Judd, Churchward, and Gray) and how well they felt they had been prepared for college. In addition, my survey included another block of questions focused on issues of computer maintenance, and how satisfied students have been with their computer use in college. In addition to the sections about computer use, the survey included information about students' demographics. Information for participants' gender was collected in order to find out if computer knowledge and habits are gender specific. The questions concerning computer knowledge and habits were categorized in four different blocks. The first block was dedicated to collecting data concerning student's access to technology in college in high school. Students were asked what kind of techno devices they owned, such as computers, laptops, and smart phones. The second block of questions was aimed at questions about students' experience with and knowledge about computer technology in college. This section was designed to collect data that could provide information about the role of computer technology in their daily life and students' experience with a variety of software. The survey focused on questions about ownership of different devices such as laptops, cell phones, as well as

students' use and experience of computer technology. For example, questions asked how many hours students spend using computers for different tasks, like surfing the web, doing homework, emailing, chatting, and how experienced they are with various kinds of software. The third section was designed to collect data about students' access to technology and computer education in college. This part of the survey probed students' prior computer education and how computer use influenced their use of and knowledge about computer technology in college. Questions in this section of the questionnaire included questions such as "How frequently did you us a computer during your time in college," what kind of computer classes did you have in college," and "please list the kind of computer technology you used in the classroom." In addition, open-ended questions in which students were asked if they thought their knowledge about computer technology has improved and if there were computer skills they had wished to have learned in high school before entering college. The last section concentrated on acquiring data concerning students' overall and extended interest in and knowledge about computer technology including questions about computer maintenance.

Design/Coding

Data collection took place in March of 2024 and the results were tested for female and male differentiations, but t-Tests showed that gender differences were insignificant, so gender differences were not considered in this study. Similarly, t-tests of differentiations among students of different age groups were also insignificant, partly due to the small sample size.

Bringing Equity to Learning Through Technology

Closing the Digital Use Divide

As per Iiyoshi, Hannafin, & Wang, (2005) traditionally, the digital divide in education referred to schools and communities in which access to devices and Internet connectivity were either unavailable or unaffordable. Although there is still much work to be done, great progress has been made providing connectivity and device access. As per Iiyoshi, Hannafin, & Wang, (2005) we have to be cognizant of a new digital divide—the disparity between students who use technology to create, design, build, explore, and collaborate and those who simply use technology to consume media passively. On its own, access to connectivity and devices does not guarantee access to engaging educational experiences or a quality education (Iiyoshi, Hannafin, & Wang, 2005). Without thoughtful intervention and attention to the way technology is used for learning, the digital use divide could grow even as access to technology in colleges increases.

Digital learning tools can offer more flexibility and learning supports than can traditional formats such as using mobile devices, laptops, and networked systems, educators are better able to personalize and customize learning experiences to align with the needs of each student. Iiyoshi, Hannafin, & Wang, (2005) can expand communication with mentors, peers, and colleagues through social media tools. Digital tools also can make it possible to modify content, such as raising or lowering the complexity level of a text or changing the presentation rate.

Roles and Practices of Educators in Technology -Supported Learning

Technology can empower educators to become co-learners with their students by building new experiences for deeper exploration of content (Iiyoshi, Hannafin, & Wang, 2005). Educators must take full advantage of technology to transform learning requires strong leadership capable of creating a shared vision of which all members of the community feel a part. Leaders who believe they can delegate the articulation of a vision for how technology can support their learning goals to a chief information officer or chief technology officer fundamentally misunderstand how technology can impact learning. Technology alone does not transform learning; rather, technology helps enable transformative learning. The vision begins with a discussion of how and why a community wants to transform learning. Once these goals are clear, technology can be used to open new possibilities for accomplishing the vision that would otherwise be out of reach. As we move to learning enabled by technology can mean a shift in the specific skills and competencies required of leaders Iiyoshi, Hannafin, & Wang, (2005). Education leaders

need personal experience with learning technologies, an understanding of how to deploy these resources effectively, and a community-wide vision for how technology can improve learning.

Limitations

The findings from the study have not been validated externally as findings may vary depending on the nature of educational institutions (technology, management and science universities may have a higher score); similarly other geographical locations may yield a different set of results based on their socio-economic factors, developed, or developing countries may significantly vary in technological advances, backgrounds of students, and infrastructure. The study is also bound by time, as the current state only could be determined due to limitations in time, a suggestion for future researchers can be to extend the study to a period when the students have transitioned to the workforce to determine their readiness for organizations, and if there was any gap in their knowledge identified during the process.

Conclusion

The timing has never been better for using technology to enable and improve learning at all levels, in all places, and for people of all backgrounds. Educators, policymakers, administrators, and teacher preparation and professional development programs now should embed these tools and resources into their practices. As educators work in collaboration with families, researchers, cultural institutions, and all other stakeholders, these groups can eliminate inefficiencies, reach beyond the walls of traditional classrooms, and form strong partnerships to support everywhere, all-the-time learning. Although the presence of technology does not ensure equity and accessibility in learning, it has the power to lower barriers to both in ways previously impossible. Technology allows greater communication, resource sharing, and improved practice so that the vision is owned by all and dedicated to helping every individual in the system improve learning for students.

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Genoeconomics: Decoding the genetic basis of entrepreneurial success

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'The fundamental unit of selection, and therefore of self-interest,
is not the species, not the group, nor even, strictly, the individual.
It is the gene, the unit of heredity.'

.... Richard Dawkins

Keywords
Genomics, Behavioral Genetics, Behavioral Genetics, Entrepreneurship and Managerial Business – Economics

Abstract

This paper explores the emerging intersection of genomics, neuroscience, and entrepreneurship. Specifically, it examines if and how genetic factors and neurobiological processes influence entrepreneurial behaviors and success. The key questions addressed are: 1) Is there a genetic basis for the entrepreneurial mindset? 2) Can genetic markers and neuroimaging data predict entrepreneurial outcomes? 3) What challenges arise when combining genetic, neuroscientific, and business data? 4) How can entrepreneurs utilize insights from genomics and neuroscience? The paper argues that synchronizing molecular genetics with behavioral data can offer new causal explanations for entrepreneurial cognition under the umbrella of "genoeconomics." However, there are methodological difficulties in analyzing genetically informative data. It cautions against genetic determinism while highlighting opportunities from mapping genetic entrepreneurial proclivities. Entrepreneurship is an intricate phenotype.

Are entrepreneurs born or made or developed or adopted? What makes an entrepreneur think outside the box and pursuing avant-garde paths to attain entrepreneurial goals? Alvin Toffler mentioned of various 'Waves' viz. Agrarian, Industrial and so on. Economics and Business Management, today, is experiencing inestimable waves viz. Heterodox Wave, Genetic Wave, Molecular Wave, Cellular Wave, Hereditary Wave, ['Infoplosion' or 'Info-Tectonics' Wave, Capability Approach Wave, Institutional Wave, Behavioral / Experimental Wave [Cognitive and Emotional dimensions / Develops and uses experiments typically with human subjects], Evolutionary Wave, Cognitive Wave, Information Wave , Artificial [Synthetic and / or Fabricated] Intelligence Wave and Neuro Wave, to list a few, from a rational perspective.

Of central interest in this paper is Managerial Business - Economics Wave. It deals with, with complex, deep-rooted problems, gears and technique to dissect market demand, assess expenses, establish pricing strategies, assess risks, and appreciate competitive dynamics. Is entrepreneurship a genetic trait? Of recent origin is emergence of incorporating genetic and biological markers into entrepreneurship. Issue that confronts is, is there a need to sync molecular genetics and entrepreneurial business data to genomic entrepreneurship; under umbrella of 'Genoeconomics'? ***Does this mean that entrepreneurship is in genes?*** *Do genes determine entrepreneurial success? Can genetics or molecular genetics and entrepreneurial data predict response to multifarious behavioral intercession? Can genetics calculate retort to intricate behavioral interference? Are genetic markers of interest for entrepreneurship research? What challenges occur when analyzing genetically informative facts? How, if at all, should entrepreneurs use and combine molecular genetics and business data? What challenges arise when analyzing genetically informative data? The moot issue is, can*

entrepreneurship be genetic? Can an entrepreneur be 'genetically-inclined'? One debatable question is why do entrepreneurial parents have entrepreneurial children? What kinds of opportunities will genetic mapping of entrepreneur offer business entities? Do the big Five Personality Traits [Openness, Conscientiousness, Extraversion, Agree-Ableness and Neuroticism] play a role? Do genetic factors influence tendency to acquire skills and develop attributes relevant to entrepreneurship? Is it crucial to emphasize that a genetic predisposition to entrepreneurship should definitely, unequivocally, not be confounded with genetic determinism? This paper aims to seek a conceptualistic conformation to the above issues

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"Our brains are best suited for certain situations. We prefer to think in causal terms, and we like predictable outcomes. We want to open doors when we know what is behind it. When we don't know, we undervalue potential outcomes".

(Schweitzer; 2021)

Introduction

Entrepreneurship involves complex cognitive capacities, from recognizing opportunities to tolerating risk. There is growing interest in rooting these behaviors in biological foundations. Genomics and neuroscience provide potential windows into the innate and neural drivers of key entrepreneurial faculties. This paper asks: can genetic proclivities and brain functioning differentiate entrepreneurial success? It explores cutting-edge techniques like gene sequencing and neuroimaging for quantifying entrepreneurial aptitude prior to real-world ventures.

The interdisciplinary route is not without challenges. Ethical barriers, data limitations, and issues of genetic determinism need resolution. However, synchronizing genetic and neuro markers with decision-making patterns may reveal new entrepreneurial "phenotypes." The promise lies in forecasting entrepreneurial outcomes, designing targeted interventions, and democratizing access. The paper provides a conceptual framework for this nexus of genoeconomics and neuroeconomics - one where entrepreneurial promise overcomes genetic peril.

The convergence of AI, entrepreneurial responsibility, evolving workplace models, and decision-making under limited information demands a paradigm shift. This confluence necessitates new approaches to substantiate decisions in the realm of entrepreneurial ventures. The emerging field of algorithmic entrepreneurship poses a crucial question: what constitutes evidence in entrepreneurial decision science?

Recognizing that traditional decision-making philosophies might not suffice, this paper advocates for a holistic and integrative approach. It emphasizes the need to understand the entrepreneurial mind and its cerebral engagement with new ideas. In essence, it challenges the orthodox views on how entrepreneurs make decisions.

Here's how it proposes to achieve this:

Identifying methods to test causal relationships: Move beyond correlations and establish evidence-based connections between factors influencing entrepreneurial decisions.

Embracing heterodox approaches: Integrate empirical cognitive and neural frameworks to understand the causal reasoning process of entrepreneurs.

Exploring the genetic-management link: Analyze the relationship between genetic predispositions and management data to reveal underlying neural pathways associated with entrepreneurial decision-making.

By undertaking these steps, this paper aims to equip entrepreneurs with novel tools and frameworks to navigate the complexities of today's dynamic world.

Research in entrepreneurship has largely ignored biological factors [Ahmed Maged Nofal, Nicos Nicolaou & Scott Shane; 2018]. An emerging trend in Social and Behavioral Sciences, Heredity, Hormones, Bodily Processes, and Neuroscience, as 'Pillars of Biology,' stand as contributory agents towards role of Biology to Entrepreneurship. Quantitative genetics and molecular genetics are the two approaches that examine the influence of biology to entrepreneurship ['Nature versus Nurture']. There appear to be

methodological, theoretical and paradigm changes as regards Biology in Entrepreneurship [Alvarez S., Barney J. B.; 2020]. This reflects the impact of genetic architecture on brain and biology of entrepreneurs [de Holan P. M.; 2014]. Research from the social sciences has variously attributed the success of these individuals to risk-taking, aggression, and sociability [David G. Rand; 2010]. The moot issue is, is there a genetic predisposition to entrepreneurship [Bönte W., Procher V. D., Urbig D.; 2016]?

Prima facie, what makes an entrepreneur think outside the box and pursuing avant-garde paths to attain entrepreneurial goals? Alvin Toffler mentioned of various 'Waves' viz [van der Loos M. J. H. M., Rietveld C. A., Eklund N., Koellinger P. D., Rivadeneira F., Abecasis G. R., Ankra-Badu G. A., Baumeister S. E., Benjamin D. J., Biffar R., Blankenberg S., Boomsma D. I., Cesarini D., Cucca F., de Geus E. J. C., Dedoussis G., D and Satpathy; 2022] Agrarian, Industrial and so on [van der Loos M. J. H. M., Rietveld C. A., Eklund N., Koellinger P. D., Rivadeneira F., Abecasis G. R., Ankra-Badu G. A., Baumeister S. E., Benjamin D. J., Biffar R., Blankenberg S., Boomsma D. I., Cesarini D., Cucca F., de Geus E. J. C., Dedoussis G., D and Satpathy; 2022]. Economics and Business Management, today, is experiencing inestimable waves viz [van der Loos M. J. H. M., Rietveld C. A., Eklund N., Koellinger P. D., Rivadeneira F., Abecasis G. R., Ankra-Badu G. A., Baumeister S. E., Benjamin D. J., Biffar R., Blankenberg S., Boomsma D. I., Cesarini D., Cucca F., de Geus E. J. C., Dedoussis G., D and Satpathy; 2022]. Heterodox Wave, Genetic Wave, Molecular Wave, Cellular Wave, Hereditary Wave, ['Infoplosion' or 'Info-Tectonics' Wave, Capability Approach Wave, Institutional Wave, Behavioral / Experimental Wave [Cognitive and Emotional dimensions / Develops and uses experiments typically with human subjects], Evolutionary Wave, Cognitive Wave, Information Wave , Artificial [Synthetic and / or Fabricated] Intelligence Wave and Neuro Wave, to list a few, from a rational perspective [Lerner D. A., Alkærsig L., Fitza M. A., Lomberg C., Johnson S. K. ;2020].

Questions addressed are How cogent should an entrepreneur be? How do affect and cognition interact in entrepreneurial decision making? How do affect and cognition interact in entrepreneurial decision making? And how moved is the *entrepreneur* during decision moment? Methodology to investigate neural computational is to scan positioning of eye movements. Role of eye movements help in gaining, possessing and tracing visual inducements, during decision formation. Current proof suggests that orientation of eye movement can be a result of intensification in decision formation. Of central interest in this paper is Managerial Business - Economics Wave [Lerner D. A., Alkærsig L., Fitza M. A., Lomberg C., Johnson S. K. ;2020]. It deals with, with complex, deep-rooted problems, gears and technique to dissect market demand, assess expenses, establish pricing strategies, assess risks, and appreciate competitive dynamics. Is entrepreneurship a genetic trait [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Of recent origin is emergence of incorporating genetic and biological markers into entrepreneurship. Issue that confronts is, is there a need to sync molecular genetics and entrepreneurial business data to genomic entrepreneurship; under umbrella of 'Genoeconomics' [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Does this mean that entrepreneurship is in genes [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Do genes determine entrepreneurial success [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Can genetics or molecular genetics and entrepreneurial data predict response to multifarious behavioral intercession [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Can genetics calculate retort to intricate behavioral interference [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Are genetic markers of interest for entrepreneurship research [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020].

What challenges occur when analyzing genetically informative facts [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. How, if at all, should entrepreneurs use and combine molecular genetics and business data [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. What challenges arise when analyzing genetically informative data [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. The moot issue is, can entrepreneurship be genetic [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. Can an entrepreneur be 'genetically-inclined' [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. One debatable question is why entrepreneurial parents have entrepreneurial children [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. What kinds of opportunities will genetic mapping of entrepreneur offer business entities [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. Do the big Five Personality Traits [Openness, Conscientiousness, Extraversion, Agree-Ableness and Neuroticism] play a role [Nicolaou N., Lockett A., Ucbasaran D., Rees G. ;2019]. Do genetic factors influence tendency to acquire skills and develop

attributes relevant to entrepreneurship [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. Is it crucial to emphasize that a genetic predisposition to entrepreneurship should definitely, unequivocally, not be confounded with genetic determinism? This paper aims to seek a conceptualistic conformation to the above issues.

Eyes are windows to the soul. There is a strategic logic as to why the five sense organs are co - located to each other. The pair of eyes work to observe watch and perceive. The ears to hear and pay attention to the language of communication received. The nose works to smell (Olfaction) and get to know of things. Tongue to taste and skin to feel. The common thread that links all these organs is that they are all located between the chin and the head. An additional link that all these sense organs receive and transmit, send or convey information, to a common recipient i.e. brain. Brain in turn controls thought, memory, emotion, touch, motor skills, vision, breathing, temperature, hunger and every process that regulates our body (Wikipedia; 2024 & Parincu, A. M. T., Capatina, A., Varon, D. J., Bennet, P. F., &Recuerda, A. M.; 2020). Functioning on the basis of a hybrid methodology, brain (and eyes) provides an algorithm for cognitive architecture of decision dynamics.

Biology and neurosciences have entered management arena in a mega way (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). This amalgamation coupled up is influx of AI, entrepreneurial responsibility, new world of work framework, and art of making decision with scant information (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). In such a scenario, sense organs in human body have been experimented to find precise data and information (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). Algorithmic entrepreneurial decision introduces a critical question; what constitutes substantiation in entrepreneurial decision sciences (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). This mandates holistic thinking and deep understanding since paradigm for entrepreneurial decision control is emerging (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). This ceases conservative philosophy, appreciate how to engage and influence cerebral of entrepreneur and help activate openness to new ideas. An area that merits analysis is how an entrepreneur decides and how do the sense organs (especially the eyes) play a pivotal role in decision making (Wikipedia; 2021)?

How cogent should an entrepreneur be (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How can biases affect entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? Are the brains of optimistic, hopeful, confident, and resilient leaders different (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How strongly did you imagine the thoughts and feelings of this person (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How much compassion did you feel for this person (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))?, and how moved were you during the decision moment (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? The humanization subscale assessed the effects induced by the priming manipulation using the questions: to what extent did you see this person as a human being, rather than a means to an end (Satpathy; 2020, 2023 & Yoon, Carolyn,

Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How responsible did you feel for this person's well-being? and to what extent did you see this person as a human being with needs, desires, and feelings? How does a brain build a cognitive code?

Entrepreneurs aim at decision satisfying necessary and sufficient conditions of optimization through mathematical analysis (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). One way to investigate neural computational is to scan positioning of eye movements linked to optical consideration (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). Investigating eye movements is expedient in providing evidence of orientation of decision behaviour replicating computational decision (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). Role of eye movements, intentional or reflex, help in gaining, possessing and tracing visual inducements, during decision formation (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). Current proof suggests that orientation of eye movement itself may not be an essential constituent. Rather, it can be as a result of intensification in contact to incitement as an influential factor in decision formation. An important question is how entrepreneur makes complex decisions. In such a scenario, pertinent issue is how Entrepreneur is going to decide when engulfed in a situation of seen and unseen forces within environment of Artificial (Fabricated and / or Synthetic) Intelligence (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? Will entrepreneurial decision making be the same as it was in the Classical / Neo - Classical era (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What would be the challenges (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What about the tsunami of information waves (Infoplosion or Info-Tectonics) (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What about the degrees of significant signal-detection problem intrinsic in complex circumstances (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are our basic cognitive operations (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do we use them in judgment, economic entrepreneurial decision, action, reason, choice, persuasion, and expression (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? Do entrepreneurial decision makers know what they need to know (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do entrepreneurial decision makers choose (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are the best incentives? When is judgment reliable (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? Can negotiation work edifice (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do cognitive conceptual resources depend on social and cultural location (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do certain products of cognitive and conceptual systems come to be entrenched as shared knowledge and method (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What makes these biases adaptive and when are they adaptive (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are the boundary conditions for these biases to be adaptive (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? When and which biases can be both adaptive and mal-adaptive at the same time, for instance, leading to positive individual but negative group or societal consequences (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are the implications (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)?

Aim of this paper is to challenge orthodox philosophy of decision making by entrepreneurs (Serra, D. ;2021). This is by identifying methods to test causal relations, heterodoxically employ empirical cognitive and neural approach (es) to causal reasoning and ascertain relation between genetic - management data to reveal neural paths in entrepreneurial decision making (Serra, D. ;2021). Questions addressed are How cogent should an entrepreneur be Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). How do affect and cognition interact in entrepreneurial decision-making Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). How do affect and cognition interact in entrepreneurial decision-making Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). And how moved is the entrepreneur during decision moment Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). Methodology to investigate neural computational is to scan positioning of eye movements. Role of eye movements help in gaining, possessing and tracing visual inducements, during decision formation. Current proof suggests that orientation of eye movement can be a result of intensification in decision formation. Purpose is to exhibit empirical mosaics in neuro - trajectory shifts(s) of entrepreneurial decision circuit. Objective is to monitor undercurrents of

neurobiological motorists in Entrepreneurial decision making. Effort is to explicate how neural investigations appreciate mental tectonic shifts in decision framework.

Methodology

Effort is to explicate how neural investigations appreciate 'tectonic shifts' in decision framework (Opris, I., Ionescu, S. C., Lebedev, M. A., Boy, F., Lewinski, P., & Ballerini, L.; 2020). This paper adopts a new approach to essence of neuroeconomics; How does entrepreneur craft entrepreneurial decisions (Sanfey, A. G.; 2007 & Lebiere, C., Pirolli, P., Thomson, R., Paik, J., Rutledge-Taylor, M., Staszewski, J., & Anderson, J. R.; 2013). What parts of eye aid decision? What ocular - impressions depict in cycle of entrepreneurial decisions? An eye movement experiment was adopted based on Tobii equipment on on single subject (N=01). The fixations were calibrated as under.

Time to First Fixation %‡4.JPG_2_N	Time to First Fixation %‡4.JPG_2_Mean	Time to First Fixation %‡4.JPG_2_Sum	Time to First Fixation %‡4.JPG_3_N
Time to First Fixation %‡4.JPG_3_Mean	Time to First Fixation %‡4.JPG_3_Sum	Time to First Fixation %‡4.JPG_4_N	Time to First Fixation %‡4.JPG_4_Mean
Time to First Fixation %‡4.JPG_4_Sum	Time to First Fixation %‡5.JPG_5_N	Time to First Fixation %‡5.JPG_5_Mean	Time to First Fixation %‡5.JPG_5_Sum
Time to First Fixation %‡6.JPG_6_N	Time to First Fixation %‡6.JPG_6_Mean	Time to First Fixation %‡6.JPG_6_Sum	Time to First Fixation %‡6.JPG_7_N
Time to First Fixation %‡6.JPG_7_Mean	Time to First Fixation %‡6.JPG_7_Sum	Time to First Fixation %‡7.JPG_10_N	Time to First Fixation %‡7.JPG_10_Mean
Time to First Fixation %‡7.JPG_10_Sum	Time to First Fixation %‡7.JPG_8_N	Time to First Fixation %‡7.JPG_8_Mean	Time to First Fixation %‡7.JPG_8_Sum
Time to First Fixation %‡7.JPG_9_N	Time to First Fixation %‡7.JPG_9_Mean	Time to First Fixation %‡7.JPG_9_Sum	First Fixation Duration %‡4.JPG_1_N
First Fixation Duration %‡4.JPG_1_Mean	First Fixation Duration %‡4.JPG_1_Sum	First Fixation Duration %‡4.JPG_2_N	First Fixation Duration %‡4.JPG_2_Mean
First Fixation Duration %‡4.JPG_2_Sum	First Fixation Duration %‡4.JPG_3_N	First Fixation Duration %‡4.JPG_3_Mean	First Fixation Duration %‡4.JPG_3_Sum
First Fixation Duration %‡4.JPG_4_N	First Fixation Duration %‡4.JPG_4_Mean	First Fixation Duration %‡4.JPG_4_Sum	First Fixation Duration %‡5.JPG_5_N
First Fixation Duration %‡5.JPG_5_Mean	First Fixation Duration %‡5.JPG_5_Sum	First Fixation Duration %‡6.JPG_6_N	First Fixation Duration %‡6.JPG_6_Mean
First Fixation Duration %‡6.JPG_6_Sum	First Fixation Duration %‡6.JPG_7_N	First Fixation Duration %‡6.JPG_7_Mean	First Fixation Duration %‡6.JPG_7_Sum
First Fixation Duration %‡7.JPG_10_N	First Fixation Duration %‡7.JPG_10_Mean	First Fixation Duration %‡7.JPG_10_Sum	First Fixation Duration %‡7.JPG_8_N
First Fixation Duration %‡7.JPG_8_Mean	First Fixation Duration %‡7.JPG_8_Sum	First Fixation Duration %‡7.JPG_9_N	First Fixation Duration %‡7.JPG_9_Mean
First Fixation Duration %‡7.JPG_9_Sum	Fixation Duration %‡4.JPG_1_N	Fixation Duration %‡4.JPG_1_Mean	Fixation Duration %‡4.JPG_1_Sum
Fixation Duration %‡4.JPG_2_N	Fixation Duration %‡4.JPG_2_Mean	Fixation Duration %‡4.JPG_2_Sum	Fixation Duration %‡4.JPG_3_N
Fixation Duration %‡4.JPG_3_Mean	Fixation Duration %‡4.JPG_3_Sum	Fixation Duration %‡4.JPG_4_N	Fixation Duration %‡4.JPG_4_Mean
Fixation Duration %‡4.JPG_4_Sum	Fixation Duration %‡5.JPG_5_N	Fixation Duration %‡5.JPG_5_Mean	Fixation Duration %‡5.JPG_5_Sum
Fixation Duration %‡6.JPG_6_N	Fixation Duration %‡6.JPG_6_Mean	Fixation Duration %‡6.JPG_6_Sum	Fixation Duration %‡6.JPG_7_N
Fixation Duration %‡6.JPG_7_Mean	Fixation Duration %‡6.JPG_7_Sum	Fixation Duration %‡7.JPG_10_N	Fixation Duration %‡7.JPG_10_Mean
Fixation Duration %‡7.JPG_10_Sum	Fixation Duration %‡7.JPG_8_N	Fixation Duration %‡7.JPG_8_Mean	Fixation Duration %‡7.JPG_8_Sum
Fixation Duration %‡7.JPG_9_N	Fixation Duration %‡7.JPG_9_Mean	Fixation Duration %‡7.JPG_9_Sum	Total Fixation Duration %‡4.JPG_1_N

Total Fixation Duration %‡4.JPG_1_Mean	Total Fixation Duration %‡4.JPG_1_Sum	Total Fixation Duration %‡4.JPG_2_N	Total Fixation Duration %‡4.JPG_2_Mean
Total Fixation Duration %‡4.JPG_2_Sum	Total Fixation Duration %‡4.JPG_3_N	Total Fixation Duration %‡4.JPG_3_Mean	Total Fixation Duration %‡4.JPG_3_Sum
Total Fixation Duration %‡4.JPG_4_N	Total Fixation Duration %‡4.JPG_4_Mean	Total Fixation Duration %‡4.JPG_4_Sum	Total Fixation Duration %‡5.JPG_5_N
Total Fixation Duration %‡5.JPG_5_Mean	Total Fixation Duration %‡5.JPG_5_Sum	Total Fixation Duration %‡6.JPG_6_N	Total Fixation Duration %‡6.JPG_6_Mean
Total Fixation Duration %‡6.JPG_6_Sum	Total Fixation Duration %‡6.JPG_7_N	Total Fixation Duration %‡6.JPG_7_Mean	Total Fixation Duration %‡6.JPG_7_Sum
Total Fixation Duration %‡7.JPG_10_N	Total Fixation Duration %‡7.JPG_10_Mean	Total Fixation Duration %‡7.JPG_10_Sum	Total Fixation Duration %‡7.JPG_8_N
Total Fixation Duration %‡7.JPG_8_Mean	Total Fixation Duration %‡7.JPG_8_Sum	Total Fixation Duration %‡7.JPG_9_N	Total Fixation Duration %‡7.JPG_9_Mean
Total Fixation Duration %‡7.JPG_9_Sum	Fixation Count %‡4.JPG_1_N	Fixation Count %‡4.JPG_1_Mean	Fixation Count %‡4.JPG_1_Sum
Fixation Count %‡4.JPG_2_N	Fixation Count %‡4.JPG_2_Mean	Fixation Count %‡4.JPG_2_Sum	Fixation Count %‡4.JPG_3_N
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Fixation Count %‡4.JPG_4_Sum	Fixation Count %‡5.JPG_5_N	Fixation Count %‡5.JPG_5_Mean	Fixation Count %‡5.JPG_5_Sum
Fixation Count %‡6.JPG_6_N	Fixation Count %‡6.JPG_6_Mean	Fixation Count %‡6.JPG_6_Sum	Fixation Count %‡6.JPG_7_N
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Total Visit Duration %‡4.JPG_1_Mean	Total Visit Duration %‡4.JPG_1_Sum	Total Visit Duration %‡4.JPG_2_N	Total Visit Duration %‡4.JPG_2_Mean
Total Visit Duration %‡4.JPG_2_Sum	Total Visit Duration %‡4.JPG_3_N	Total Visit Duration %‡4.JPG_3_Mean	Total Visit Duration %‡4.JPG_3_Sum
Total Visit Duration %‡4.JPG_4_N	Total Visit Duration %‡4.JPG_4_Mean	Total Visit Duration %‡4.JPG_4_Sum	Total Visit Duration %‡5.JPG_5_N
Total Visit Duration %‡5.JPG_5_Mean	Total Visit Duration %‡5.JPG_5_Sum	Total Visit Duration %‡6.JPG_6_N	Total Visit Duration %‡6.JPG_6_Mean
Total Visit Duration %‡6.JPG_6_Sum	Total Visit Duration %‡6.JPG_7_N	Total Visit Duration %‡6.JPG_7_Mean	Total Visit Duration %‡6.JPG_7_Sum
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Total Visit Duration %‡7.JPG_8_Mean	Total Visit Duration %‡7.JPG_8_Sum	Total Visit Duration %‡7.JPG_9_N	Total Visit Duration %‡7.JPG_9_Mean
Total Visit Duration %‡7.JPG_9_Sum	Percentage Fixated %‡4.JPG_1_N	Percentage Fixated %‡4.JPG_1_Mean	Percentage Fixated %‡4.JPG_1_Sum
Percentage Fixated %‡4.JPG_2_N	Percentage Fixated %‡4.JPG_2_Mean	Percentage Fixated %‡4.JPG_2_Sum	Percentage Fixated %‡4.JPG_3_N
Percentage Fixated %‡4.JPG_3_Mean	Percentage Fixated %‡4.JPG_3_Sum	Percentage Fixated %‡4.JPG_4_N	Percentage Fixated %‡4.JPG_4_Mean
Percentage Fixated %‡4.JPG_4_Sum	Percentage Fixated %‡5.JPG_5_N	Percentage Fixated %‡5.JPG_5_Mean	Percentage Fixated %‡5.JPG_5_Sum
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Percentage Fixated %‡6.JPG_7_Mean	Percentage Fixated %‡6.JPG_7_Sum	Percentage Fixated %‡7.JPG_10_N	Percentage Fixated %‡7.JPG_10_Mean
Percentage Fixated	Percentage Fixated	Percentage Fixated	Percentage Fixated

%‡7.JPG_10_Sum	%‡7.JPG_8_N	%‡7.JPG_8_Mean	%‡7.JPG_8_Sum
Percentage Fixated %‡7.JPG_9_N	Percentage Fixated %‡7.JPG_9_Mean	Percentage Fixated %‡7.JPG_9_Sum	

Fixation Data

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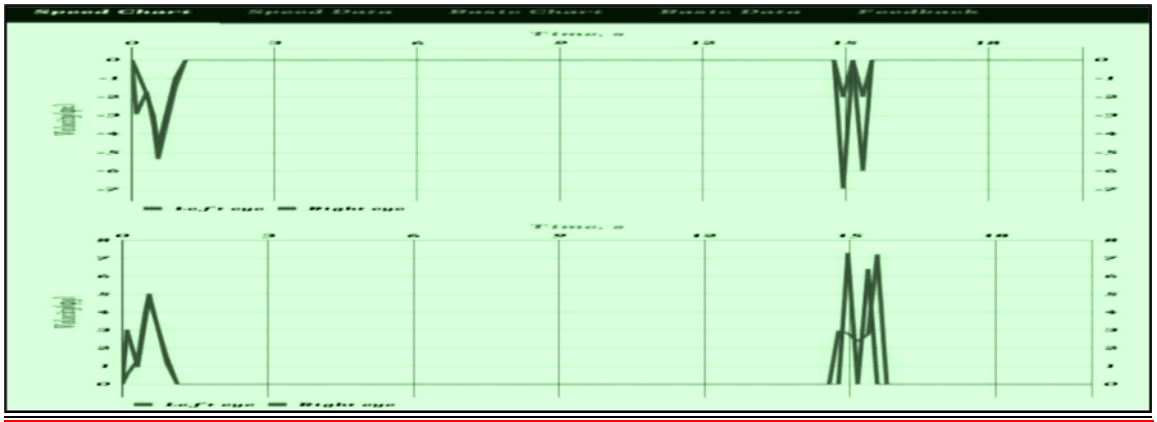
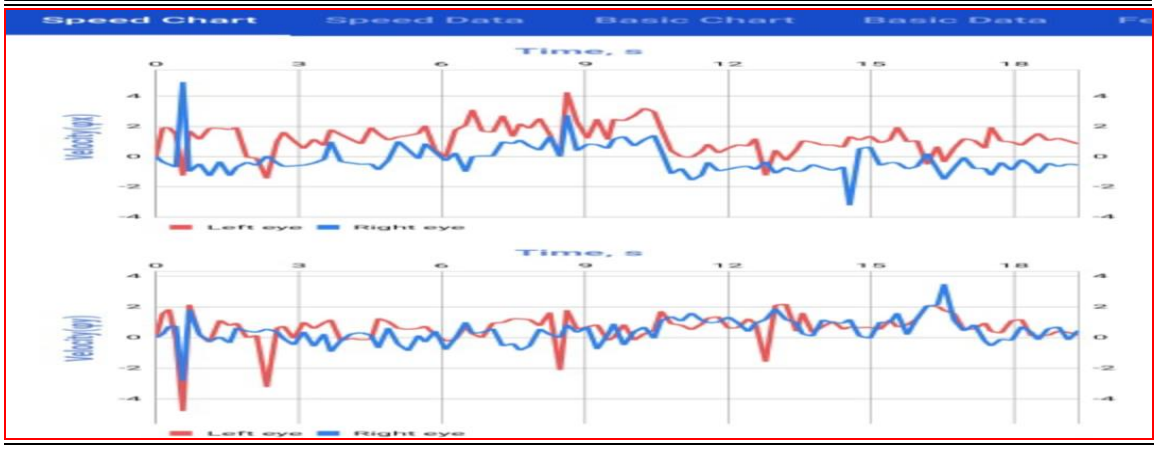
A complicated question is entrepreneurs' brainiacs[Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? How does an entrepreneur juggle between forces seen and unseen, felt and not - felt, perceived and not perceived, calculated and not calculated[Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? How does an entrepreneur plan towards succession planning [Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? Is it always that the entrepreneur plans to hand over his business to his children [Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? Are his children well equipped mentally, physically and brain - wise to take over the entrepreneurial responsibilities? Is there a point in conducting a gene mapping or brain mapping or tests of those sorts? What patterns emerge from a gene mapping or brain mapping and how would it aid in depicting the horoscope of becoming an entrepreneur? A spur of the moment thought is, does luck play a part in becoming an entrepreneur? Interestingly, what it takes to thrive in entrepreneurship that creates, nurtures and manages the business entity? Is it in the blood or genes or in their brains?

Issue that confronts is, is there a need to sync molecular genetics and entrepreneurial business data to genomic entrepreneurship; under umbrella of 'Genoeconomics' [Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? The answer in today's scenario is a 'Yes.' The architecture and functionality of genes do depict linear progression and make conform all the significant cellular processes as to make available 'in sequence,' 'the design' of the entrepreneurial mind set[Wilson, R. A., Barker, M. J., & Brigandt, I., ;2007]. Research in philosophy of molecular genetics is generating new-fangled thoughts about fundamental concepts of universal philosophical curiosity together with reductionism, information, and causation[Wilson, R. A., Barker, M. J., & Brigandt, I., ;2007].

Does this mean that entrepreneurship is in genes[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Do genes determine entrepreneurial success[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Can genetics or molecular genetics and entrepreneurial data predict response to multifarious behavioral intercession[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Can genetics calculate retort to intricate behavioral interference[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Are genetic markers of interest for entrepreneurship research [Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? The answer in today's scenario is a 'Yes.' This discussion boils down to 'heritable trait' [Dretske, F.; 1991]? This argument incorporates that organisms inherited qualities that their parents had developed all the way through reaction to various ecological demands [Dretske, F.; 1991]? New technologies open new transom into genetic domains, make new phenomenon reachable, or shed a dissimilar light on known entities and process [Dretske, F.; 1991]?

Fixation Grid





Neural Computation
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Analysis

GT Xmm and GT Ymm

	GT Xmm	GT Ymm
Average	53.6454	37.56731
SD	46.07925	27.86904
Minimum	0.228	0.228
Maximum	124.488	58.368
Correlation Coefficient between X and Y	0.059095	

coefficient (rs):	0.059095
N:	2510

T statistic:	2.964672
DF:	2508
p Value	0.003059

Pearson's correlation between GT Xmm and GT Y mm

t-Test: Paired Two Sample for Means		
	GT Xmm	GT Ymm
Mean	53.64540239	37.56731
Variance	2124.144008	776.9929
Observations	2510	2510
Pearson Correlation	0.059095335	
Hypothesized Mean Difference	0	
Df	2509	
t Stat	15.36244575	
P(T<=t) one-tail	2.84034E-51	
t Critical one-tail	1.645461174	
P(T<=t) two-tail	5.68068E-51	
t Critical two-tail	1.960909938	

t-Test between GT Xmm and GT Y mm

Xmm and Ymm

	GT Xmm	GT Ymm
Average	58.73349986	34.96853
SD	45.01363509	24.92231
Minimum	0.244872	0.002782
Maximum	164.8438632	104.0674
Correlation Coefficient between X and Y	0.110136819	

coefficient (rs):	0.110136819
N:	2510
T statistic:	5.549405033
DF:	2508
p Value	3.16724E-08

Pearson's correlation between Xmm and Y mm

t-Test: Paired Two Sample for Means		
	Xmm	Ymm
Mean	58.7335	34.96853
Variance	2027.035	621.3693
Observations	2510	2510
Pearson Correlation	0.110137	

Hypothesized Mean Difference	0
df	2509
t Stat	24.29744
P(T<=t) one-tail	1.4E-117
t Critical one-tail	1.645461
P(T<=t) two-tail	2.7E-117
t Critical two-tail	1.96091

t-Test between Xmm and Y mm
AOI-X and AOI-Y

	GT Xmm	GT Ymm
Average	2.614343	1.839841
SD	32.59004	21.60089
Minimum	0	0
Maximum	546	256
Correlation Coefficient between X and Y	0.628113	

coefficient (rs):	0.628113
N:	2510
T statistic:	40.42531
DF:	2508
p Value	1.4E-275

Pearson's correlation between Xmm and Y mm

t-Test: Paired Two Sample for Means		
	AOI_X	AOI_Y
Mean	2.614342629	1.839840637
Variance	1062.53435	466.7842232
Observations	2510	2510
Pearson Correlation	0.628112678	
Hypothesized Mean Difference	0	
df	2509	
t Stat	1.528300477	
P(T<=t) one-tail	0.063282002	
t Critical one-tail	1.645461174	
P(T<=t) two-tail	0.126564004	
t Critical two-tail	1.960909938	

t-Test between Xmm and Y mm
Time REL and AOIX Vs AOIY
Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
TIM REL	2510	1.05E+08	41915.79869	5.87E+08
AOI_X	2510	6562	2.614342629	1062.534

AOI_Y	2510	4618	1.839840637	466.7842		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.94E+12	2	1.46981E+12	7512.965	0	2.996925
Within Groups	1.47E+12	7527	195636757.3			
Total	4.41E+12	7529				

Pitch – Gaze ANG – DIFF GZ

	PITCH GT	PITCH DATA	GAZE GT	GAZE ANG	DIFF GZ
Average	4.285543	7.753364	12.7785	23.08164	11.9605
SD	3.179111	5.232118	5.163941	30.90108	29.84877

Issues

What challenges occur when analyzing genetically informative facts [Garson, J.; 2019]? How, if at all, should entrepreneurs use and combine molecular genetics and business data[Garson, J.; 2019]? What challenges arise when analyzing genetically informative data[Garson, J.; 2019]? The moot issue is, can entrepreneurship be genetic [Garson, J.; 2019]? Can an entrepreneur be 'genetically-inclined' [Garson, J.; 2019]? One debatable question is why do entrepreneurial parents have entrepreneurial children [Garson, J.; 2019]? What kinds of opportunities will genetic mapping of entrepreneur offer business entities? Do the big Five Personality Traits [Openness, Conscientiousness, Extraversion, Agree-Ableness and Neuroticism] play a role? Do genetic factors influence tendency to acquire skills and develop attributes relevant to entrepreneurship? Is it crucial to emphasize that a genetic predisposition to entrepreneurship should definitely, unequivocally, not be confounded with genetic determinism?

Conclusion

This paper set out to explore the emerging research at the intersection of genomics, neuroscience, and entrepreneurship. The core research questions were:

1) Is there a genetic basis for the entrepreneurial mindset?
2) Can genetic and neuroscientific data be used to predict entrepreneurial proclivities and outcomes?
3) What are the challenges in analyzing and applying genetically informative data?
4) Should findings about genetic predispositions shape how entrepreneurs approach opportunities?

Identifying and Nurturing Entrepreneurial Talent

The paper ventured into the nascent field of "genoeconomics," exploring the exciting intersection of genomics, neuroscience, and entrepreneurship. While conceptual reviews suggest its immense potential in uncovering and cultivating entrepreneurial aptitude, ethical considerations and methodological hurdles demand responsible navigation.

Beyond the Promise:

While identifying genomic and neurofunctional markers linked to entrepreneurial behavior holds immense promise, robust validation through large-scale studies and controlled experiments is essential. We must move from correlations to causations, employing validated measures of entrepreneurial success while accounting for diverse socio-economic contexts. Furthermore, designing interventions that leverage this knowledge ethically and effectively demands rigorous testing.

Navigating the Ethical Landscape:

As with any powerful tool, ethical considerations paramount. Informed consent, privacy, and non-discrimination must be embedded in research practices. Open dialogue with diverse stakeholders, including entrepreneurs, scientists, and ethicists, is crucial to ensure responsible development and prevent misuse of information.

Cracking the Code of Complexity:

Understanding the intricate interplay between genes, brain, environment, and entrepreneurial outcomes requires sophisticated statistical models. Distinguishing innate predispositions from environmental shaping of brain function is critical. We must also explore epigenetic factors mediating gene-environment interactions.

Beyond Individuals: Societal Implications:

The impact extends far beyond individual identification. Population-level genetic diversity likely influences innovation within entrepreneurial ecosystems. Integrating genoeconomics insights into economic development models and policies can foster innovation-driven growth, but necessitates careful consideration of potential societal implications, including legal and social impacts.

The Road Ahead:

As genomic sequencing and neuroimaging technologies leap forward, genoeconomics research will accelerate. By rigorously addressing the research directions outlined – from robust hypothesis testing to navigating ethical complexities and cracking the code of biological and environmental influences – we can explore the vast potential of this field. Imagine a future where individuals leverage their unique genetic and neuro-cognitive strengths, empowered by tailored support systems, to fuel innovation and prosperity. Embracing responsible development is key to ensuring this future benefits individuals, societies, and economies alike.

The paper concludes that the nascent field of "genoeconomics", combining genomic and neuroscientific insights with behavioral data has promise in identifying and nurturing entrepreneurial aptitude across societies. Targeted interventions could be designed to develop critical cognitive faculties even without genetic advantages. But fully actualizing the potential of this approach requires resolving methodological barriers and separating insights about innate potential from ideas of predetermined destinies.

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On some confirmations in genomic entrepreneurship

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'The fundamental unit of selection, and therefore of self-interest,
is not the species, not the group, nor even, strictly, the individual.
It is the gene, the unit of heredity.'

.... Richard Dawkins

Keywords
Genomics, Behavioral Genetics, Behavioral Genetics, Entrepreneurship and Managerial Business – Economics

Abstract

Entrepreneurship is an intricate phenotype. Are entrepreneurs born or made or developed or adopted? What makes an entrepreneur think outside the box and pursuing avant-garde paths to attain entrepreneurial goals? Alvin Toffler mentioned of various 'Waves' viz. Agrarian, Industrial and so on. Economics and Business Management, today, is experiencing inestimable waves viz. Heterodox Wave, Genetic Wave, Molecular Wave, Cellular Wave, Hereditary Wave, ['Infoplosion' or 'Info-Tectonics' Wave, Capability Approach Wave, Institutional Wave, Behavioral / Experimental Wave [Cognitive and Emotional dimensions / Develops and uses experiments typically with human subjects], Evolutionary Wave, Cognitive Wave, Information Wave , Artificial [Synthetic and / or Fabricated] Intelligence Wave and Neuro Wave, to list a few, from a rational perspective. Of central interest in this paper is Managerial Business - Economics Wave. It deals with, with complex, deep-rooted problems, gears and technique to dissect market demand, assess expenses, establish pricing strategies, assess risks, and appreciate competitive dynamics. Is entrepreneurship a genetic trait?

Of recent origin is emergence of incorporating genetic and biological markers into entrepreneurship. Issue that confronts is; is there a need to sync molecular genetics and entrepreneurial business data to genomic entrepreneurship; under umbrella of 'Genoeconomics'? Does this mean that entrepreneurship is in genes? Do genes determine entrepreneurial success? Can genetics or molecular genetics and entrepreneurial data predict response to multifarious behavioral intercession? Can genetics calculate retort to intricate behavioral interference? Are genetic markers of interest for entrepreneurship research? What challenges occur when analyzing genetically informative facts? How, if at all, should entrepreneurs use and combine molecular genetics and business data? What challenges arise when analyzing genetically informative data? The moot issue is; can entrepreneurship be genetic? Can an entrepreneur be 'genetically-inclined'? One debatable question is; why do entrepreneurial parents have entrepreneurial children? What kinds of opportunities will genetic mapping of entrepreneur offer business entities? Do the big Five Personality Traits [Openness, Conscientiousness, Extraversion, Agree-Ableness and Neuroticism] play a role? Do genetic factors influence tendency to acquire skills and develop attributes relevant to entrepreneurship? Is it crucial to emphasize that a genetic predisposition to entrepreneurship should definitely, unequivocally, not be confounded with genetic determinism? This paper aims to seek a conceptualistic conformation to the above issues

"Our brains are best suited for certain situations. We prefer to think in causal terms, and we like predictable outcomes. We want to open doors when we know whats behind it. When we dont know, we undervalue potential outcomes". (Schweitzer; 2021)

Introduction

Biology and neurosciences have entered management arena. This amalgamation coupled up is influx of AI, entrepreneurial responsibility, new world of work framework, and art of making decision with scant information. In such a scenario, sense organs in human body have been experimented to find precise data and information. Algorithmic entrepreneurial decision introduces a critical question; what constitutes substantiation in entrepreneurial decision sciences. This mandates holistic thinking and deep understanding since paradigm for entrepreneurial decision control is emerging. This ceases conservative philosophy, appreciate how to engage and influence cerebral of entrepreneur and help activate openness to new ideas. Aim of this paper is to challenge orthodox philosophy of decision making by entrepreneurs. This is by identifying methods to test causal relations, heterodoxically employ empirical cognitive and neural approach (es) to causal reasoning and ascertain relation between genetic - management data to reveal neural paths in entrepreneurial decision making.

Research in entrepreneurship has largely ignored biological factors [Ahmed Maged Nofal, Nicos Nicolaou & Scott Shane; 2018]. An emerging trend in Social and Behavioral Sciences, Heredity, Hormones, Bodily Processes, and Neuroscience, as 'Pillars of Biology', stand as contributory agents towards role of Biology to Entrepreneurship. Quantitative genetics and molecular genetics are the two approaches that examine the influence of biology to entrepreneurship ['Nature versus Nurture']. There appear to be methodological, theoretical and paradigm changes as regards Biology in Entrepreneurship [Alvarez S., Barney J. B.; 2020]. This reflects the impact of genetic architecture on brain and biology of entrepreneurs [de Holan P. M.; 2014]. Research from the social sciences has variously attributed the success of these individuals to risk-taking, aggression, and sociability [David G. Rand; 2010]. The moot issue is, is there a genetic predisposition to entrepreneurship [Bönte W., Procher V. D., Urbig D.; 2016]?

Prima facie, what makes an entrepreneur think outside the box and pursuing avant-garde paths to attain entrepreneurial goals? Alvin Toffler mentioned of various 'Waves' viz [van der Loos M. J. H. M., Rietveld C. A., Eklund N., Koellinger P. D., Rivadeneira F., Abecasis G. R., Ankra-Badu G. A., Baumeister S. E., Benjamin D. J., Biffar R., Blankenberg S., Boomsma D. I., Cesarini D., Cucca F., de Geus E. J. C., Dedoussis G., D and Satpathy; 2022] Agrarian, Industrial and so on [van der Loos M. J. H. M., Rietveld C. A., Eklund N., Koellinger P. D., Rivadeneira F., Abecasis G. R., Ankra-Badu G. A., Baumeister S. E., Benjamin D. J., Biffar R., Blankenberg S., Boomsma D. I., Cesarini D., Cucca F., de Geus E. J. C., Dedoussis G., D and Satpathy; 2022]. Economics and Business Management, today, is experiencing inestimable waves viz [van der Loos M. J. H. M., Rietveld C. A., Eklund N., Koellinger P. D., Rivadeneira F., Abecasis G. R., Ankra-Badu G. A., Baumeister S. E., Benjamin D. J., Biffar R., Blankenberg S., Boomsma D. I., Cesarini D., Cucca F., de Geus E. J. C., Dedoussis G., D and Satpathy; 2022]. Heterodox Wave, Genetic Wave, Molecular Wave, Cellular Wave, Hereditary Wave, ['Infoplosion' or 'Info-Tectonics' Wave, Capability Approach Wave, Institutional Wave, Behavioral / Experimental Wave [Cognitive and Emotional dimensions / Develops and uses experiments typically with human subjects], Evolutionary Wave, Cognitive Wave, Information Wave , Artificial [Synthetic and / or Fabricated] Intelligence Wave and Neuro Wave, to list a few, from a rational perspective [Lerner D. A., Alkærsig L., Fitza M. A., Lomberg C., Johnson S. K. ;2020].

Questions addressed are How cogent should an entrepreneur be? How do affect and cognition interact in entrepreneurial decision making? How do affect and cognition interact in entrepreneurial decision making? And how moved is the *entrepreneur* during decision moment? Methodology to investigate neural computational is to scan positioning of eye movements. Role of eye movements help in gaining, possessing and tracing visual inducements, during decision formation. Current proof suggests that orientation of eye movement can be a result of intensification in decision formation. Of central interest in this paper is Managerial Business - Economics Wave [Lerner D. A., Alkærsig L., Fitza M. A., Lomberg C., Johnson S. K. ;2020]. It deals with, with complex, deep-rooted problems, gears and technique to dissect market demand, assess expenses, establish pricing strategies, assess risks, and appreciate competitive dynamics. Is entrepreneurship a genetic trait [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Of recent origin is emergence of incorporating genetic and biological markers into entrepreneurship. Issue that confronts is, is there a need to sync molecular genetics and entrepreneurial business data to genomic entrepreneurship; under umbrella of 'Genoeconomics' [Rietveld C. A., Slob E. A.

W., Thurik A. R.;2020]. Does this mean that entrepreneurship is in genes [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Do genes determine entrepreneurial success [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Can genetics or molecular genetics and entrepreneurial data predict response to multifarious behavioral intercession [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Can genetics calculate retort to intricate behavioral interference [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. Are genetic markers of interest for entrepreneurship research [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020].

What challenges occur when analyzing genetically informative facts [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. How, if at all, should entrepreneurs use and combine molecular genetics and business data [Rietveld C. A., Slob E. A. W., Thurik A. R.;2020]. What challenges arise when analyzing genetically informative data [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. The moot issue is, can entrepreneurship be genetic [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. Can an entrepreneur be 'genetically-inclined' [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. One debatable question is why entrepreneurial parents have entrepreneurial children [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. What kinds of opportunities will genetic mapping of entrepreneur offer business entities [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. Do the big Five Personality Traits [Openness, Conscientiousness, Extraversion, Agree-Ableness and Neuroticism] play a role [Nicolaou N., Lockett A., Ucbasaran D., Rees G. ;2019]. Do genetic factors influence tendency to acquire skills and develop attributes relevant to entrepreneurship [Nicolaou N., Lockett A., Ucbasaran D., Rees G.; 2019]. Is it crucial to emphasize that a genetic predisposition to entrepreneurship should definitely, unequivocally, not be confounded with genetic determinism? This paper aims to seek a conceptualistic conformation to the above issues.

Eyes are windows to the soul. There is a strategic logic as to why the five sense organs are co - located to each other. The pair of eyes work to observe watch and perceive. The ears to hear and pay attention to the language of communication received. The nose works to smell (Olfaction) and get to know of things. Tongue to taste and skin to feel. The common thread that links all these organs is that they are all located between the chin and the head. An additional link that all these sense organs receive and transmit, send or convey information, to a common recipient i.e. brain. Brain in turn controls thought, memory, emotion, touch, motor skills, vision, breathing, temperature, hunger and every process that regulates our body (Wikipedia; 2024 & Parincu, A. M. T., Capatina, A., Varon, D. J., Bennet, P. F., &Recuerda, A. M.; 2020). Functioning on the basis of a hybrid methodology, brain (and eyes) provides an algorithm for cognitive architecture of decision dynamics.

Biology and neurosciences have entered management arena in a mega way (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). This amalgamation coupled up is influx of AI, entrepreneurial responsibility, new world of work framework, and art of making decision with scant information (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). In such a scenario, sense organs in human body have been experimented to find precise data and information (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). Algorithmic entrepreneurial decision introduces a critical question; what constitutes substantiation in entrepreneurial decision sciences (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). This mandates holistic thinking and deep understanding since paradigm for entrepreneurial decision control is emerging (Boyatzis, R., & McKee, A.; 2011 and Ceschi, A., Costantini, A., Sartori, R., Weller, J., & Di Fabio, A.; 2019). This ceases conservative philosophy, appreciate how to engage and influence cerebral of entrepreneur and help activate openness to new ideas. An area that merits analysis is how an entrepreneur decides and how do the sense organs (especially the eyes) play a pivotal role in decision making (Wikipedia; 2021)?

How cogent should an entrepreneur be (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial

decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How do affect and cognition interact in entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How can biases affect entrepreneurial decision making (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? Are the brains of optimistic, hopeful, confident, and resilient leaders different (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How strongly did you imagine the thoughts and feelings of this person (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How much compassion did you feel for this person (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))?, and how moved were you during the decision moment (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? The humanization subscale assessed the effects induced by the priming manipulation using the questions: to what extent did you see this person as a human being, rather than a means to an end (Satpathy; 2020, 2023 & Yoon, Carolyn, Richard Gonzalez, Antoine Bechara, Gregory S. Berns, Alain A. Dagher, Laurette Dubé, Scott A. Huettel et al. ; 2012))? How responsible did you feel for this person's well-being? and to what extent did you see this person as a human being with needs, desires, and feelings? How does a brain build a cognitive code?

Entrepreneurs aim at decision satisfying necessary and sufficient conditions of optimization through mathematical analysis (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). One way to investigate neural computational is to scan positioning of eye movements linked to optical consideration (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). Investigating eye movements is expedient in providing evidence of orientation of decision behaviour replicating computational decision (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). Role of eye movements, intentional or reflex, help in gaining, possessing and tracing visual inducements, during decision formation (Algumaei, M., Hettiarachchi, I. T., Farghaly, M., & Bhatti, A. ;2023). Current proof suggests that orientation of eye movement itself may not be an essential constituent. Rather, it can be as a result of intensification in contact to incitement as an influential factor in decision formation. An important question is how entrepreneur makes complex decisions. In such a scenario, pertinent issue is how Entrepreneur is going to decide when engulfed in a situation of seen and unseen forces within environment of Artificial (Fabricated and / or Synthetic) Intelligence (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? Will entrepreneurial decision making be the same as it was in the Classical / Neo - Classical era (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What would be the challenges (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What about the tsunami of information waves (Infoplosion or Info-Tectonics) (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What about the degrees of significant signal-detection problem intrinsic in complex circumstances (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are our basic cognitive operations (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do we use them in judgment, economic entrepreneurial decision, action, reason, choice, persuasion, and expression (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? Do entrepreneurial decision makers know what they need to know (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do entrepreneurial decision makers choose (Satpathy; 2022, 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are the best incentives? When is judgment reliable (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? Can negotiation work edifice (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do cognitive conceptual resources depend on social and cultural location (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? How do certain products of cognitive and conceptual systems come to be entrenched as shared knowledge and method (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What makes these biases adaptive and when are they adaptive (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are the boundary conditions for these biases to be adaptive (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? When and which biases can be both adaptive and mal-adaptive at the same time, for instance, leading to positive individual but negative

group or societal consequences (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)? What are the implications (Satpathy; 2023 & Krajbich, I., Oud, B., & Fehr, E.; 2014)?

Aim of this paper is to challenge orthodox philosophy of decision making by entrepreneurs (Serra, D. ;2021). This is by identifying methods to test causal relations, heterodoxically employ empirical cognitive and neural approach (es) to causal reasoning and ascertain relation between genetic - management data to reveal neural paths in entrepreneurial decision making (Serra, D. ;2021). Questions addressed are How cogent should an entrepreneur be Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). How do affect and cognition interact in entrepreneurial decision-making Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). How do affect and cognition interact in entrepreneurial decision-making Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). And how moved is the entrepreneur during decision moment Daniel Kahneman, Amos Tversky, ;1972 and Dimov, C., Khader, P. H., Marewski, J. N., &Pachur, T. ;2020). Methodology to investigate neural computational is to scan positioning of eye movements. Role of eye movements help in gaining, possessing and tracing visual inducements, during decision formation. Current proof suggests that orientation of eye movement can be a result of intensification in decision formation. Purpose is to exhibit empirical mosaics in neuro - trajectory shifts(s) of entrepreneurial decision circuit. Objective is to monitor undercurrents of neurobiological motorists in Entrepreneurial decision making. Effort is to explicate how neural investigations appreciate mental tectonic shifts in decision framework.

Methodology

Effort is to explicate how neural investigations appreciate 'tectonic shifts' in decision framework (Opris, I., Ionescu, S. C., Lebedev, M. A., Boy, F., Lewinski, P., & Ballerini, L.; 2020). This paper adopts a new approach to essence of neuroeconomics; How does entrepreneur craft entrepreneurial decisions (Sanfey, A. G.; 2007 & Lebiere, C., Pirolli, P., Thomson, R., Paik, J., Rutledge-Taylor, M., Staszewski, J., & Anderson, J. R.; 2013). What parts of eye aid decision? What ocular - impressions depict in cycle of entrepreneurial decisions? An eye movement experiment was adopted based on Tobii equipment on on single subject (N=01). The fixations were calibrated as under.

Time to First Fixation %‡4.JPG_2_N	Time to First Fixation %‡4.JPG_2_Mean	Time to First Fixation %‡4.JPG_2_Sum	Time to First Fixation %‡4.JPG_3_N
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Time to First Fixation %‡4.JPG_4_Sum	Time to First Fixation %‡5.JPG_5_N	Time to First Fixation %‡5.JPG_5_Mean	Time to First Fixation %‡5.JPG_5_Sum
Time to First Fixation %‡6.JPG_6_N	Time to First Fixation %‡6.JPG_6_Mean	Time to First Fixation %‡6.JPG_6_Sum	Time to First Fixation %‡6.JPG_7_N
Time to First Fixation %‡6.JPG_7_Mean	Time to First Fixation %‡6.JPG_7_Sum	Time to First Fixation %‡7.JPG_10_N	Time to First Fixation %‡7.JPG_10_Mean
Time to First Fixation %‡7.JPG_10_Sum	Time to First Fixation %‡7.JPG_8_N	Time to First Fixation %‡7.JPG_8_Mean	Time to First Fixation %‡7.JPG_8_Sum
Time to First Fixation %‡7.JPG_9_N	Time to First Fixation %‡7.JPG_9_Mean	Time to First Fixation %‡7.JPG_9_Sum	First Fixation Duration %‡4.JPG_1_N
First Fixation Duration %‡4.JPG_1_Mean	First Fixation Duration %‡4.JPG_1_Sum	First Fixation Duration %‡4.JPG_2_N	First Fixation Duration %‡4.JPG_2_Mean
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Total Fixation Duration %‡6.JPG_6_Sum	Total Fixation Duration %‡6.JPG_7_N	Total Fixation Duration %‡6.JPG_7_Mean	Total Fixation Duration %‡6.JPG_7_Sum
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Total Fixation Duration %‡7.JPG_8_Mean	Total Fixation Duration %‡7.JPG_8_Sum	Total Fixation Duration %‡7.JPG_9_N	Total Fixation Duration %‡7.JPG_9_Mean
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Fixation Count %‡4.JPG_2_N	Fixation Count %‡4.JPG_2_Mean	Fixation Count %‡4.JPG_2_Sum	Fixation Count %‡4.JPG_3_N
Fixation Count %‡4.JPG_3_Mean	Fixation Count %‡4.JPG_3_Sum	Fixation Count %‡4.JPG_4_N	Fixation Count %‡4.JPG_4_Mean
Fixation Count %‡4.JPG_4_Sum	Fixation Count %‡5.JPG_5_N	Fixation Count %‡5.JPG_5_Mean	Fixation Count %‡5.JPG_5_Sum

Fixation Count %‡6.JPG_6_N	Fixation Count %‡6.JPG_6_Mean	Fixation Count %‡6.JPG_6_Sum	Fixation Count %‡6.JPG_7_N
Fixation Count %‡6.JPG_7_Mean	Fixation Count %‡6.JPG_7_Sum	Fixation Count %‡7.JPG_10_N	Fixation Count %‡7.JPG_10_Mean
Fixation Count %‡7.JPG_10_Sum	Fixation Count %‡7.JPG_8_N	Fixation Count %‡7.JPG_8_Mean	Fixation Count %‡7.JPG_8_Sum
Fixation Count %‡7.JPG_9_N	Fixation Count %‡7.JPG_9_Mean	Fixation Count %‡7.JPG_9_Sum	Total Visit Duration %‡4.JPG_1_N
Total Visit Duration %‡4.JPG_1_Mean	Total Visit Duration %‡4.JPG_1_Sum	Total Visit Duration %‡4.JPG_2_N	Total Visit Duration %‡4.JPG_2_Mean
Total Visit Duration %‡4.JPG_2_Sum	Total Visit Duration %‡4.JPG_3_N	Total Visit Duration %‡4.JPG_3_Mean	Total Visit Duration %‡4.JPG_3_Sum
Total Visit Duration %‡4.JPG_4_N	Total Visit Duration %‡4.JPG_4_Mean	Total Visit Duration %‡4.JPG_4_Sum	Total Visit Duration %‡5.JPG_5_N
Total Visit Duration %‡5.JPG_5_Mean	Total Visit Duration %‡5.JPG_5_Sum	Total Visit Duration %‡6.JPG_6_N	Total Visit Duration %‡6.JPG_6_Mean
Total Visit Duration %‡6.JPG_6_Sum	Total Visit Duration %‡6.JPG_7_N	Total Visit Duration %‡6.JPG_7_Mean	Total Visit Duration %‡6.JPG_7_Sum
Total Visit Duration %‡7.JPG_10_N	Total Visit Duration %‡7.JPG_10_Mean	Total Visit Duration %‡7.JPG_10_Sum	Total Visit Duration %‡7.JPG_8_N
Total Visit Duration %‡7.JPG_8_Mean	Total Visit Duration %‡7.JPG_8_Sum	Total Visit Duration %‡7.JPG_9_N	Total Visit Duration %‡7.JPG_9_Mean
Total Visit Duration %‡7.JPG_9_Sum	Percentage Fixated %‡4.JPG_1_N	Percentage Fixated %‡4.JPG_1_Mean	Percentage Fixated %‡4.JPG_1_Sum
Percentage Fixated %‡4.JPG_2_N	Percentage Fixated %‡4.JPG_2_Mean	Percentage Fixated %‡4.JPG_2_Sum	Percentage Fixated %‡4.JPG_3_N
Percentage Fixated %‡4.JPG_3_Mean	Percentage Fixated %‡4.JPG_3_Sum	Percentage Fixated %‡4.JPG_4_N	Percentage Fixated %‡4.JPG_4_Mean
Percentage Fixated %‡4.JPG_4_Sum	Percentage Fixated %‡5.JPG_5_N	Percentage Fixated %‡5.JPG_5_Mean	Percentage Fixated %‡5.JPG_5_Sum
Percentage Fixated %‡6.JPG_6_N	Percentage Fixated %‡6.JPG_6_Mean	Percentage Fixated %‡6.JPG_6_Sum	Percentage Fixated %‡6.JPG_7_N
Percentage Fixated %‡6.JPG_7_Mean	Percentage Fixated %‡6.JPG_7_Sum	Percentage Fixated %‡7.JPG_10_N	Percentage Fixated %‡7.JPG_10_Mean
Percentage Fixated %‡7.JPG_10_Sum	Percentage Fixated %‡7.JPG_8_N	Percentage Fixated %‡7.JPG_8_Mean	Percentage Fixated %‡7.JPG_8_Sum
Percentage Fixated %‡7.JPG_9_N	Percentage Fixated %‡7.JPG_9_Mean	Percentage Fixated %‡7.JPG_9_Sum	

Fixation Data

Meancpl_PRE	Meancpl_MID	Meancpl_POST	Meancc_PRE	Meancc_MID	Meancc_POST	Meand_PRE	Meand_MID
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'meanOS3_PRE'	'meanOS3_MID'	meanOS3_POST	'meanOS4_PRE'	'meanOS4_MID'	meanOS4_POST	'meanOS5_PRE'	'meanOS5_MID'
'meanOS7_	'meanOS7_	meanOS7_	'meanOS8_	'meanOS8_	meanOS8_	'meanOS9_	'meanOS9_

PRE'	MID'	POST	PRE'	MID'	POST	PRE'	MID'
'meanOS11_PRE'	'meanOS11_MID'	meanOS11_POST	'meanOS12_PRE'	'meanOS12_MID'	meanOS12_POST	'meanOS13_PRE'	'meanOS13_MID
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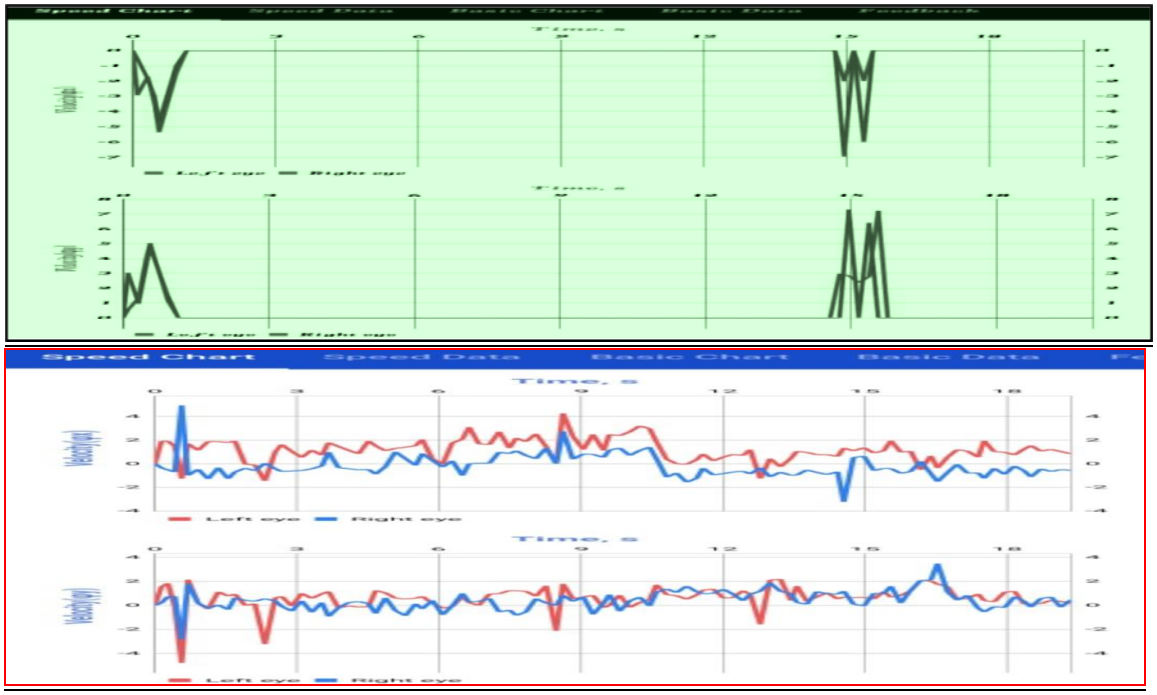
3.50479377039872	2.46886401729825	0.189138036537095	0.299231600579291	2.07880852027191	1.24453607980225	0.034328833027025	0.113848495489966
0.97986460378069	4.40820859882584	2.39470386315116	3.34566229600427	4.97165203039749	0.623542251195416	0.002943553599264	0.0364756842317
0.028820903333812	0.023432790467177	0.026494063345465	0.006864887122972	0.2242953468419	0.01194677380002	0.775848644716696	1.0719457771252
1.06221338954201	1.64302729382723	1.40750609563324	0.748910230618164	1.30144596653534	1.2517946820225	0.465118738221993	1.11953322183625
1.07959913990909	2.03091216108785	1.72343280190014	1.17640835145372	2.02859729918536	0.942226393624024	0.574155541393185	2.13388819681712
1.21768133048939	1.78656726700945	1.60112104575669	0.848186811325569	1.40013049909752	1.47671457844849	0.643303476345023	1.0834918001024
0.221224652515781	1.18952914781573	0.569588418878133	0.517141785540733	1.04218267129682	0.963418403765178	0.662881031511005	1.42576594462872
3.14829495405972	3.12128693667845	4.12157098622588	0.118072000059449	0.068177592645147	0.055718943579187	0.426470588235294	0.474509803921569
3.58062986200838	0.209085436990738	0.133851021823704	1.53391210947659	0.411011003081302	0.25088309555811	0	1.32682344110594
0.009392433098682	0.055577803670476	0.073991718358291	1.04552793937842	0.255431582859528	0.072687408894037	4.73347231589283	1.48265014074094
0.094112320322366	0.30701816776532	6.43172907137261	0.444099886929202	5.00577798494118	0.392834073141924	0.004096197764654	0.639237820016248
5.28738320115841	2.87625359003095	3.68249098861573	6.01363652168022	9.89240555093028	2.43279531166612	0.038209263509808	0.051553576578347
0.141501246609298	0.042193200897835	0.245683872390225	0.206928125292441	0.143802842474506	0.085147143286366	2.04243220102233	1.47935915474636
2.16577156486448	1.57023936537419	1.19639824241147	1.93443211853626	1.68056049407276	1.02204492286689	1.71346133223136	0.752185609381171
1.94543172018504	1.8804912758705	1.35088623479043	1.85272585157904	1.73519882380048	1.08423383556975	2.48099641021547	1.81453620603851
2.05333178265122	1.11188649934362	0.788325211633051	2.14569885214584	1.50758648198643	1.3181993082357	1.26257793913992	1.02339288332876
1.41478544773624	1.0516027884378	0.558940298176634	2.22574343214423	1.30495934927271	1.16027060720516	1.5829314448577	0.773594241979086

A complicated question is entrepreneurs' brainiacs[Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? How does an entrepreneur juggle between forces seen and unseen, felt and not - felt, perceived and not perceived, calculated and not calculated[Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? How does an entrepreneur plan towards succession planning [Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? Is it always that the entrepreneur plans to hand over his business to his children [Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? Are his children well equipped mentally, physically and brain - wise to take over the entrepreneurial responsibilities? Is there a point in conducting a gene mapping or brain mapping or tests of those sorts? What patterns emerge from a gene mapping or brain mapping and how would it aid in depicting the horoscope of becoming an entrepreneur? A spur of the moment thought is, does luck play a part in becoming an entrepreneur? Interestingly, what it takes to thrive in entrepreneurship that creates, nurtures and manages the business entity? Is it in the blood or genes or in their brains?

Issue that confronts is, is there a need to sync molecular genetics and entrepreneurial business data to genomic entrepreneurship; under umbrella of 'Genoeconomics' [Beurton, P., Falk, R., and Rheinberger, H.-J. (eds.); 2000]? The answer in today's scenario is a 'Yes'. The architecture and functionality of genes do depict linear progression and make conform all the significant cellular processes as to make available 'in sequence', 'the design' of the entrepreneurial mind set[Wilson, R. A., Barker, M. J., & Brigandt, I., ;2007]. Research in philosophy of molecular genetics is generating new-fangled thoughts about fundamental concepts of universal philosophical curiosity together with reductionism, information, and causation[Wilson, R. A., Barker, M. J., & Brigandt, I., ;2007].

Does this mean that entrepreneurship is in genes[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Do genes determine entrepreneurial success[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Can genetics or molecular genetics and entrepreneurial data predict response to multifarious behavioral intercession[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Can genetics calculate retort to intricate behavioral interference[Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? Are genetic markers of interest for entrepreneurship research [Colyvan, M., Linquist, S., Grey, W., Griffiths, P. E., Odenbaugh, J., & Possingham, H. P., 2009]? The answer in today's scenario is a 'Yes'. This discussion boils down to 'heritable trait' [Dretske, F.; 1991]? This argument incorporates that organisms inherited qualities that their parents had developed all the way through reaction to various ecological demands [Dretske, F.; 1991]? New technologies open new transom into genetic domains, make new phenomenon reachable, or shed a dissimilar light on known entities and process [Dretske, F.; 1991]?

Fixation Grid



Neural Computation


```
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id='track704'
d='m 195.41,676.42 h 41.4 v 15 h -41.4 z'
```


Analysis

GT Xmm and GT Ymm

	GT Xmm	GT Ymm
Average	53.6454	37.56731
SD	46.07925	27.86904
Minimum	0.228	0.228
Maximum	124.488	58.368
Correlation Coefficient between X and Y	0.059095	

coefficient (rs):	0.059095
N:	2510

T statistic:	2.964672
DF:	2508
p Value	0.003059

Pearson's correlation between GT Xmm and GT Y mm

t-Test: Paired Two Sample for Means		
	GT Xmm	GT Ymm
Mean	53.64540239	37.56731
Variance	2124.144008	776.9929
Observations	2510	2510
Pearson Correlation	0.059095335	
Hypothesized Mean Difference	0	
Df	2509	
t Stat	15.36244575	
P(T<=t) one-tail	2.84034E-51	
t Critical one-tail	1.645461174	
P(T<=t) two-tail	5.68068E-51	
t Critical two-tail	1.960909938	

t-Test between GT Xmm and GT Y mm

Xmm and Ymm

	GT Xmm	GT Ymm
Average	58.73349986	34.96853
SD	45.01363509	24.92231
Minimum	0.244872	0.002782
Maximum	164.8438632	104.0674
Correlation Coefficient between X and Y	0.110136819	

coefficient (rs):	0.110136819
N:	2510
T statistic:	5.549405033
DF:	2508
p Value	3.16724E-08

Pearson's correlation between Xmm and Y mm

t-Test: Paired Two Sample for Means		
	Xmm	Ymm
Mean	58.7335	34.96853
Variance	2027.035	621.3693
Observations	2510	2510

Pearson Correlation	0.110137
Hypothesized Mean Difference	0
df	2509
t Stat	24.29744
P(T<=t) one-tail	1.4E-117
t Critical one-tail	1.645461
P(T<=t) two-tail	2.7E-117
t Critical two-tail	1.96091

t-Test between Xmm and Y mm

AOI-X and AOI-Y

	GT Xmm	GT Ymm
Average	2.614343	1.839841
SD	32.59004	21.60089
Minimum	0	0
Maximum	546	256
Correlation Coefficient between X and Y	0.628113	

coefficient (rs):	0.628113
N:	2510
T statistic:	40.42531
DF:	2508
p Value	1.4E-275

Pearson's correlation between Xmm and Y mm

t-Test: Paired Two Sample for Means		
	AOI_X	AOI_Y
Mean	2.614342629	1.839840637
Variance	1062.53435	466.7842232
Observations	2510	2510
Pearson Correlation	0.628112678	
Hypothesized Mean Difference	0	
df	2509	
t Stat	1.528300477	
P(T<=t) one-tail	0.063282002	
t Critical one-tail	1.645461174	
P(T<=t) two-tail	0.126564004	
t Critical two-tail	1.960909938	

t-Test between Xmm and Y mm

Time REL and AOIX Vs AOIY

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
TIM REL	2510	1.05E+08	41915.79869	5.87E+08

AOI_X	2510	6562	2.614342629	1062.534		
AOI_Y	2510	4618	1.839840637	466.7842		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.94E+12	2	1.46981E+12	7512.965	0	2.996925
Within Groups	1.47E+12	7527	195636757.3			
Total	4.41E+12	7529				

Pitch – Gaze ANG – DIFF GZ

	PITCH GT	PITCH DATA	GAZE GT	GAZE ANG	DIFF GZ
Average	4.285543	7.753364	12.7785	23.08164	11.9605
SD	3.179111	5.232118	5.163941	30.90108	29.84877

Issues

What challenges occur when analyzing genetically informative facts [Garson, J.; 2019]? How, if at all, should entrepreneurs use and combine molecular genetics and business data[Garson, J.; 2019]? What challenges arise when analyzing genetically informative data[Garson, J.; 2019]? The moot issue is; can entrepreneurship be genetic [Garson, J.; 2019]? Can an entrepreneur be 'genetically-inclined' [Garson, J.; 2019]? One debatable question is; why do entrepreneurial parents have entrepreneurial children [Garson, J.; 2019]? What kinds of opportunities will genetic mapping of entrepreneur offer business entities? Do the big Five Personality Traits [Openness, Conscientiousness, Extraversion, Agree-Ableness and Neuroticism] play a role? Do genetic factors influence tendency to acquire skills and develop attributes relevant to entrepreneurship? Is it crucial to emphasize that a genetic predisposition to entrepreneurship should definitely, unequivocally, not be confounded with genetic determinism?

Conclusion

Biological species are often examples of a 'natural kind'. This subject is of recent origin. Thoughts differ. Opinions are diverse. Arguments are powerful and it is a never-ending debate [in terms of 'reductionism' vs. 'anti-reductionism']. There is a call for a comparative analysis between; set of ontological, epistemological, and methodological claims [Sokal, R. R. and T. J. Crovello; 1970]. This area of research replicates long-standing disagreement [self-consciously naturalistic, recognizing no profound discontinuity] [Sokal, R. R. and T. J. Crovello; 1970]. It would be safe to conclude that molecular biology does have the kind of theory based around a set of laws or a set of mathematical models that is familiar with management sciences [Sokal, R. R. and T. J. Crovello; 1970].

1. Eye movements steady images on retina.
2. Eye movements are behaviours (pattern).
3. Eye movements depict a pattern – image.
4. Eye movements depict the flow of information (inwards) through the iris, pupil, and retina to the brain.
5. Eye movements can be calibrated in lab conditions to process data input and information output.
6. Question is how much information can be obtained from single fixation?
7. Question is about perceptual span varies as function of difficulty of distractor agent?
8. Eye movements determine what one sees, attends to, and remembers about surroundings.
9. Results suggest scientific and practitioner perspectives and explain how deep significant entrepreneurial decision tectonic shifts(s) influence decision plates.

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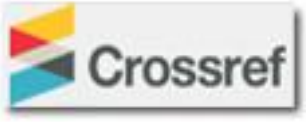

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THE BUSINESS & MANAGEMENT REVIEW
Volume 15 Number 1 December 2024

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