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Study the Impact of Artificial Intelligence Applications on Insurance Industry: A case of Jordan

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Abstract

This research offers significant contributions to the understanding of the ways in which the insurance sector in Jordan is adjusting to the integration of artificial intelligence. Comprehending the effects and advantages of AI implementations can assist industry participants in making knowledgeable determinations concerning their adoption and integration tactics. This study aimed at the impact of artificial intelligence and the insurance industry in Jordan. The results of the study showed that there is a statistically positive significant effect of artificial intelligence ((risk, revenue, customer satisfaction) in insurance sector in Jordan. At the level of significance ($\alpha \leq 0.05$), the results of the study showed that The correlation coefficient was (80%), indicating a strong relationship between artificial intelligence and the insurance industry. Where the study recommends Employees need to be made aware of the need of embracing artificial intelligence (AI) as a tool that enhances their work rather than a necessity for their continued employment.

Keywords: Artificial Intelligence, Insurance Industry, Jordan, Risk, Revenue, customer satisfaction.

Introduction

Insurance companies carry out their activities and ensure the continuity of their growth and development in relation to the quality of insurance services they provide to their customers and their growing interest in financial technologies related to insurrect and its tools, which gives them the opportunity to expand their customer groups, including the poor, young women and low-income individuals from different groups. Efforts should be made to reduce the cost of insurance services, increase market share, increase turnover rate, help them obtain various financial services, provide insurance products suitable for their financial ability, and at the same time protect them from the various risks underwritten. Expanding the customer base is one of the most important goals that all insurance companies strive for, especially as competition among them increases. Through the use of artificial intelligence (AI) technology, a technological revolution is rapidly sweeping the world, with a huge impact on the insurance industry and economic well-being.

Several other articles highlight the importance and benefits of AI applications in the insurance industry and predict major changes in operations in the coming years (Parachute 2020; Raikkonen et al. 2018). Popular areas of application of AI in insurance research are fraud detection and claims retention (Lopez and Milhaud 2021).

Grizz et al. (2020) focus on the application of machine learning in non-life insurance, emphasizing the positive impact of artificial intelligence on risk assessment to improve the long-term overall profitability of insurance companies. Tekaya et al. (2020) present arguments in a foreword to AI research in financial services by outlining current use cases and the benefits of implementing big data and AI models in banking, credit risk management, fraud detection, and insurance.

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Eling et al. (2021) analyze AI impact teach step specifically highlights the potential for AI to enhance revenue streams, loss prediction and loss prevention measures for insurance practitioners. Artificial Intelligence (AI) revenues in insurance are expected to grow 23% to $3.0 billion between 2019-2024, yet the suitability of black-box AI models in insurance practices remains questionable (Bean 2021). The growth of AI as an intelligent that can perform complex computational tasks is services, particularly within insurance practices. Data and its potential use are seen as a primary strategic asset and a source of competitive advantage in financial services firms, with AI models Leverage of such

data providing numerous advantages (Kim and Gardner, 2015). Insurance companies must store and analyze vast amounts of data. To collect and analyze data about policyholders, insurers typically use customer relationship management systems and enterprise resource planning technologies. The problem with using these different systems and technologies, however, is that it is very difficult to make the data actionable. Insurers must first upload the data to a single location so that actuaries, financial reporters, claims personnel, and other authorized staff can access the data. The aim of this study is to identify the impact of artificial intelligence and how to benefit from it developing the insurance industry in Jordan.

Literature Review

The digitalization of the insurance industry is already quite advanced and has gone far beyond the transition from analogue to digital information processing (Stoeckliet al., 2018). Eling and Lehmann (2018) describe digitalization as 'the integration of the analogue and digital worlds with new technologies that enhance customer interaction, data availability, and businessprocesses'. Digital transformation is also driven by InsurTechs,14 which have emerged in the last decade (Riikkinenet al., 2018). New technologies affecting the insurance industry include cloud computing, telematics, the Internet of Things (IoT), mobile phones, block chain technology,17 artificial intelligence and predictive modeling (Cappiello, 2020). Digitalization has already had a considerable impact along the insurance value chain and will continue to do so as new technologies emerge and mature (Eling and Lehmann, 2018).18 Key changes comprise enhanced process efficiency, improved underwriting and product development, reshaped customer interactions and distribution strategies and new business models (Albrecher et al., 2019). Whilst, Bohnert et al. (2019) show in their study that digitalization activities have a significantly positive impact on the business performance of insurance companies.

Kumar et al., (2019) analyzed the extent and market penetration of artificial intelligence (AI) in insurance services to solve existing concerns for increased customer satisfaction in the hotel sector. According to the findings of this study, artificial intelligence may lead to greater levels of customer satisfaction and profits, as well as a decrease in instances of fraud, operational challenges, and effective time.

Richter and Resch (2021) claimed that their research investigates the influence of artificial intelligence (AI) on the leadership of insurance companies located in different countries. The usage of technology driven by artificial intelligence (AI) has already been applied in the insurance sector, and businesses are seeking for new methods to employ it.

Kelley et al., (2018) reported that artificial intelligence (AI) has the ability to enhance the value chain of the insurance sector by altering connections, rethinking business platforms, and disclosing data that was previously concealed. AI will be used by insurance companies to improve the way in which they analyze large amounts of data, develop algorithms more quickly using transactional data, and combine data in new ways in order to discover better underwriting risks and price the risks of different insureds based on what their business risks are really worth.

Paruchuri, H. (2020) reported that data has been the insurance industry's primary focus in the recent years. There is a pressing demand for solutions that analyses or manages big data in the sector because of the explosion in data creation. Due to an environment marked by increased competition, fraud activities, flexible market places, high prospects from customers, and strict standards, the current circumstances are seen as requiring a slow but rigorous adjustment. As the amount of big data grows, the sector's use of machine learning to solve underwriting and forfeiture avoidance, entitlements management, fraud detection, product evaluation, transactions, and client capabilities will bring the business under a cloud of doom in the future. This article has looked at a few scenarios and showed the importance of machine learning in processing customer data and addressing entitlement concerns. The future of insurance companies will be brighter if machine learning is properly used.

Alfaouri & Tahat (2020) carried out research under the title Artificial Intelligence and the Impact It Will Have On Jordanians Working in the Insurance Industry. This research was conducted with the intention of demonstrating the significance of artificial intelligence (AI) in the insurance sector. According to the findings of the research, artificial intelligence (AI) and the expansion of the insurance industry in Jordan are positively related to one another. The example firms used AI systems in order to enhance how they performed their job, increase their profits, and get a higher return on their investments. Additionally, it reduced the amount of time they needed to spend on operational tasks and assisted them in working more quickly.

Theoretical Framework and Hypotheses Development

The study's theoretical framework is founded on the premise that the insurance industry in Jordan can experience substantial changes through the implementation of artificial intelligence (AI) technology. The framework acknowledges that the proficient implementation of AI technologies holds the capability to impact and transform diverse facets of the insurance sector, particularly with respect to risk evaluation, revenue generation, and customer contentment.

Enholm et al. (2022) posit that AI is perceived as a novel instrument that has the potential to enhance operational procedures and enhance decision-making within the insurance industry. The statement recognises the potential of AI applications, including machine learning algorithms and predictive analytics, to automate mundane tasks, simplify intricate workflows, and offer valuable insights through sophisticated data analysis methods (Boute et al., 2022). The utilisation of artificial intelligence (AI) can potentially improve the risk assessment accuracy, revenue optimisation strategies, and customer satisfaction levels of insurance companies in Jordan by providing personalised and efficient services.

Moreover, the theoretical framework underscores the importance of employees' cognizance and endorsement of AI as a means that supplements and amplifies their labour instead of constituting a menace to their job security. The statement acknowledges the importance of raising employee awareness regarding the advantages and prospects that artificial intelligence (AI) can offer in their respective job functions, in order to achieve successful AI implementations. According to Vrontis et al. (2022), the cultivation of a culture that embraces AI technologies can enable employees to actively engage in the adoption process, acquire the essential competencies to collaborate with AI systems, and optimise their potential in the dynamic digital environment.

In general, the theoretical framework establishes a basis for investigating the effects of AI applications on the insurance sector within the context of Jordan. The text underscores the possible advantages of Artificial Intelligence (AI) in domains such as hazard evaluation, income generation, and client contentment, while underscoring the significance of employee cognizance and acquiescence as pivotal elements for the triumphant execution of AI. The study endeavours to authenticate and enhance the theoretical framework through empirical research and analysis, thereby furnishing significant insights for the insurance industry in Jordan.

The following essential measurements will provide the ideas behind this study's thesis, " Study the Impact of Artificial Intelligence Applications on Insurance Industry: A case of Jordan." This section includes the hypothesis, which will be proven or rejected based on the following hypothesis:

Null Hypothesis (H_0): There is a statistically positive significant effect of artificial intelligence in insurance sector in Jordan.

First Hypothesis (H_1): There is a statistically negative significant effect of artificial intelligence in insurance sector in Jordan.

Methodology

The objective of the study was to obtain perspectives from personnel operating within the insurance sector in Jordan. A sample size of 125 individuals was chosen for the purpose of data collection. The selected candidates were drawn from a heterogeneous applicant pool comprising multiple organizations within the insurance industry. A sample of 15 companies was selected from the population for the purpose of this study. In order to gather quantitative data for the study, a structured and closed-ended questionnaire was employed. The researchers conducted a survey among a chosen group of employees in the insurance industry in Jordan through phone calls. This method enabled them to gain a more comprehensive understanding of the nuances of the industry and the particular methods by which artificial intelligence (AI) is utilized to improve operational efficiency within the sector.

The study endeavored to acquire comprehensive insights into the perspectives and experiences of employees in the insurance industry with respect to AI applications by utilizing this data collection method. The utilization of a structured and closed-ended questionnaire facilitated response consistency, thereby enabling researchers to effectively analyse and derive significant conclusions from the collected data.

Data Analysis:

The collected data in the study was subjected to various statistical treatments utilising the statistical software package, SPSS (Statistical Package for the Social Sciences), for analysis purposes. The aforementioned treatments were designed to elicit significant insights from the data and furnish a thorough comprehension of the research goals. Initially, a descriptive analysis was performed to provide a summary and present the essential features of the data. The present study entailed the computation of statistical indices, including the arithmetic mean, median, standard deviation, and frequency distributions. Through the analysis of descriptive statistics, scholars obtained a comprehensive understanding of the data, detected any discernible patterns or trends, and ascertained the measures of central tendency in the dataset.

Furthermore, an evaluation was conducted to gauge the internal consistency and dependability of the survey utilized for gathering data through a reliability test. The assessment was pivotal in determining the degree to which the items on the questionnaire accurately assessed the identical underlying construct. Through the evaluation of the questionnaire's reliability, researchers can ascertain the dependability and accuracy of the responses furnished by the participants. In addition, the research hypotheses were subjected to suitable statistical methods utilizing the SPSS software. The utilization of these methodologies enabled scholars to scrutinize the interconnections and correlations

among variables and ascertain whether the gathered data corroborated or refuted the postulated hypotheses. The study utilized statistical analysis to offer empirical evidence and establish dependable conclusions regarding the influence of artificial intelligence on the insurance sector in Jordan.

In the study, the data analysis phase encompassed various methods such as descriptive analysis for data summarization, reliability testing to ensure questionnaire consistency, and statistical techniques to scrutinize and authenticate the research hypotheses. The aforementioned analyses have established a sturdy groundwork for comprehending the results and deducing significant inferences from the gathered information.

Sample of the Study

The study involved a sample of 125 employees from various insurance companies in Jordan. The participants were contacted and administered a survey to gather insights about the insurance industry in the country. The sample comprised employees from 15 different insurance companies, and Table 1 presents the distribution of individuals according to their respective companies. The presented table displays the frequency distribution of employees across various companies, accompanied by their respective percentages. As an illustration, the Arab Orient Insurance Company was found to have a workforce of 16 individuals, representing 12.8% of the overall sample population. Likewise, the remaining corporations exhibited diverse counts of participants, which corresponded to their individual proportions within the population under investigation. The inclusion of individuals from various insurance companies in this study facilitated a heterogeneous representation, thereby affording researchers a comprehensive understanding of the insurance sector in Jordan from multiple vantage points.

Table 1: Frequency and percentage of the sample according to companies Insurances (n=125).

Name of the company	Frequency	Percentage
Arab Orient Insurance Company	16	12.8%
Middle East Insurance Company	10	8%
AlQudus Insurance Company.	12	9.6%
Al-Nisr Al-Arabi Insurance Company	11	8.8%
Delta Insurance Company	12	9.6%
Al Manara Insurance Company	4	3.2%
Newton Insurance Company	7	5.6%
Philadelphia Insurance Company	10	8%
International Insurance	11	8.8%
Islamic insurance company	10	8%
United Insurance Company	12	9.6%
National Insurance Company	9	7.2%
The Jordanian French Insurance Company	8	6.4%
Jordan Arab Insurance Group	9	7.2%
Arab International Union Insurance Company	5	4%
Total	125	100%

Reliability Test

The research conducted an evaluation of the inter-rater reliability among the participants through a reliability test. Inter-rater reliability pertains to the degree of consistency and similarity in the ratings or evaluations provided by various raters or observers. The present instance denotes the coherence of answers among the individuals who participated in the research. The results of the reliability test indicate that the inter-rater reliability was found to be 74%, a value that is considered statistically acceptable. The aforementioned percentage indicates a significant level of concurrence or coherence among the respondents' answers. A greater degree of inter-rater reliability signifies a heightened level of concurrence among the raters, implying that the data obtained from the subjects is dependable and uniform. The study's questionnaire demonstrated efficacy in eliciting consistent responses from participants, as evidenced by the statistically accepted inter-rater reliability of 74%. The present discovery enhances the assurance in the dependability of the gathered data, given that it showcases a noteworthy degree of concurrence among the surveyed individuals.

Results

The study's results offer valuable insights into the perspectives and viewpoints of the participants concerning the

influence of artificial intelligence (AI) on the insurance sector. The survey instrument, comprising a set of twelve inquiries, was formulated to evaluate diverse facets pertaining to the application of artificial intelligence in the insurance industry. The investigators employed a Likert scale to compute the means and standard deviations of the participants' responses, thereby facilitating an assessment of their levels of agreement. Table 2 displays the descriptive statistics of the participants' responses, including the mean and standard deviation, as well as the ranking and agreement levels for each item.

One of the key findings of the study revealed that the statement "Artificial intelligence aids in mitigating customer complaints" garnered the highest mean score of 3.66. The aforementioned statement suggests a considerable degree of consensus among the respondents regarding the beneficial influence of artificial intelligence on mitigating customer grievances in the insurance sector. Conversely, the statement "Artificial intelligence is aiding the insurance sector in cost-saving and revenue generation by providing customers with tailored services" received the lowest mean score of 2.07. The findings indicate a comparatively diminished degree of consensus among the respondents concerning the capacity of artificial intelligence to reduce expenses and produce income through the provision of customized services to clients.

Drawing from the results, it can be inferred that the respondents held a collective perspective that artificial intelligence exerts a favorable influence on diverse facets of the insurance sector. The results suggest a significant agreement among the participants regarding the favorable impacts of AI in mitigating customer grievances, detecting fraudulent emails, constructing risk prediction models, and revolutionizing various industry procedures, including but not limited to, distribution, underwriting, pricing, and claims. This is evident from the considerably high mean scores obtained.

The data indicates a potential variance in perspectives regarding the degree to which artificial intelligence (AI) impacts cost reduction and revenue generation within the insurance sector, as evidenced by the lower mean score. The results of this study illuminate the viewpoints and dispositions of the respondents regarding artificial intelligence (AI) in the insurance industry, and offer significant discernments into the possible advantages and difficulties linked with its adoption.

Table 2: means and deviations to companies Insurances (n=125).

No.	Items	Mean	Standard Deviation	Rank	Agreement Degree
1	Artificial intelligence provides assistance to insurance companies, brokers and policyholders in terms of increasing efficiency, effectiveness, speed, efficiency and volume of information exchange.	3.30	1.10	7	High
2	Artificial intelligence can provide solutions to most of the problems facing the sector, especially in terms of compensation or clearing between companies.	3.36	.87	5	High
3	Artificial intelligence is helping the insurance industry to save money and even generate more revenue, as it gives customers exactly what they want when they want.	2.07	1.27	10	Medium
4	Artificial intelligence Spurious emails can be tracked down to prevent Predict security breaches	3.55	1.03	2	High
5	Insurance companies can develop their own artificial intelligence tools to analyze risks, which will affect the amount of insurance and determine the type of insurance coverage.	2.90	.93	9	High
6	Artificial intelligence also provides the opportunity for insurance companies to create different risk forecasting models, and thus the company designs insurance		.75		

	policies suitable for different customer needs.	3.51		3	High
7	Artificial intelligence helps reduce losses incurred by insurance companies as a result of fraudulent claims.	3.22	.99	8	High
8	Artificial intelligence helps to reduce complaints from customers.	3.60	1.05	1	High
9	Features of the bank's artificial intelligence The ability to adapt to his cognitive environment In insurance companies.	3.35	1.10	6	High
10	Artificial intelligence technologies have played a major transformative role in the industry, from distribution processes to underwriting, pricing and claims.	3.46	.97	4	High

Hypotheses Testing

The objective of the research was to ascertain the presence of a statistically noteworthy influence of artificial intelligence (AI) within the insurance sector of Jordan. A multiple regression analysis was performed to evaluate the relationship between artificial intelligence, risk, revenue, and customer satisfaction in insurance companies, based on the correlation coefficients. Table 3 displays the correlation coefficients that exist between artificial intelligence and the three variables of interest, namely risk, revenue, and customer satisfaction. The findings demonstrate robust and affirmative associations between artificial intelligence and all three variables.

The Pearson correlation coefficient between artificial intelligence and risk is 0.65, and the associated p-value is 0.000. The data suggests that there exists a significant positive correlation between artificial intelligence (AI) and risk, as supported by statistical analysis. The present study reveals that the utilization of artificial intelligence (AI) in the insurance sector of Jordan is linked with an elevated degree of efficacy in risk management.

Regarding the association between artificial intelligence and revenue, it is observed that the Pearson correlation coefficient is 0.67, with a p-value of 0.004. The findings indicate a noteworthy correlation of a positive nature between artificial intelligence (AI) and the generation of revenue within the insurance industry, as supported by statistical analysis. The results suggest that the integration of AI technology within insurance firms leads to a rise in profits through the improvement of operational procedures and decision-making capabilities.

Additionally, the association between artificial intelligence and customer satisfaction exhibits a Pearson correlation coefficient of 0.70, accompanied by a p-value of 0.000. The aforementioned observation denotes a statistically noteworthy and affirmative correlation between artificial intelligence (AI) and the contentment of customers. The findings indicate that the incorporation of artificial intelligence (AI) technologies within the insurance sector has a favorable effect on customer satisfaction, plausibly due to enhanced service provision, customized experiences, and streamlined operations.

In brief, the study has established significant positive correlations between artificial intelligence and risk, revenue, and customer satisfaction in the insurance sector of Jordan, as indicated by the correlation coefficients and their corresponding p-values. The results of this study suggest that artificial intelligence (AI) has a significant influence on multiple facets of the insurance domain. This supports the conjecture that there exists a statistically noteworthy effect of AI in the insurance sector of Jordan.

Table 3 Correlation coefficients between artificial intelligence in the insurance industry in Jordan

		Risk	Revenue	Customer satisfaction
artificial intelligence	Pearson Correlation	0.65**	0.67**	0.70**
	Sig. (2-tailed)	0.000	0.004	0.002
	N	125	125	125

Table (4) shows the results of the statistical test for the model of this hypothesis, which is represented by the presence of a set of independent variables (risk, revenue, customer satisfaction) and one dependent variable representing (insurance industry).

The table indicates that there is a statistically significant effect of the variables of independent artificial intelligence

by excluding them (risk, revenue, customer satisfaction) on the insurance industry, through the value of F and equal to (69.46), which is greater than its tabular value and equal to (2.65) and significant at the level of significance (0.05), and the value of R^2 and equal (0.69) indicates that artificial intelligence by excluding it has explained (69%) of the variation in the insurance industry. The correlation coefficient was (80%), indicating a strong relationship between artificial intelligence and the insurance industry.

It appears from the results of the table of coefficients for this hypothesis that the dimension of Customer Satisfaction had the largest impact among the dimensions of artificial intelligence in the dependent variable (insurance industry), as the value of its beta coefficient β = 0.385)) and what enhances this effect is the calculated and equal value of (T) (5.76), which is greater than its tabular and equal value (1.988), and a significant level (0.005 (Sig = after that, it came in second place in terms of impact after (Revenue), as the value of its beta coefficient = 0.255 (β), and what This effect enhances the calculated value of (T) equal to (3.161), which is greater than its tabular value, and a significant level (0.001 (Sig = = After that, it came in third place in terms of impact after (Risk), as the value of its beta coefficient reached (0.226 = β) and what enhances this effect is the calculated and equal value of (T), which is greater than its tabular value, and a significant level (Sig = 0.020) Which indicates the presence of There is a statistically positive significant effect of artificial intelligence in insurance sector in Jordan.

Table 4: the results of multiple regression to detect the effect of artificial intelligence diminsions variables (risk, revenue, customer satisfaction) in insurance sector in Jordan

Independent variables	value t	Sig. t	Beta	R	R^2	Value F	Sig. F	Durbin-Watson
Risk	2.66	0.020	0.226	0.80	0.6**9**	69.46	0.001*	1.72
Revenue	3.161	0.001	0.255					
Customer Satisfaction	5.76	0.005	0.385					
Significant at the level of statistical significance($\alpha \leq 0.05$).								
Tabularity of the value of (1.988)				For the calculated value (2.65)				

Discussion

The research carried out on the ramifications of artificial intelligence (AI) within the insurance sector in Jordan produced a number of noteworthy discoveries. Gupta et al. (2022) reports that the responses obtained from a sample of employees in the insurance industry indicate a favorable perception of the advantages of AI in enhancing efficiency, effectiveness, and information sharing among insurance companies, brokers, and policyholders. This implies that artificial intelligence (AI) possesses the capability to improve diverse facets of the industry.

The participants recognized the potential of artificial intelligence (AI) to offer remedies to the difficulties encountered by the industry, specifically with regard to compensation or clearing among firms (Fatima et al., 2020). This underscores the significance of artificial intelligence in tackling challenges that are specific to various industries. Additionally, the research findings indicate that the implementation of AI technology can aid the insurance sector in reducing costs and increasing profits by enhancing customer satisfaction through more efficient fulfilment of their needs. The data suggests that there was a moderate level of agreement among the respondents, as evidenced by the comparatively lower mean score for this particular item (Shkarlet et al., 2020).

The aforementioned analysis has underscored the efficacy of artificial intelligence (AI) in monitoring and forecasting security breaches. This capability can aid in the prevention of unsolicited emails and safeguarding the industry against deceitful practices (Wang et al., 2020). The aforementioned discovery highlights the significance of artificial intelligence (AI) in reducing potential hazards and upholding the authenticity of insurance procedures. Additionally, the research illustrated that artificial intelligence enables insurance firms to construct prognostic models for risk assessment and customize insurance plans to cater to the specific requirements of clients (Satuluri, 2021). The capacity to tailor policies has the potential to augment customer contentment and enhance the overall quality of service. Furthermore, the results revealed that the implementation of AI technology has the capability to decrease financial losses that stem from deceitful claims, thus demonstrating its capacity to alleviate monetary hazards for insurance firms (Roszkowska, 2021).

In addition, the respondents expressed a high level of concurrence regarding the potential of AI to mitigate customer grievances. This implies that the integration of AI-based solutions can augment customer experiences and foster

greater levels of contentment (Nguyen et al., 2022). The positive influence of AI on the insurance sector in Jordan was reinforced by the multiple regression analysis conducted in the study. The findings of the study indicate that there exist significant correlations between artificial intelligence (AI) and various factors such as risk, revenue, and customer satisfaction, as reported by the author in the specified year. The results suggest that the rise in AI adoption is associated with favorable outcomes in risk management, revenue generation, and customer satisfaction in the insurance industry. In summary, the findings of this research offer convincing proof that Artificial Intelligence (AI) exerts a noteworthy influence on the insurance sector in Jordan. The research results emphasize the capability of artificial intelligence (AI) to augment efficacy, tackle obstacles, enhance risk mitigation, augment revenue, and elevate customer contentment in the industry (Boustani, 2022). The aforementioned insights can serve as a valuable resource for insurance companies seeking to efficiently integrate AI technologies into their operations, thereby achieving favorable results and maintaining a competitive edge in the dynamic landscape of the industry.

Conclusion

The main results showed that there is a positive statistical relationship between the use of artificial intelligence in its dimensions (risk, revenue, customer satisfaction) in the insurance industry in the Jordanian insurance sector, and this result illustrates the importance of using artificial intelligence systems that are characterized by speed and efficiency to enable insurance companies to develop models to generate revenue and start using smart financial management tools. However, the AI technologies that are now accessible and used by insurance companies are mostly fixed and that the application of AI in the insurance sector is still in its early stages, and its primary output is to identify requirements and assess risks. It is essential to have dynamic systems that can recognize changing market trends so that they can provide more realistic and fast services and make the necessary adjustments to financial plans. The use of artificial intelligence has also led to an increase in the level of investment for Jordanian insurance companies due to improvements in their profits. Moreover, the use of (artificial intelligence) in Jordanian insurance companies has led to saving time in their operations and speeding up operations.

Recommendation and Future Work

The following are some recommendations made by the study:

i. In order for businesses in Jordan to run smoothly, reliably, effectively, efficiently, and up to date, the use of artificial intelligence must become an integral component of their operations. This mandate applies not just to the insurance industry but to all businesses.

ii. Employees need to be made aware of the need of embracing artificial intelligence (AI) as a tool that enhances their work rather than a necessity for their continued employment.

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Financial markets and the energy transition: evidence from the optimization of investment portfolios

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Abstract
Our economic system has been sustained for several hundred years by energy, which has played a fundamental role in the development and implementation of most of sectors (Adedoyin et al., 2020). This livelihood is accompanied by an enormous negative impact on the environment. According to data obtained from a report recently published by the International Energy Agency (IEA, 2023), energy-related greenhouse gas (GHG) emissions have grown by 1% in 2022, reaching unprecedented levels of 41.3 Gt CO_2-eq. A figure 89% of which is accounted for by fossil fuel-related emissions. In addition to this major impact of fossil fuels, the world's dependence on this energy source must also be taken into account. According to the Energy Institute (2023), the percentage of primary energy demand coming from fossil fuels was 82% in 2022, a percentage that, according to institutions such as the Energy Information Administration (2022), will remain stable over time, forecasting a 70% share of energy demand for fossil fuels by 2050. These data represent a handicap for achieving the goals to mitigate the environmental impact that this type of energy has on the planet. Moreover, organizations such as the Intergovernmental Panel on Climate Change (IPCC, 2023) warn that it is very likely that the goal of maintaining global temperatures at 1.5ºC will not be achieved even in the most favorable scenario of minimum GHG emissions. Not only does the current energy demand pose a problem, but the population will grow, so the demand for energy will also increase unprecedentedly. According to the United Nations (UN), the global population is expected to reach 9.7 billion by 2050. To avoid that energy coming from fossil fuels, huge efforts must be made to change the global energy matrix (United Nations, 2015). Some companies even venture to launch concrete percentages. A report recently published by the oil giant Exxon Mobil (Exxon Mobil, 2023), warns that 15% more energy will be needed to maintain population growth at a certain standard of living. To avoid further damage to the planet, major changes are needed. According to the same report, it is estimated that by 2050, solar and wind energy will account for up to 11% of energy production, compared to 2% today.

This change in the energy matrix from fossil fuels to renewable energy is known as Renewable Energy Transition (RET) (Li, et al. 2020). A transition that is indispensable if the planet is to have a cleaner future in terms of energy consumption and production, being strictly necessary to make a shift towards less polluting energies such as wind or solar (Imteyaz et al., 2021; Bhattarai, et al. 2022). Empirical studies such as Koondhar et al. (2021) or Bilgili et al. (2016) have shown that higher consumption of renewable energy reduces the level of emissions. However, the rate of action is dangerously low considering the proposed targets to rapidly mitigate environmental impact. According to a recent survey by the World Energy Council (WEC, 2023), 64% of global energy leaders warn that the global energy transition is too slow to achieve the UNFCCC Paris Agreement commitments and UN Sustainable Development Goals. One of the reasons for this slow pace may be due to the high cost of capital and the need for investment, as this survey also warns. This need for investment is supported by reports such as the International Renewable Energy Agency (IRENA, 2023), recognizing that efforts in installed renewable capacity must triple by 2050 to achieve the goal of maintaining the 1.5ºC scenario. Other institutions such as the International Energy Agency (IEA, 2023) also warn of this need, indicating that the flow of investment towards renewable energies must be considerably increased for a safe and reliable energy transition. Thus, the global financial system has become the biggest challenge at this time to achieve the energy sustainability goals (WEC, 2023).

Climate finance is the tool that the financial system uses to study public and private investment flows to mitigate the risks associated with climate change. It is an area of study that has grown considerably in terms of the attention provided by the academic community, policy makers and practitioners (Hong, et al. 2020).

Climate finance must become a cornerstone of the financial system, so it cannot be disconnected from the reforms or changes that concern it (Aglietta, et al. 2015). On the other hand, political leaders must also design policies to attract more capital to cleaner energy sources to mitigate negative environmental impacts (CFLI, 2021). One such policy is disinvestment in carbon-intensive industries, as empirically demonstrated by Fang, et al. (2018) indicating that these types of industries present more risk relative to less carbon-intensive industries. In the energy investment area, the International Energy Agency (IEA, 2023) forecasts that $2.8 trillion will be invested in this sector in 2023, of which $1.7 trillion will go to clean energy. To reach these investment levels, sustainable investment initiatives such as The Climate Finance Leadership Initiative and the Principles for Responsible Banking have the potential to influence this transition, reaching the investment levels needed to mitigate climate change (Hong, et al. 2020).

Given the relevance of climate finance in the energy transition, this study aims to empirically analyze the risk-return duality for a global set of energy companies framed in fossil fuels and renewable energy. Through portfolio management, an optimization and simulation analysis is carried out to verify the portfolio's performance according to the weights of each company in the portfolios. The results show that fossil fuel companies have a greater presence than renewable energy companies in the portfolios optimized by standard deviation and by the modified Sharpe ratio, indicating that, a priori, the financial markets are not in favor of renewable energies in terms of risk-return. These results have worrying practical implications as it highlights the lack of predisposition of the financial markets towards the energy transition in terms of investment.

The COVID-19 pandemic's impact on work dynamics in IT Software Development Organisations in South Africa, based on Organisational Size and Managerial Levels.

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Abstract

Abstract

Purpose - This article explores how COVID-19 has impacted the ways of work for software developers and managers in South African IT companies, focusing on changes during and after the COVID-19 Pandemic. It also considers differences in how organizations of varying sizes and managerial levels have encountered these changes.

Design, methodology approach - Authors gained insight into how the COVID-19 pandemic affected the ways of work and performance of South African IT institutions, particularly in software development, due to changing dynamics such as working from home.

Findings – The results indicate notable variations in the reported scores of Small, Medium and Large South African IT companies regarding the alterations in where they worked before, during and after the COVID-19 outbreak. Additionally, there are discernable differences between the scores submitted by Operational personnel, Middle Managers and Senior managers, especially regarding the Organization's size.

Originality/value – This paper discusses how Software Developing Organizations in a developing country like South Africa adapted to changes in their work demographics before, during and after the COVID-19 pandemic. As issues such as population growth, migration, intolerance, and conflict continue to rise, developed nations are starting to experience similar challenges faced by developing and semi-developed countries such as South Africa. Therefore, this article is relevant to all IT professionals in developed and developing nations who must adapt to a diverse and ever-changing world.

Keywords - Software development companies, COVID-19, ways of work, managerial levels, size of Organization

Paper type - Research paper

Introduction

In January 2020, the outbreak of COVID-19 prompted the World Health Organization (WHO) to declare a "public health emergency of worldwide concern." In response, most countries declared public health emergencies through their Disease Control and Prevention Agencies by the end of January or early February 2020 (Mihailović et al., 2021). By mid-2020, governments implemented restrictions to limit movement, leading to a surge in remote work (Furnell and Shah, 2020). This shift from traditional physical offices to virtual online workplaces immediately mitigated the spread of the COVID-19 pandemic and accelerated the digitalization and decentralization of office operations. However, remote work also presents challenges, particularly to the IT industries.

Although many organizations provided security tools, such as antivirus software, firewalls, virtual private network (VPN) clients, and endpoint protection, to their employees working from home, the specific tools and usage varied based on each Organization's policies, as well as the roles and responsibilities of both employers and employees and the available IT infrastructure. In more technologically advanced regions, employees often receive 4G or 5G unlimited mobile data and up to 62MB of fiber to their homes (FTTH). However, in less developed nations, employers and employees faced challenges with power sources, connectivity, and access to high-quality internet services during the Pandemic, making it extremely difficult to access, download, or complete any cloud- and internet-based work (Wang and Alexander, 2021). While the literature has extensively discussed the cybersecurity threats faced by developed nations during the Pandemic, there is limited information on the IT security practices followed in developing countries (Ahmad, 2020; Agba, Ocheni, and Agba, 2020). Given the world's continuous change, diversity, and even elements of silent intolerance and conflict, it is essential to understand how IT companies in developing nations, such as South Africa, mitigated IT security and cyber threats. Particularly interesting is the extent to which IT software developing companies were affected by the COVID-19 pandemic. Currently, little is known about how COVID-19 impacted the ways of working in small, medium, and large software-developing companies in a developing context. From a developing nation context, essential questions that need to be answered include the extent to which COVID-19 impacted IT software developing organizations, whether the size of the organization mattered, whether separate roles within the Organization experienced different impacts, and whether working in an online environment was seen as a positive experience. Furthermore, it is important to explore whether IT security was one of the sectors severely impacted by COVID-19.

Initial concerns

The COVID-19 pandemic caused widespread fear and uncertainty, profoundly impacting people's way of life. Unfortunately, many individuals were not adequately trained to ensure they had the necessary skills for working from home. As a result, concerns arose regarding managing real-time decision-making, online training, and continuous monitoring as cyber threats and attacks began to impact privacy. Educating individuals on recognizing and responding to phishing frauds and other cyber-attacks became essential. Regrettably, due to the Pandemic's sudden onset, many organizations could not train and prepare their employees for remote work-related communications once lockdowns were implemented. As a result, many organizations had to rely on computer software and high-speed telecommunications networks to mitigate risks (Okereafor and Adelaiye, 2020). Mismatches between skills and technology became commonplace (Pranggono and Arabo, 2021), as most regulations and company policies were hastily made to facilitate working from home.

Impact of Cyberattacks on Businesses

Despite businesses' widespread adoption of teleworking, studies have shown that many organizations struggled to maintain functionality during the Pandemic. This was due to numerous factors such as a lack of technical capability, disregard for necessary safety standards, improper configuration of home ICT (Information and Communication Technology) devices, increased cybercrime rates, a lack of education, and gaps in employee computer literacy (Switzerland, 2022). Unsurprisingly, the shift to online platforms resulted in fresh waves of security risks and attacks during the Pandemic (Borkovich and Skovira, 2020; Furnell and Shah, 2020). Internet of Things (IoT) devices, such as game consoles and smart televisions, were vulnerable to attacks in typical home environments. Employees who worked from home often connected their IoT and smart devices, such as televisions and phones, to the same unsecured router they used to access their company's network. Employers had no or only limited control over the patching or upgrading of these devices, which posed severe risks to businesses during the Pandemic (Mihailović et al., 2021).

IT Security in a Developing Context: The South African Scenario

The South African environment uniquely blends Western and African cultures, presenting developed and developing perspectives in a constantly changing and diverse business landscape. Rather than allowing one culture to dominate and overshadow others, integrating diverse cultures in South Africa is closely tied to governmental management and control. Three management styles directly influence management in the country: Eurocentric, Afro-centric, and Synergistic Inspirational. Based on Western values, the Eurocentric approach emphasizes individualism and self-centeredness and has dominated South African industries due to colonialism and past oppressive policies. However, many South African societies strongly oppose this approach as an extension of oppression, resulting in a lack of trust towards anything foreign. In contrast, the Afro-centric approach is based on Ubuntu thinking, which promotes inclusivity and community. It encourages using a home base when dealing with internal or external organizational challenges, opposes individualism and embraces collectivism, emphasizing the importance of the social unit. The Synergistic Inspirational (SI) approach combines time-honored African management practices, principles, and philosophies with Western management methods. It seeks unity in diversity, promoting the development of shared values while building trust and respect when values differ. South Africa's diverse environment thus provides valuable insights for first world and Western industries on managing and developing IT software within diverse cultures and organizations in highly diversified settings (Kruger and Johnson, 2008).

Towards a Solution

To ensure sensitivity, confidentiality, and access to necessary information, initial attempts at research encountered reluctance from organizations to participate. However, this challenge was addressed by focusing solely on employees from South African-based IT Service and Development Organizations with whom the University has established collaborative agreements. Companies were selected voluntarily from the categories of Small (1-100 employees), Medium (101-500 employees), and Large Organizations (5001 or more employees). The sample for the study depicted in Table 1 comprised 102 IT employees from 57 IT organizations in South Africa. It is worth noting that several representatives were interviewed from some organizations, with small organizations accounting for 49%, medium-sized organizations representing 17.6%, and large organizations accounting for 33.3%. The participants were selected for their diverse ethnicity and gender (Wright and Wright, 2002; Yip, Han, and Sng, 2016).

All survey data was collected using a digitalized Questionnaire, with respondents indicating whether they "Strongly Agree", "Agree", "Disagree", or "Strongly Disagree" with stated questions. Google Forms was utilized to distribute the questionnaires, with respondents maintaining anonymity. Of the 123 surveys sent out, 102 were received from 57 organizations, and 62 individuals were willing to elaborate on their responses through one-on-one interviews or Zoom meetings. Confidentiality and sensitivity were maintained throughout the data collection process. After analyzing the data, insights were gained into the IT interventions used by South African organizations to mitigate risks during the COVID-19 pandemic. Data validation checks were performed to ensure accuracy and completeness, with IBM SPSS software used for analysis and modelling, and Microsoft Excel used for creating graphs and figures. The resulting data was carefully prepared for tabular and graphic presentation, analysis, and interpretation (Roopa and Rani, 2012).

An objective stance was maintained in analyzing all research results. All statistical calculations were verified by the North-West Universities' Statistical Department, a facility that focuses on the scientific design and management of research. The analysis that follows consists of the descriptive statistics used for each question. Descriptive statistics involves arranging, summarizing, and presenting the data so that the meaningful essentials of the data can be extracted and interpreted easily. Statistics established the basic statistical measures of the response variable for every question. Unless expressly stated, in all instances, findings are elaborated upon from a positive affirmation. Where the probability of exceeding the norm (p-value) was less than 0.05, the decision rule was to reject the null hypothesis at a 5% significance level.

Results and Findings

Size of company					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Small (1-100 Employees)	50	49,0	49,0	49,0
	2 Medium (101-500 Employees)	18	17,6	17,6	66,7
	3 Large (501 > Employees)	34	33,3	33,3	100,0
	Total	102	100,0	100,0	

Table 1: Company size.

Regarding Table 2, the representative presented a comprehensive profile of their workforce, consisting of individuals with diverse skill sets, encompassing 39 operational, 53 middle management, and ten senior management positions. The roles were categorized into Business Partners and Executive Officers for Senior Managers, Project Managers, Business Analysts, Scrum masters, Development Leads for Middle Managers, and Developers for Operational personnel.

Roles of interviewee.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Operational	39	38,2	38,2	38,2
	2 Middel Management	53	52,0	52,0	90,2
	3 Senior Management	10	9,8	9,8	100,0
	Total	102	100,0	100,0	

Table 2: Managerial Position.

Table 3, the Crosstabulation of the company's size and the Role of the interviewee revealed that out of the 102 interviewees, 50 worked for small companies, 18 were from medium-sized companies, and 34 were associated with large organizations. Further analysis revealed that out of the 50 individuals from small companies, 17 were operational, 28 were middle managers, and 5 were senior managers. For medium-sized companies, seven interviewees were operational, 9 were middle management, and 2 were senior managers. Finally, for large companies, 15 were operational, 16 were middle managers, and 3 were senior managers.

Size of company * Roles of interviewee. Crosstabulation					
Count					
		Roles of interviewee.			
		1	2	3	Total
Size of company	1	17	28	5	50
	2	7	9	2	18
	3	15	16	3	34
Total		39	53	10	102

Table 3: Size of company and Role of interviewee.

Before COVID-19

As per Table 4, the data indicate that before the Pandemic, most work was done on-premises in South African IT Software Developing Companies interviewed, with 85.3% of employees Strongly Agreeing (46.1%) or Agreeing (39.2%) and only 14.7% Strongly Disagreeing (8.8%) or Disagreeing (5.9%).

Before COVID-19, most work was done on the premise.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	9	8,8	8,8	8,8
	2 Disagree	6	5,9	5,9	14,7
	3 Agree	40	39,2	39,2	53,9
	4 Strongly Agree	47	46,1	46,1	100,0
	Total	102	100,0	100,0	

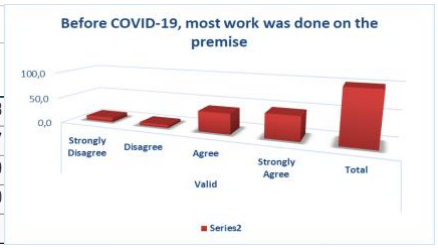

Table 4: Before COVID-19 – Work done on Premise.

Of interest is that in Large Organizations, 31 out of 34 (91%) interviewees; in Medium-sized Organizations, 16 out of 18 (88%) and small organizations, 40 out of 50 (80%) respondents agreed or strongly agreed that before the covid-19 Pandemic, they were working from the office as can be seen in Table 5.

Size of company * Before COVID-19, most work was done on the premise.						
Crosstab						
Count						
		Before COVID-19, most work was done on the premise.				
		1	2	3	4	Total
Size of company	1	7	3	22	18	50
	2	0	2	7	9	18
	3	2	1	11	20	34
Total		9	6	40	47	102

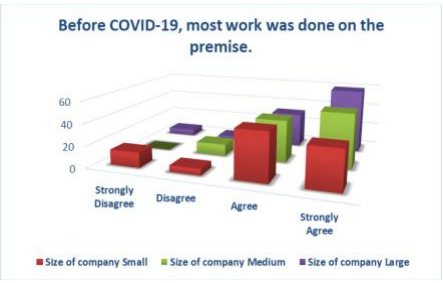

Table 5: Before Covid-19 – Work done on Premise: Size of company.

When viewed from the perspective of the role of the interviewee, 46 out of 53, or 87% of Middle and 9 out of 10, or 90% of Strategic Managers either strongly agreed or agreed that most of their work was done on premises. At the same time, 32 out of 39 or 82% of operational personnel agreed or strongly agreed that they worked from the office before the COVID-19 pandemic.

Roles of interviewee. * Before COVID-19, most work was done on the premise.						
Crosstab						
Count						
		Before COVID-19, most work was done on the premise.				
		1	2	3	4	Total
Roles of interviewee.	1	7	0	11	21	39
	2	1	6	22	24	53
	3	1	0	7	2	10
Total		9	6	40	47	102

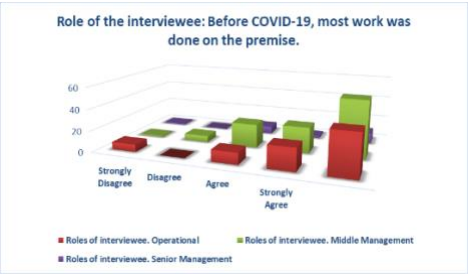

Table 6: Before Covid-19 – Work done on Premise: Role of Interviewee

Before Covid- Work on Premises per Managerial Level and Organisational Size			
	Small	**Medium**	**Large**
Senior	100%	100%	66%
Middel	86%	78%	94%
Operational	65%	100%	93%

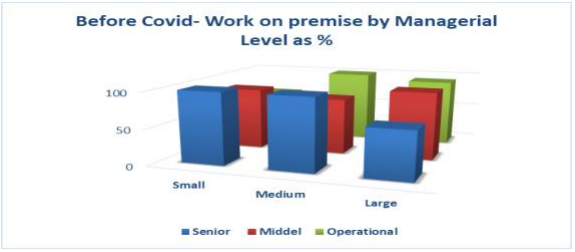

Table 7: Before Covid-19 - Work on Premise: Role of Interviewee, per organizational size

Regarding Table 7, Deeper analysis revealed that all senior managers in Small and Medium-sized institutions worked from the office before the Pandemic. However, one of the three senior managers interviewed in large organizations indicated that he worked from home before the Pandemic. As for middle managers in small organizations, 85% agreed, or fully agreed that they worked on-premises before the Pandemic. In medium-sized organizations, 78% of middle

managers and 94% of those in large organizations reported that they worked from the office before the Pandemic. It is worth noting that among operational personnel, primarily programmers, in small organizations, the percentage was 65% for those who agreed or strongly agreed that most of their work was done on-premises before the Pandemic. However, for operational personnel in medium-sized and large organizations, the percentages were much higher, with 100% of medium-sized organizational, operational personnel and 93% of large organizations operational personnel agreeing, or strongly agreeing, that before the Pandemic, their work was done on-premises with one operational interviewee in a large organization stated that he had already been working from home before the Pandemic started.

During Covid-19

As per Table 8 below, during the Pandemic, the data indicate that most work was done off-premises in South African IT Software Developing Companies interviewed, with 87.2% of employees Strongly Disagreeing (63.7%) or Disagreeing (23.5%) and only 12.7% Strongly Agreeing (4,98%) or Agreeing (7.8%) that most work was still done on premises.

During COVID-19, most work was done on the premise.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	65	63,7	63,7	63,7
	2 Disagree	24	23,5	23,5	87,3
	3 Agree	8	7,8	7,8	95,1
	4 Strongly Agree	5	4,9	4,9	100,0
	Total	102	100,0	100,0	

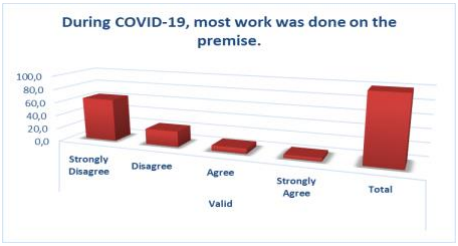

Table 8: During COVID-19 – Work done on Premise.

According to Table 9, in interviews conducted with employees of large organizations during the COVID-19, 91% or (31 out of 34) indicated that they worked off-premises during the Pandemic. Similarly, in medium-sized organizations, 94% (17 out of 18) of interviewees and 82% (41 out of 50) in small organizations either Strongly Disagreed or Disagreed with the notion that they were still working from the office during the Pandemic.

Size of company * During COVID-19, most work was done on the premise.

Crosstab

Count		During COVID-19, most work was done on the premise.				
		1	2	3	4	Total
Size of company	1	31	10	6	3	50
	2	11	6	1	0	18
	3	23	8	1	2	34
Total		65	24	8	5	102

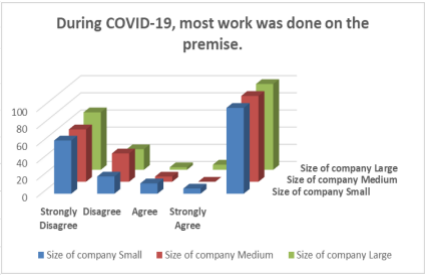

Table 9: During COVID-19 – Work done on Premise: Role of Interviewee

When considering the experiences of those being interviewed, it was found that 89% of Middle Managers and 70% of Strategic Managers either strongly disagreed or disagreed that their work was conducted on-site during the Pandemic. Conversely, 90% of operational personnel disagreed or strongly disagreed that they worked from the office during the COVID-19 pandemic, with only 4 out of 39 operational personnel indicating that they still predominately worked on premises during the Pandemic.

During Covid- Work on Premises per Managerial Level and Organisational Size

	Small	Medium	Large
Senior	**40%**	**0%**	**33%**
Middel	22%	11%	6%
Operationa	18%	0%	6%

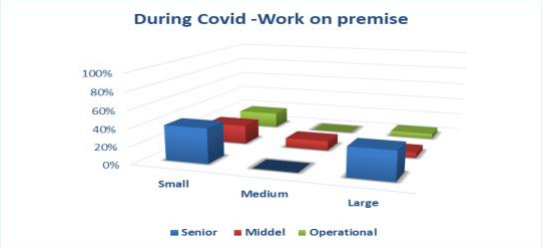

Table 10: During Covid-19 – Work done on Premise: Size of company and Managerial Level

Regarding the topic of remote work during the COVID-19 pandemic, it was found that most interviewees reported working from home. In small organizations, 35% of senior managers agree or strongly agree that they still did work on-premises during the Pandemic. Similarly, 34% of senior managers in large organizations shared this sentiment. However, all senior managers in medium-sized companies indicated working from home. Middle managers in small organizations had an 86% rate of confirming remote work, while middle managers in medium and large organizations reported rates of 89% and 94%, respectively. Operational personnel in small organizations reported a percentage increase to 83% working remotely, while medium and large organizations had even higher rates of remote work at 100% and 93%, respectively. Scrutiny revealed that it was developers, development leads, and project managers who indicated that during the Pandemic, they were required to return to the office to complete work or attend meetings.

Post Covid19

Table 11 shows that South African IT software development companies continue to conduct most of their work remotely following the COVID-19 pandemic, although at lower rates than during the Pandemic. A significant majority of employees, 68.6%, either strongly disagreed (29.4%) or disagreed (39.2%) with the notion that most work had returned to the Organization's premises. Thus, only 31.4% of employees strongly agreed (6.9%) or (24.5%) that most work returned to on-premises post-Covid-19.

Post-COVID-19, most work was done on the premise.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	30	29,4	29,4	29,4
	2 Disagree	40	39,2	39,2	68,6
	3 Agree	25	24,5	24,5	93,1
	4 Strongly Agree	7	6,9	6,9	100,0
	Total	102	100,0	100,0	

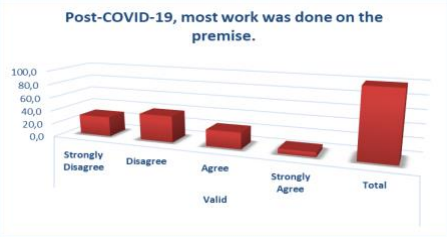

Table 11: Post COVID-19 most work was done on the premise.

According to Table 11, 68.6% of all employees interviewed indicated they did not return to the office after the COVID-19 Pandemic. Closer scrutiny, as presented in Table 12 below, reveals that 59% (20 out of 34) employees of large organizations indicated either strongly disagreeing or disagreeing that work returned to the organizational premises. Similarly, in medium-sized organizations, 72% (13 out of 18) of interviewees and 74% (37 out of 50) in small organizations strongly disagreed or disagreed with the notion that they needed to return to the office.

Size of company * Post-COVID-19, most work was done on the premise.

Crosstab

Count

		Post-COVID-19, most work was done on the premise.				
		1	2	3	4	Total
Size of company	1	22	15	8	5	50
	2	3	10	5	0	18
	3	5	15	12	2	34
Total		30	40	25	7	102

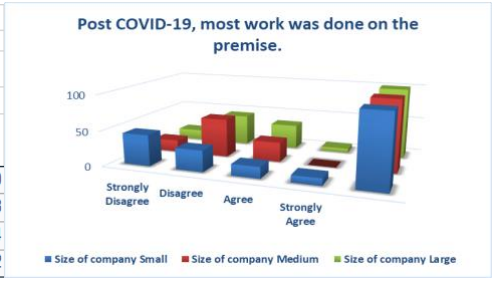

Table 12: Post-COVID-19: Most work was done on the premises, per organizational size.

Regarding Table 13, all managerial levels, Operational (66%), Middle Managers (70%) and Senior Managers (70%) indicated that in mid-2022, most work was still done remotely in the post-COVID-19 world. Table 14 is primarily operational developers, development leads and project managers in small, medium, and enterprise-sized organizations required to return to the office.

Roles of interviewee. * Post-COVID-19, most work was done on the premise.

Crosstab

Count

		Post-COVID-19, most work was done on the premise.				
		1	2	3	4	Total
Roles of interviewee.	1	12	14	9	4	39
	2	16	21	14	2	53
	3	2	5	2	1	10
Total		30	40	25	7	102

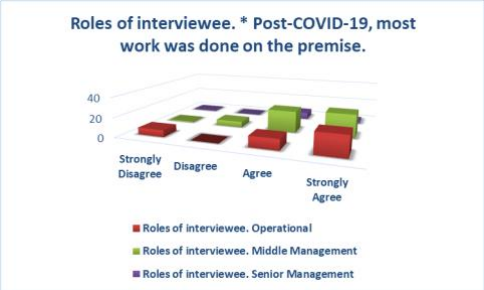

Table 13: Post-COVID-19: Most work was done on the premises, per Managerial levels.

Post Covid- Work on Premises per Managerial Level and Organisational Size

	Small	Medium	Large
Senior	**20%**	**50%**	**33%**
Middel	22%	22%	50%
Operational	35%	29%	13%

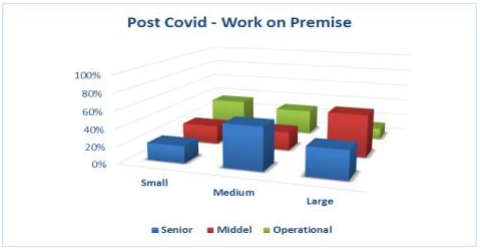

Table 14: Post-COVID-19: Most work was done on the premises, per Managerial levels and size of Organization.

Discussion

When viewed holistically, it can be concluded that the COVID-19 pandemic significantly impacted the South African IT Software developing industry. Not only did the pandemic change where people worked, but also to what extent working from home affected returning to the office. Regarding Table 14 below, 74% of Small, 67% of Medium, and 85% of large organizations, or 77.4% of employees interviewed, agreed that the COVID-19 pandemic impacted their organization (33.3% strongly agreed, and 44.1% agreed). Regarding their role within the Organization, the impact of the COVID-19 pandemic was felt by Middle Managers (83%, Strongly Agreeing – 40%; Agreeing 43%), followed by Operational personnel (77%, Strongly Agreeing – 31%; Agreeing 46%), and least felt by Senior Managers 405 (Strongly Agreeing – 10%; Agreeing 30%).

COVID-19 had an impact on my organisation.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Strongly Disagree	6	5,9	5,9	5,9
	2 Disagree	18	17,6	17,6	23,5
	3 Agree	44	43,1	43,1	66,7
	4 Strongly Agree	34	33,3	33,3	100,0
	Total	102	100,0	100,0	

Table 15: COVID-19 had an impact on my organization

Size of company * COVID-19 had an impact on my organisation.

Crosstab

Count		COVID-19 had an impact on my organisation.				
		1	2	3	4	Total
Size of company	1	2	11	24	13	50
	2	2	4	9	3	18
	3	2	3	11	18	34
Total		6	18	44	34	102

Table 16: Size of organization – COVID-19 had an impact on my organization

Roles of interviewee. * COVID-19 had an impact on my organisation.

Crosstab

Count		COVID-19 had an impact on my organisation.				
		1	2	3	4	Total
Roles of interviewee.	1	4	5	18	12	39
	2	2	7	23	21	53
	3	0	6	3	1	10
Total		6	18	44	34	102

Table 17: Role of Interviewee - COVID-19 had an impact on my organization

In summary, Figure 1 shows that before the COVID-19 pandemic, all Small, Medium and Large South African Software Developing Companies interviewed indicated that they worked on-premises. This changed drastically during the Pandemic, with all organizations indicating that they primarily worked away from the office. Post the COVID-19 Pandemic, there was a significant return to on-premises work, but not to the extent of before the Pandemic.

Figure 1: Changes in working demographics Before, During and after the COVID-19 pandemic in South African IT Software Companies as per organizational size and Managerial level.

Regarding the roles Interviewees play within their organizations, it became clear from Figure 1 above that the role played within the organization not only significantly impacted to what extent interviewees agreed or disagreed with the statements that before, during, and post-Covid-19 most work was done on-premise, but also influence their return to the office, with less Senior Managers per percentage, in Small Organizations returning to the office, than in Medium and Large Organizations. In small and medium-sized organizations, more operational personnel returned to work than in large organizations. In contrast to Small and Medium-sized organizations, primarily middle managers returned to large organizations' offices. Findings were further explored during the structured interviews, and answers alluded to the following reasons:

Question 1: Why did so few operational personnel return to work in Large South African IT organizations?

Comment Operational Level Developer 1 - Large South African Organization: "*The most significant impact was the initial delays; the teams adapted quickly*".

Comment: Operational level Developer: Large South African Organization: "*An online platform has allowed for collaboration from multiple countries and cities to collaborate on a single projec*t".

Comment: Middle Manager: Development lead Large Multinational Organization; "*My development team were working in a hybrid fashion (3 days at the office, 2 days from home) before COVID-19, so it was easy to just switch to full remote working. Also, my team is spread across South Africa and the UK, so we overcame the challenges long before COVID-19 occurred*".

In contrast to:

Comment: Middle Manager: Project Manager Large South African Organization: "*Although COVID-19 had a positive impact in forcing external companies to improve their IT infrastructure and be able to work more remotely, in regard to change-management and Software development, it is best to work with end-users on-site/face-to-face*".

Comment: Operational: Developer Medium-sized South African Organization: "*COVID-19 was a double-edged blade. On the one hand, it allowed some people to work more efficiently and have more time to spend with their families. People have more free time due to not having to travel. There is also a more significant divide between older and newer generations. Older generations prefer working from the office, while newer generations prefer working from home.*"

Comment 5: Operational: Developer, Small South African Organization: "*COVID-19 forced companies in my field of expertise to adapt and improve in areas that didn't seem important at firs*t".

Question 2: Why did so many less Senior Managers return to work in Small South African organizations?

Comment: Strategic Manager: People and Culture Business Partner South African Large-sized Organization: "*In my opinion, COVID-19 19 had a positive impact on the whole IT industry. More businesses are going digital, which means increased opportunities for us, and working from home has become the new normal.*"

Comment: Strategic Product Owner: South African-based medium-sized Organization: "*Working in a purely online*

environment afforded huge benefits. Huge teams (Focus Groups) could be assembled at a moment's notice to deal with issues. Previously it could have taken days or weeks to assemble the correct people in a single boardroom to discuss a problem".

Comment: Strategic Manager: IT Operations Manager Small-sized South African Organization: "*In my organization, projects almost came to a stand-still during Covid-19, and although staff have returned to office, pre-pandemic levels of project execution have not been realized*".

Question 3: Why did so many more Middle Managers return to work in Large and medium-sized organizations than in Small and Medium-sized ones?

Comment: Middle Manager: Project Manager; Scrum Master of a Large South African International Multinational Organization: "*The challenges around infrastructure and communication were tough in the initial stages of COVID-19. People would work from home with an internet connection that did not have the capacity for it. This, coupled with constant load shedding, made managing projects exceedingly difficult before the team was prepared with better line speeds and a UPS. I think the workplace has benefited from the Pandemic in changing the model of how we work (I think we have become more productive and happier), but it has also come at the price of losing relationships made "around the water cooler" and those face-to-face interactions I think is necessary for a company culture (and personal well-being)*".

Comment: Middle Manager: Development lead Large-sized South African-based Organization: "*Overall, Covid had a drastic impact on the way we think, work, and collaborate. Although we had all the tools needed for working remotely even before covid the tools were used a lot more when COVID hit. We could not dismiss the effectiveness of having a face-to-face conversation with our peers before we had to move to online means of work, i.e., walking up to a colleague to ask a question, whereas we needed to use communication tools like teams to try and get answers".*

In contrast to
Comment: Middle Manager: Support Engineer Small South African Organization: "*I prefer working from home. If I don't physically have to be there to do it, then it's better to work from home 100% of the time*".

Comment 4: Middle Manager: Project Manager Medium-sized South African Organization: *Online meetings work well for most things. The most significant impact was on relationships and culture.*"

These statements above shed light on the impact of the COVID-19 pandemic on South African IT institutions' work practices and performance, specifically in software development, as remote work became the norm.

Conclusion

This is the first article in a series that delves into the impact of the Pandemic on software developers and middle and senior IT managers in South African software companies. The study explores the changes they experienced during and after the Pandemic and how organizations of varied sizes and management levels adapted to them. The findings revealed significant differences in the reported scores of small, medium, and large IT companies and between operational personnel, middle managers, and senior managers.

Before the Pandemic, all employees in software companies worked on-premises, but this changed drastically during the Pandemic as most organizations shifted to remote work. While there was a significant return to on-premises work post-pandemic, it did not revert to pre-pandemic levels. The study highlights that an employee's role in an organization significantly influences their return to the office, with fewer senior managers in small organizations returning to the office than in medium and large ones.

The study also indicated that in small and medium-sized organizations, more operational personnel returned to work than in large organizations, while in large organizations, it was primarily middle managers who returned to the office. COVID-19 presented challenges but allowed some people to work more efficiently and have more time for their families. As more businesses went digital, working from home became the norm, but it presented different problems to different organizational sizes and the roles operational personnel and managers play in such settings. Remote

working was easier for teams, especially development teams already working in a hybrid fashion or spread across various locations. COVID-19 impacted and favored such a diverse workforce as in many large and multinational organizations, leading to fewer operational employees needing to return to the office after the Pandemic. However, this caused middle managers in large organizations to face new challenges in executing projects. As such, more middle managers in large organizations return to work due to a need to collaborate and have face-to-face conversations with peers to mitigate new challenges of an operational workforce now mainly working from home. The study highlights that while online meetings work well for most, they significantly impact relationships and company culture. The study provides valuable insights into the changes that software companies experienced during and after the Pandemic and how they adapted to these changes.

Short biography

CE van Niekerk (Tina) is a North-West University postgraduate student pursuing a Master of Science in Computer Science. Having served as a project manager for several honours' projects, she has developed excellent leadership and organizational honours and overseen the successful execution of four research initiatives, ensuring they were completed within budget and on time.

Professor C.J. (Neels) Kruger is a distinguished IT Strategy, Project Management, Governance, and Security expert. He offers consulting services to external stakeholders and has supervised numerous postgraduate students. Prof. Kruger is a reviewer for esteemed journals and works as a Strategic Consultant, consulting state and private organisations on critical topics such as business alignment, IT and Business Strategy, Governance, and Knowledge Management.

Dr Liebenberg S.C. (Shawn) holds the position of senior lecturer and senior subject specialist (statistical consultant) at the Faculty of Natural and Agricultural Sciences of North-West University, where he has accumulated a decade of experience in statistical consultation. Within his role, he provides comprehensive support services encompassing statistical survey design, data processing, and analysis, alongside the interpretation and reporting of outcomes for students, staff, and industry stakeholders.

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Influence Of Investment Dynamics In Intangible Assets On The Growth Rate Of Profit Of Enterprises

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Abstract

Within the framework of the catastrophe theory, one of the methods of effective investment forecasting of the development of small enterprises has been developed. The classification of intangible assets into core and additional, incorporating the principles of synergetics, has made it possible to significantly simplify the solution to the problem of effective investment in intangible assets. It is shown that the use of point coefficients of elasticity in the study of the dynamics of movement of a representative point on the equilibrium catastrophe surface is a necessary element in constructing an optimal development strategy of a company. The high sensitivity of the coefficients of elasticity to changes in the financing of intangible assets has been revealed. This makes it possible to recognize in advance the emergence of dynamic instability in the development of small businesses and prevent the subsequent destruction of the structure of intangible assets. In the region of slow growth in numerical values of profit, a new phenomenon was discovered, which can be conditionally compared to a second-order phase transition described in thermodynamics. In this area, a smooth continuous change in profit is accompanied by a sharp jump-like change to infinitely large numerical values of the first derivatives of profit of intangible assets. This phenomenon can be explained by a spontaneous abrupt transformation of the internal properties of intangible assets, and, as a consequence, the emergence of qualitatively new interactions of intangible assets. The versatility of the presented methodology allows it to be used for prognostic purposes not only for an individual enterprise, but also for sectors of the economy of both individual regions and the country as a whole.

Keywords: small and medium-sized businesses, intangible assets, coefficients of elasticity, cusp catastrophe, investment forecasting

The revolution in digital technology and the development of the Internet has caused the transformation of the main sectors of the industrial world economy into a digital post-industrial economy (Economic Report of the US President, 2001; Roztocki, 2019). Under these conditions, the leading role of such an intangible asset as human capital has become a key success factor not only for firms engaged in the sector of information and communication technologies, education, science and knowledge services (consulting) (Roztocki et al., 2019), but also for companies in other industries that benefit from the advances of digital technology and the Internet.

The current situation in the business environment has led to the fact that a characteristic feature of the development of modern small enterprises has become the dominant influence of intangible assets on profits in comparison with tangible and financial assets (Economic Report of the US President, 2001; Gamayuni, 2015). Such dependence is usually observed at all stages of enterprise development, from the moment of inception to the period of decline (Apichanangkul & Zhang, 2012; Gang & Apichanangkul, 2013).

The state of intangible assets, their structural changes and the dynamics of interactions with each other fully reflect the general state of the enterprise and its development prospects (Julienti & Ahmad, 2010). From the point of view of systems theory, small enterprises are complex systems that are open to the external business environment. The study of this issue is complicated by the fact that non-linear systems, such as small and medium-sized enterprises, have synergistic and emergent effects (Policy Depart., 2021; Xu et al., 2018). It should be noted that the development of

open systems has the characteristic features of disasters (Gilmore, 1993). Therefore, intangible assets, as one of the main components of small business, are also subject to catastrophic changes (Apichanangkul & Zhang, 2012).

After the COVID-19 pandemic, which set back economic progress for decades, the growth rate of the number of small businesses has exploded (Bartik et al., 2020; Dejardin et al., 2023). At the same time, the importance and relevance of assessing the impact of the dynamics of structural changes in intangible assets on the amount of income has increased. Of particular importance to the study is the fact that the results of the above calculations are suitable for optimizing the investment of a small enterprise with limited financial capabilities.

The primary challenge facing small businesses is finding algorithms to effectively utilize their limited financial resources to maximize profits. This challenge prompted the goal of the presented study: to develop a simple and reliable method that helps business leaders in making optimal investment decisions

Research methodology

Disaster theory is widely used in modern economic and financial research (Gang & Apichanangkul, 2013). The main economic model of catastrophe theory (cusp catastrophe) is the assembly or folding of the equilibrium surface of states of the object under study (Baack & Cullen, 1994; Grasman et al., 2009). Such a model requires three variables. Two independent variables (arguments) and one dependent variable (function). One of the independent variables is known as the "normal factor" and the other is known as the "split factor". Changes in the normal factor can lead to discontinuous states. The splitting factor determines the conditions under which the normal factor affects the function continuously or discontinuously. These theoretical provisions were taken into account in the present study.

The cusp catastrophe model is a convenient tool for studying the structural stability of an open system (Barunik & Vosvrda, 2009; Bigelow, 1982; Thom, 1980; Zheng et al., 2010). However, before using the cusp catastrophe model, it is necessary to classify intangible assets in accordance with the goals and objectives of this study. Such a classification will allow us to divide intangible assets into two main groups. One group in its totality constitutes a normal factor.

In our notation, such intangible assets are called main or underlying assets. The other group forms the splitting factor. Assets in this group will be designated as additional The main idea of the study is as follows. Using the method of analysis of hierarchies, on the basis of expert opinions, a system of vectors of priorities of intangible assets is built at characteristic moments in the development of a small enterprise. Further, according to the catastrophe equation, the surface of the state of the object under study is constructed. The point depicting the state of the firm moves over time on the surface of catastrophes. The trace of such a movement forms a continuous spatial trajectory - the line of life. The construction of the life line opens up the possibility of studying the nonlinear dynamics of the movement of the representing point. From the set of dynamic characteristics of a non-linear economic system, A. Marshall's point elasticity coefficients (Pindyck & Rubinfeld, 2001) were chosen as the variables that most closely correspond to the goals of our research.

Classification of intangible assets in the framework of the theory of catastrophes

In the modern economy, intangible assets play a decisive role in the functioning of enterprises. This fact is reflected in the widely used balanced scorecard (BSC), the main objective of which is to ensure the superiority of the enterprise among competitors in such an intangible asset as human capital (Gang & Apichanangkul, 2013; Teichgräber et al., 2021). It should be noted that in a knowledge-based business, intangible assets make up the bulk of a company's market value (Salojàrvi, 2004; Salojärvi et al., 2005).

The value of intangible assets lies in the fact that they contribute to high income. The hierarchical structure of enterprise management has a great influence on the functioning of intangible assets. The article considers the most general version of the task, when managers and top managers are removed from the direct production cycle, and their competence includes only control and management.

The formation of an enterprise is always accompanied by the emergence and formation of certain intangible assets and the structure of relations between them. From the point of view of synergetics, these are the main or basic intangible assets. They form the framework of the future structure of intangible assets, and the quality and dynamics of interactions between them largely determine the success of the enterprise. Therefore, it is logical to call the main assets also underlying assets. Then, as the enterprise develops, additional assets are built into this structure, strengthening and supporting the main (basic) assets due to their new connections. Chronologically, the main intangible assets arise before additional assets. The chronological approach also allows classification of additional assets. Those assets that came later are likely to be of lesser value and have less of an impact on income.

The composition of the main intangible assets has the property of invariance with respect to different enterprises. The independence of the content of the main intangible assets from the type of enterprise further confirms their fundamental role in the development of the enterprise. Additional intangible assets do not have the property of invariance. Any enterprise has an individual set of additional intangible assets with its own classification.

For a more precise definition of which assets are core and which are complementary, we present the classification (Table 1) proposed by Reilly and Schweihs (1999). Complementing the asset list with research results (Belo et al., 2014; Boennen & Glaum, 2014; Carlucci & Schiuma, 2007; Corrado et al., 2005, 2006; Curado et al., 2011; F-Jardon & Gonzalez-Loureiro, 2013; Liao, 2013; Orens, 2009; Pantzalis & Park, 2009; Ujwary-Gil, 2015), in which intangible assets (third column) are classified into economic categories such as human resources (HR), structural capital (SC), market capital. (MC), information capital (IC) and organizational capital (OC), computerized information (CI), innovative property (IP), economic competencies (EC).

In the third column of Table. 1 it is shown that many intangible assets have signs of different business components (capitals) due to the diversity of their properties and functions. This approach helps to understand the complex and intricate relationships between intangible assets. It becomes obvious that, having simultaneously all the "colors" and "shades" of different capitals, intangible assets interact with each other both within each component of the business, and within the entire set of intangible assets of the enterprise.

The main and most important intangible asset, without a doubt, is human capital (Economic Report of the US President., 2001) or, in other words, human resources (HR). This indicates that even preliminary work on organizing an enterprise is impossible without human resources. During this period of time, other types of intangible assets are either absent or in their infancy.

Among the main intangible assets that make up human resources (human capital), from our point of view, the following strategically important factors can be distinguished:

1. Professional skills of the leader (personal know-how of the leader; effective management; the ability to select the right employees), which includes the human and business qualities of the leader who receives the approval and support of the team when pursuing his policy.

2. Professionalism of employees with individual knowledge and skills (know-how). The availability of prospects for professional and career growth. Regular investments of the owners of the enterprise in education, health, safety and in an environment that ensures the effective work of employees.

3. A favorable psychological climate in the company, created by the absence of conflicts of interest among employees and the satisfaction of people with their wages, which, in turn, is ensured by effective management, labor contracts and agreements with trade unions or with leaders of the workforce of the enterprise.

However, the availability of human resources is only a necessary condition for obtaining high incomes, but not a sufficient condition for the normal functioning of such complex open systems as an enterprise or a company. A sufficient condition for this is the presence of additional intangible assets.

The structure of relations between intangible assets is formed in such a way that the system can more quickly and adequately respond to changes in the external environment, while maintaining itself as a single living organism. Assistance to personnel in making operational decisions is assigned to the main intangible assets. At the same time, a change in external circumstances, for example, the intensity of external information noise, can cause a change in the fluctuations of the main intangible assets. Under certain conditions, these short-term fluctuations of the main intangible assets can turn into long-term fluctuations of large amplitude and then become parameters that determine the functioning of the entire system (order parameters). As for additional intangible assets, their transfer to order parameters is fundamentally impossible. By their nature, they form an infrastructure that connects the central basic intangible assets with the external environment. Additional intangible assets adapt the response of the enterprise to the control signals of the external environment. Figuratively speaking, if we consider an enterprise as a living organism, then the main intangible assets are its brain, and additional intangible assets are its body, which is responsible for the proper functioning of the brain.

If the relationship between intangible assets is flexible and strong, then the structure of additional intangible assets is able to absorb adverse external influences, preserving the main intangible assets from destruction. This is typical for enterprises whose structural capital is built in such a way that many powers of the upper hierarchical management structure are transferred to lower levels of execution. Simple issues that arise in production practice are resolved directly by the performers and do not require the intervention of top management. Due to this, the number of functional degrees of freedom of the enterprise increases.

Priority vector calculation

As a universal object of study, a dental clinic was chosen, organized in 2008, which fully meets the definition of a small business. Currently, the clinic continues its successful activities. The expert opinion is based on a joint discussion between the General Director (work experience as a doctor in dentistry - more than 41 years; experience as a top manager of various dental clinics - more than 25 years) and the commercial director of the clinic (Bachelor of Economics, Master of Financial Management, work experience as a commercial director - more than 17 years).

At the end of 2012, the clinic began to experience some difficulties in its work, which were caused by negative phenomena in the dynamics of interactions of intangible assets. With the skillful actions of the clinic management, the current crisis situation was successfully overcome. At the time of the study (March, 2016), the clinic was in the stage of stable profit.

The experts were asked to build 6 pairwise comparison matrices of intangible assets. These matrices reflect 6 states of the enterprise at the most important moments of its life, which include: the beginning of labor activity, the first successes, the achievement of zero profit, the crisis, the rehabilitation after the crisis and the achievement of a stable positive profit. To build the matrix, the most significant intangible assets for the clinic were selected from Table 1 (marked in bold). The number of assets is 9. This is the maximum allowed (Saaty 1980). Intangible assets for the convenience of calculations are located by experts in accordance with the growth of influence on the income of the clinic (Table 2).

The application of the Analytic Hierarchy Process (AHP) method, as developed by Saaty (1980), yields the following values for the priority vector *b*:

$$b = (0.0220;\ 0.0440;\ 0.0822;\ 0.0932;\ 0.1293;\ 0.1372;\ 0.1527;\ 0.1671;\ 0.1724)^{T}.$$

Criteria for the significance of an intangible asset help to sort assets into basic and additional. One of the criteria of significance is the time of origin of the asset. Underlying assets appear first in time. Another criterion is the fact that

the enterprise cannot exist without the underlying asset. Additional assets arise later than the main ones. The absence of an additional asset slows down and impairs the operation of the enterprise, but it continues to function. Therefore, customer relations (a6), effective management (a7), selected and trained workforce (a8), individual know-how (a9), constitute a group of core assets. All other assets such as: client lists (a1), system of the organization of the enterprise (a2), information systems (a3), instructions and methods of work (a4), promotion: marketing research, advertising, exhibitions (a5) form a group of additional assets. The impact on the firm's earnings is obviously determined by the total impact of all elements of the group. Therefore, the total impact of additional assets will be denoted by the symbol X, and the impact of all key assets will be denoted by the symbol Y. Namely:

$$X = w_1 a_1 + w_2 a_2 + w_3 a_3 + w_4 a_4 + w_5 a_5, \quad Y = w_6 a_6 + w_7 a_7 + w_8 a_8 + w_9 a_9$$

It is assumed that the significance of each asset corresponds to its nominal value, that is, the weight coefficients $w_j = 1$, $j = 1,..,9$.

In the given example, these quantities take on numerical values

$$X = 0.3907 \approx 0.39, \quad Y = 0.6093 \approx 0.61.$$

We found that the impact on profit of four key assets is more than 60%, and the impact of five additional assets does not exceed 40%.

The method of analysis of hierarchies according to the described scheme was also used to determine the priority vectors in the remaining five cases. The results of the empirical study formed the basis for the study of the dynamics of the development of the dental clinic.

Investigation of the company's development dynamics using the cusp-catastrophe model

Studying the dynamics of an enterprise's development with the involvement of the principles of synergy involves conducting research on a model in the form of an equilibrium surface of catastrophes. According to Tom's classification, economic objects are characterized by a catastrophe model in the form of a fold (Lorenz,1993).

The model is based on the cusp catastrophe equation, the canonical form of which is:

$$z^3 + zx + y = 0.$$

Discussion of obtained results

The state of the clinic at each moment of time is displayed on the surface of catastrophes in the form of a representing point. The trace from the movement of the representing point forms a line of life. The life line is highlighted in red (Figure 1) .

The numbers and circles on the life line indicate the serial numbers of the clinic states, and the positions of the depicting point at the corresponding points in time. The transverse (g*i*G*i*) and longitudinal (h*i*H*i*) lines are sections of the vertical planes of the state surface. The possible movement of the representative point along one section helps to represent the possible changes in the state of the clinic if only one asset is changed.

As can be seen from Figure1, the enterprise develops in such a way that the representing point bypasses the fold area (the area of the catastrophe). This means that a small enterprise with limited financial capabilities is trying to avoid catastrophic changes in the structure of intangible assets by redistributing investment flows from insignificant to more significant assets in advance. This way reduces the risks of business activity and maintains competitiveness.

Studies of dynamics using the coefficient of elasticity.

All events caused by changes in the conditions of the clinic unfold sequentially in time. Therefore, the study of the dynamics of changes in the state of the clinic is a necessary element of research when compiling a model of investment forecasts. We especially note that the activity of any enterprise provides for regular financial investments in human capital. For this, the conditions must be met $y(t) > 0,\ y'(t) \neq 0$. In the process of life of a small enterprise, only the dynamics and nature of the interactions of intangible assets change, while the structure of interactions and the actual intangible assets are completely preserved.

To determine the choice of dynamic variables, we take into account that the reaction of profit (factor *z*) to the dynamics of changes in the main intangible assets (factor *y)* is constantly present. According to A. Marshall (Pindyck & Rubinfeld, 2001), the degree of response of the factor z to minor changes in the factor y is determined by the point elasticity coefficient $E_y(z)$:

$$E_y\left(z(t)\right) = \lim_{\Delta t \to 0}\left(\frac{\Delta z(t)}{z(t)} \Big/ \frac{\Delta y(t)}{y(t)}\right) = \frac{z'(t)}{z(t)} \Big/ \frac{y'(t)}{y(t)}, \tag{1}$$

Where $\Delta t = \hat{t} - t$, $\hat{t}$ and t – are the given and current values of time, Δz – is the change in factor *z*, Δy – is the change in factor *y*.

There is a constant feedback between the factors *z* and *y*, which manifests itself in the fact that changes in *z* are taken into account by the managers and owners of a small enterprise when the value of subsequent investments in the factor *y* changes. Therefore, formula (1) can be supplemented with the relations

$$E_y\left(z(t)\right) \cdot E_z\left(y(t)\right) = 1 \tag{2}$$

and

$$\frac{E_y\left(z(t)\right) \cdot E_x\left(y(t)\right)}{E_x\left(z(t)\right)} = 1. \tag{3}$$

In terms of meaning, elasticity coefficients $E_x\left(y(t)\right), E_x\left(z(t)\right), E_y\left(z(t)\right)$ are dynamic parameters that quantitatively determine the response of the system to a change in one or another factor. To make the obtained results more clear, we rewrite formula (1) in the form:

$$E_y\left(z(t)\right) = \frac{z'(t)}{y'(t)} \Big/ \frac{z(t)}{y(t)}. \tag{4}$$

The elasticity coefficient $E_y(z)$ according to formula (3) determines the intensity (velocity) of profit change caused by the change in the intensity (velocity) of investment in intangible assets. At the same time, the intensity of changes in formula (4) falls on the unit of profit density *z*(*t*) received from the unit of financial investments in intangible assets

y(*t*). It can be seen from formulas (1) and (4) that the elasticity coefficient $E_y(z)$ at profit density values $z(t)/y(t)$ close to zero takes extremely large values under the condition $z'(t)/y'(t) \neq 0$, that is, with continued financial investments. If this situation becomes prolonged (the period is determined by financial statements: from a year or more), then this is an alarming sign that the existing relationship between intangible assets is beginning to slow down business development. Changes are required in the qualitative composition of existing intangible assets in order to improve their dynamics and the nature of interactions until the situation becomes critical.

Thus, in studies of the dynamics of the evolution of the economic system, the coefficients of elasticity acquire an additional meaning as indicators of the stability of the process of enterprise development. They show the reaction of profit to changes in the value of assets. This approach allows us to study in detail the dynamics of changes in the state of the clinic at every moment of time throughout the life path and to scientifically substantiate the volumes and directions of financial investments in the assets of the enterprise at any stage of the development of the enterprise.

The impact of the dynamics of underlying assets on the dynamics of earnings

On Figure 2 shows the elasticity curve $E_y\left(z(t)\right)$ of the change in profit $z(t)$ relative to the change in the main intangible assets $y(t)$. Vertical dashed lines mark the time points of the clinical state measurement. The numbers next to them indicate the serial number of the clinic's condition.

The graph on the initial section $t \in [t_1, t_2]$ from the value $E_y(z(0))=0$ very slowly decreases to the value $E_y(z(2))= -3.1435 \cdot 10^{-1}$ (see Table 3). This means that an increase in the instantaneous rate (intensity) of investment in the factor *y* by 1% leads to a loss of profit with an intensity of -0.31435% attributable to the amount of profit $z(t)$ received from a unit of financial investment in the main intangible assets $y(t)$.

The curve in Figure 2 reflects the dynamics of changes in the profit of a particular dental clinic. According to experts, the loss of profit is associated with financial investments in the education of the leading doctors of the clinic. Raising the professional level of doctors excluded the combination with work. These necessary actions caused a decrease in patient flow, followed by a decrease in profits.

The applying of elasticity coefficients made it possible to detect a singularity in the region of zero profit on the equilibrium surface of catastrophes. The peculiarity lies in the fact that the instability of internal processes that affect the change in profit is significantly increased here. In this area, income from intangible assets changes smoothly without bursts and dips. The very structure of interactions of intangible assets remains unchanged over time. Only the dynamics of these interactions changes, whether manifests itself in the fact that the first derivatives of income on basic and additional intangible assets change their values abruptly. If we draw a distant analogy with a similar phenomenon in condensed matter physics (Feynman et al., 2011), then the observed phenomenon can be compared with a second-order phase transition that exists in thermodynamics. Such a comparison is very arbitrary, since in condensed media the second derivatives experience a jump in values, and in our case, the first derivatives of the initial values.

It should be noted that the phenomenon of phase transition is observed in the area of slow growth in numerical values of profit. This does not constitute stagnation in the conventional sense, but rather a slower rate of development for the enterprise relative to the average values of key indicators. In the case under consideration, such an area falls on the period when the enterprise reaches zero profit. Taking into account life cycles in the development of an enterprise (Gupta et al., 2013), it can be assumed that the phenomenon of phase transition has a certain periodicity, determined by the periods of life cycles.

Let's consider the emerging situation in more detail. The life line (Figure 1) at this moment (t_3 = 4 years) smoothly overcomes the value of zero profit. At the same time, in this case (as shown in Figure 2), the elasticity coefficient Ey(z(t)) experiences a sudden change (a jump), shifting from negative to positive infinity

It follows from formula (1) that infinity in the values of the elasticity coefficient Ey(z(t)) arises due to division by $z(4) \approx 0$. This circumstance makes the profit especially sensitive to the smallest changes in the asset y. Arises an absolute elasticity of profit relative to the totality of main assets. And, for values of time $t \to 4-0$, investing in main assets can lead to absolute damages $z \to -\infty$, and for time of values $t \to 4+0$, it leads to directly opposite results $z \to \infty$. What in its entirety means the extreme instability dynamics of the development of the clinic. If formula (2) is taken into account, then the magnitude $E_y(z) = \pm\infty$ can be put in correspondence with the numerical value $E_z(y) = 0$. And this means that a change in the factor *z* does not cause a change in the factor *y*, which corresponds to the disappearance of the feedback.

The appearance of such information is a signal to business owners that they need to be more circumspection when moving along this area of the life line. During this period, enterprise managers need a careful analysis of the connections between intangible assets and timely identification of hidden problems.

In the interval $t \in [t_4, t_5]$ the profit grows steadily. The elasticity coefficient $E_y(z(t))$ takes the form of a bell with its apex at a point at the point $t_{max} \approx 6.2$ years with a maximum $E_y(z)\big|_{t_{max}} \approx 8$. At other points of this interval, the response of the system is less than the maximum and becomes even less with the development of the clinic.

Thus, the graph helps to understand and warn the situation in which enterprises sometimes find themselves, when financial investments in basic assets do not bring the expected increase in the velocity of change of profit, since the enterprise has already entered the band of stability of dynamic processes and small values of profit elasticity. Let's go back to the time t_4 when the representative point passes the neighborhood of the beginning of the assembly. This moment of overcoming the crisis phenomena by the clinic falls on the inflection point of the curve of the elasticity coefficient $E_y(z(t))$ and outwardly does not manifest itself in any way in the form of bursts characterizing the instability of the process. That is, the reaction of profit to changes in the velocity of investment flow into main assets is a sustainable process. This indicates a strengthening of ties and a partial ossification of the structure of the main intangible assets. But since $E_y(z(t)) > 1$, the connections and structure still retain some flexibility.

Thus, the study of the dynamics of changes in profit from changes in additional intangible assets clarifies and makes the forecast of investment results more reliable.

Influence of the dynamics of additional assets on the dynamics of profit

Figure 3 shows the reaction of profit to relative changes in additional assets in the form of a graph of the coefficient of elasticity $E_x(z(t))$. In the interval $t \in [t_2, t_3]$ the values $E_x(z(t)) = -\infty$. This behavior of the $E_x(z(t))$ coefficient curve is explained by the fact that the representative point in Figure 1 at this time moves along the life line strictly according to the coincident sections (h2 H2), (h3 H3), parallel to the coordinate axis y. Sources in the vicinity of the life line Therefore, investing in additional assets does not change profit (Figure1). Moreover, they are unprofitable (Figure3), since the invested funds are not purchased. Therefore, investments in additional assets during this period of time are undesirable.

Historically, the initial signs of dynamic instability in the clinic's intangible asset structure emerged at t = t3, manifesting as a conflict of interest between one of the clinic's employees and the team's interests.

The clinic's management took measures to change the qualitative composition of the existing intangible assets and strengthen the links between them. The volume of investments in main assets increased slightly, while in additional assets it decreased significantly. In Figure 1, such a solution led to a displacement of the representative point towards the top of the catastrophic fold. During this period, the profit dynamics is characterized by elasticity coefficients $E_x(z(t)) \to 0$ and $E_y(z(t)) > 1$.

However, the measures taken were not enough. During the entire period $t \in [t_3, t_4]$, the crisis phenomena gradually accumulated. The clinic's management tried to change the situation in a positive direction by redistributing investment flows into intangible assets. But such actions did not remove the accumulated internal contradictions. Therefore, it was decided to change the structure of interactions of intangible assets. This decision falls at the time t_4 = 5.7 years. At this moment, when the representative point is near the beginning of the assembly, a surge is observed on the curve of the coefficient $E_x(z(t))$. And this is a sign of the instability of the dynamic process.

Investing in main assets made it possible to effectively remove the crisis phenomena and get out of the state of dynamic instability. An attempt to invest additional assets, as an alternative solution to overcome the crisis, would lead to a shift of the representative point along the section line (g4, G4) towards an increase in the size of the fold (from g4 to G4) and to an aggravation of crisis phenomena. The way out of the crisis situation in this case would become more difficult and painful.

For values t > t_4, a period of gradual stabilization of the dynamics of the structure of intangible assets comes. At this time, on the one hand, the reaction of profit to changes in additional assets is completely absent and, on the other hand, the reaction of profit to the dynamics of the main assets is significantly reduced. There is an increase in elasticity while strengthening the links between all intangible assets. This state of affairs indicates that the clinic has entered a period of mature development.

Cross elasticity

Figure 4 shows a plot of the cross-elasticity coefficient $E_x(y(t))$. The semantic value of the coefficient $E_x(y(t))$ is determined by formula (3). We represent the formula (3) in the form:

$$E_x\left(y(t)\right) = \frac{E_x\left(z(t)\right)}{E_y\left(z(t)\right)}. \tag{5}$$

It becomes obvious that the cross-elasticity coefficient (5) is an indicative assessment of how much the system (profit, factor z) is more or less sensitive to factor x compared to frequency y.

In the interval $t \in [t_1, t_2]$ reaction of z, to changes in x are more pronounced than in y. On the segment $t \in [t_2, t_3]$ the curve does not exist, which means its behavior is indefinite. Starting from $t \geq t_3$, the graph of $E_x(y(t))$ is very similar to the graph of $E_x(z(t))$. The reaction of profit to changes in additional assets compared to the dynamics of the main intangible assets is practically absent. Obviously, for investment planning problems, the graph of the cross-correlation coefficients is less informative compared the graphs of the coefficients $E_x(z(t))$ and $E_y(z(t))$. However, in case emergency of uncertainty in profit dynamics, the cross-correlation coefficient $E_x(y(t))$, as a source of additional information, can help in making the right decision.

The diagrams represented do not allow a comparative analysis between the share ratios of intangible assets and the numerical values of the elasticity coefficients. For such a study, Table 3 presents the numerical values of the elasticity coefficients at six points with the initial data. The three right columns show the numerical values of the elasticity coefficients $E_\alpha(\beta)$, where $\alpha, \beta = \{x, y, z\}$.

Let's consider the most important moments of the clinic's life: t_1 (birth), t_3 (reaching zero profit) and t_4 (exiting the crisis).

Origin of the enterprise (t_1=0 years).

The method of analysis of hierarchies based on expert recommendations indicates that the impact on profit of additional assets is 100% and is absent from the main assets. At the moment of the clinic's establishment, $E_y(z)\big|_{t_1=0} = 0$. Consequently, the change of profit *z* relative to the main assets *y* is absolutely inelastic. Therefore, the volume of investments in basic assets at the time of inception and at the initial stage does not affect the change in the magnitude of profit.

The coefficient of elasticity of profit dynamics relatively to additional assets equals $E_x(z) = -4.8878 \cdot 10^{-3}$. This is consistent with the results of the analytic hierarchy process (AHP) (Saaty, 1980).

The value of the coefficient of cross-elasticity $E_x(y) = \infty$ shows the absolute elasticity of the factor *y* relative to the factor *x*. The expression $E_x(y) = \infty$ is equivalent to the relation $E_y(x) = 0$. Therefore, the changes in the factor *x* for the factor *y* are insignificant.

Therefore, investment in additional and basic assets should be minimal, but sufficient for the normal operation of the firm.

Reaching zero profit (t_3= 4 years).

According to the method of analysis of hierarchies based on expert recommendations, the impact on profit of additional and basic assets is 39% and 61%, respectively. The reaction of profit to dynamic changes in assets (Table 3) is such that the elasticity coefficients take on infinite values $E_x(z) = -\infty$, $E_y(z) = \infty$. That is, the change in profit *z* with respect to additional *x* and basic basic assets y is absolutly elastic. Infinity symbols speak of uncontrollability and instability of dynamic processes. In such a situation, any most insignificant random change (fluctuation) in the structure of internal relations under certain conditions of the external business environment can intensify and gain a foothold. If such changes are caused by the degradation of links between assets, then gradual accumulation will eventually lead to a crisis.

The value of the cross-correlation coefficient $E_x(y)\big|_{t_3=4} = -4.1190 \cdot 10^2$ means that a change in factor x by 1% or a change in factor *y* by -41.19% cause the same reaction of factor *z*.

The calculations presented in the article indicate a higher sensitivity of elasticity coefficients compared to the AHP method to changes in the structure of intangible assets links. So, the considered period of enterprise development, the results of the AHP do not reflect the emergence of uncertainty and instability in the development of the company, while the elasticity coefficients directly indicate this. If we take into account the value of the cross-correlation coefficient, then in the position of dynamic uncertainty at that time it is preferable to invest in the core assets. Moreover, it is desirable to even reduce the amount of investment in additional assets. This conclusion confirms the correctness of the investment decision of the clinic management, which was reflected in the change in the direction of movement of the representing point on the surface of states towards the top of the fold of the surface of catastrophes.

Overcoming the crisis (t_4= 5.7 years).

At the moment t_4, the period of accumulation of minor disagreements in the structure of intangible assets connections ends, the totality of which is reborn into a new quality - a systemic crisis of the enterprise.

By this time, the share ratio of investments in additional and main assets in the vector of priority (AHP) was 16% and 84%, respectively. This made it easier to overcoming the crisis. Relatively little investment was needed to get out of the crisis.

An important role is played by the location of the representing point. Depending on the area of the catastrophic fold, in which the depicting point is located at the moment of crisis, the contradictions within the system may turn out to be deep and difficult to resolve, or, conversely, weakly expressed and easily removed. If the clinic had to overcome the crisis with a jump from the area of a clearly defined fold, then this would require a very significant amount. At the same time, any delay in this state leads to an aggravation of contradictions within the system, the growth of the problem and the complication of overcoming the crisis.

The value $E_y(z)\big|_{t_4=5.7} = 5.5360$ means that an increase in the value of fixed assets *y* by 1%, caused by investments, increases profit *z* by 5.5360%. The negative value $E_x(y)\big|_{t_4=5.7} = -1.0103 \cdot 10^1$ indicates that investing in additional assets *x* and changing the latter by 1% causes a drop in profit *z* by -55.932%. At the same time, the value $E_x(y)\big|_{t_4=5.7} = -1.0103 \cdot 10^1$, as follows from relation (3), means that the effect for the factor *z* from investing in *x* is equivalent to the negative effect from investing the factor y increased by -10.103 once.

That is, it makes sense to increase the investment of core assets and reduce the financing of additional assets that are unprofitable at the moment.

In reality, the management of the clinic decided to slightly increase the investment of additional assets and the same decrease in fixed assets. As can be seen from Figure 1, this decision is rather correct than erroneous. It was accepted by the head of the clinic intuitively, based on his many years of experience in managing a large dental clinic in a multidisciplinary medical association.

After 8 months (t_5= 6.5 years) the ratio between intangible assets (additional/main) was equal to 0.2/0.8. The position of the clinic and the dynamics affecting profits have stabilized.

Discussion of the results obtained

The study of the dynamics of development of small enterprises with limited financial capabilities involves obtaining the following results:

1. A classification of intangible assets into core and additional ones has been introduced, which greatly simplifies the solution of the problem of effective investment of intangible assets.

2. An empirical method for determining the control points of an enterprise is proposed. The method is based on the classical Saaty hierarchy analysis method.

3. A method has been found for constructing a mathematical model of the equilibrium surface of an acute catastrophe based on 6 empirical control points of the lesion focus of a small enterprise.

4. Evaluation of the general state of the company using the numerical values of the elasticity coefficients together with the coordinates of the position of the representing point on the model of the equilibrium surface of the catastrophe allows managers and owners of firms to build an optimal strategy for the development of the company by redirecting investment flows among intangible assets.

5. The study of company dynamics based on the theory of catastrophe does not take into account changes in the external socio-economic environment that have a significant impact on the state of the company. Therefore, the

construction of a disaster surface must be carried out regularly, since the appearance of the surface will change with new data and these changes reflect the degree of dependence of the company on external conditions. The smaller the changes, the more stable and competitive the enterprise is at the time of new research. The results obtained in the study can be figuratively represented as a description of the movement of a ship on a rough sea.

6. It is shown that with the approach to the crisis situation, the timely redistribution of investment flows between intangible assets makes it possible to change the direction and maintain the pace of enterprise development, leaving aside the cusp catastrophe area. At the same time, investments in human capital (underlying or main asset) increase by limiting or stopping investments in additional intangible assets. The company's budget is saved. Economic and financial risks are reduced.

7. In the conducted studies, A. Marshall's coefficients of elasticity (sensitivity) $E_y\left(z(t)\right)$, $E_x\left(z(t)\right)$ and $E_x\left(y(t)\right)$ were used as dynamic variables in the construction of investment forecasts. Elasticity coefficients act as indicators of the stability of the enterprise development process, showing the reaction of the rate of change in profit to the rate of change in the value of assets. The time dependence of the profit elasticity coefficient relative to changes in intangible assets reveals in detail the dynamics of the enterprise development and allows much earlier than the traditional method of analyzing hierarchies to determine the beginning of the destruction of the structure of intangible assets and the emergence of a state of dynamic instability in the state of small business.

The use of elasticity coefficients made it possible to detect a feature in the area of slow growth in numerical values of profit. Taking into account the life cycles in the development of an enterprise as an open system, it can be assumed that the phenomenon of phase transition has a certain periodicity, determined by the periods of life cycles. The peculiarity is that here the instability of internal processes affecting changes in profit increases significantly, despite the fact that income from intangible assets changes smoothly and continuously, without jumps and failures. Elasticity coefficients in the form of first derivatives from income for basic and additional intangible assets change their values in a jump. If we draw a distant analogy with a similar phenomenon in condensed matter physics (Feynman R.P. et al. 2011), then the observed phenomenon can be compared with a second-order phase transition that exists in thermodynamics. Such a comparison is very conditional, since in condensed matter the second derivatives experience a jump in values, and in our case, the first derivatives of the initial values.

The explanation for this phenomenon from our point of view is as follows. In the area of slow profit growth, which in this case falls on period of zero income, the structure and value of intangible assets change smoothly and continuously. Wherein, the amount of income does not outwardly experience sharp changes. Simultaneously, in the dynamics of interactions of intangible assets, there is (Figure 2 and Figure 3) a sharp response in the rate of change in income to the rate of change in intangible assets, which can be explained by a change in the nature of interactions between people as carriers of human capital.

8. It is shown that for reliable investment forecasts, knowledge about the values of elasticity coefficients is not enough. For example, at point A (Figure 1) with a value of $t_A \approx 4.2$ years, the elasticity coefficients are equal to $E_y(z(t_A)) \approx 15$ (Figure 2), $E_x(z(t_A)) \approx -50$ (Figure 3). However, if you are guided by these indicators and invest only in the main assets, then you can very quickly find yourself in that part of the assembly (point B in Figure 1) where the area of catastrophe is most clearly expressed, that is, in a state of severe crisis. On the other hand, knowing only the coordinates of the representative point on the surface of catastrophes, without taking into account the elasticity coefficients, is also not enough to make a reliable forecast of the results of investments. An example is the passage of the representative point of the position of zero profit. A smooth lifeline does not reflect the emergence and development of internal contradictions in the structure of assets, which, however, are clearly indicated by elasticity coefficients.

9. The reliability of forecasts of the results of investing in assets depends on the joint consideration at the time of the study of the location of the representative point on equilibrium the surface of catastrophes, the direction of the vector of the displacement this point, and the values of the elasticity coefficients

$E_y\left(z(t)\right), E_x\left(z(t)\right), E_x\left(y(t)\right)$. The direction of the displacement vector is set by the ratio of the sizes of investments in various assets.

Conclusion

The main problem of small enterprises is the efficient use of limited financial resources in order to obtain the maximum possible profit. This circumstance determines the relevance of research into the dynamics of enterprise development. One possible solution to this problem is the use of catastrophe theory.

The purpose of the presented work is to develop a simple and reliable method that helps managers of enterprises with limited financial capabilities find optimal investment solutions. In the study conducted, using a specific example, it is shown that for this it is necessary and sufficient to know the coordinates, the speed of movement of the depicted point on the equilibrium surface of the disaster and the elasticity coefficients of the profit obtained relatively of intangible assets.

To solve the problem, a mathematical model of changes in the state of the enterprise was built based on the theory of disasters. A method has been developed for constructing a disaster surface based on 6 empirical points by solving a system of six nonlinear equations. To reliably predict the results of investing intangible assets, it is proposed to use elasticity coefficients of changes in profit relative to the assets under study.

It has been established that elasticity coefficients are highly sensitive to the dynamics of changes in the interactions of intangible assets. The use of elasticity coefficients made it possible to discover, in the area of slow growth in numerical values of profit, a new phenomenon inherent in the development of small and medium-sized enterprises. The found phenomenon can be roughly compared with a second-order phase transition that exists in thermodynamics. Elasticity coefficients make it possible to identify at an early stage the emergence of dynamic instability in the development of small businesses and prevent the future destruction of the structure of intangible assets. It can be assumed that the phenomenon of phase transition has a certain periodicity, determined by the periods of life cycles characteristic of enterprises.

It is shown how timely redistribution of financial flows from additional to main intangible assets, begun at the first negative changes in the dynamics of interactions of intangible assets, eliminates the problem of a large-scale crisis in business development.

The developed methodology has versatility, which implies its use not only in small and medium-sized businesses, but also in making forecasts for the economic development of both individual regions and the country as a whole.

A brief biography of the author

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Table 1

Extended classification of intangible assets by Reilly and Schweihs (1999)

Components of the business (capitals) supported by intangible assets	Common namesof intangible asset sets	Components of the business (capitals), the signs of which intangible assets possess
Marketing	Trademarks	MC, EC
	Trade names	MC, EC
	Brands	MC, EC
	Logos	MC, EC
	Promotion: marketing research, advertising, exhibitions	MC, EC

Development and use of technology	Patents on products and processes	IP
	Patent applications	IP
	Technical documentation	IC
	Technical know-how	IC, IP
Creative activity	Literary works and copyright	HR, IP
	Musical works and copyright	HR, IP
	Publishing rights	IP
Data processing	Patented software computers	HR, IC, CI, IP
	Copyright of the software	HR, IP
	Automated database	SC, IC, CI
	Information systems	SC, IC
	Network and technology	IC, CI, SC
	Mascots and templates for integrated circuits	IP
Engineering activities	Experimental industrial designs	MC, IP
	Patents on products	IP
	Engineering drawings and diagrams	IC, IP
	Projects	IC, IP
	Branded documentation	SC, IC
Work with clients	Client lists	MC, IC, EC
	Contracts with clients	MC, OC, EC
	Customer relations	MC, OC, EC
	Presence of regular customers	MC, EC
	Resumed contracts with clients	MC, OC, EC
	Presence of insiders in the organizations-partners or among clients	MC, EC
	Open purchase orders	MC, EC
Signing and compliance with contracts	Profitable contracts with suppliers	MC, IP, EC
	License agreement	IP
	Franchise agreements	IP
	Agreement on nonparticipation in the competition	OC
Human capital, Human resources	Selected and trained workforce	HR, OC, EC, goodwill
	Effective management	HR, OC, EC, goodwill
	Employment agreements	IP, EC
	Agreements with trade unions	HR, OC, EC
	Intellectual property	IC, IP, EC
	Intellectual capital (individual know-how)	HR, EC, goodwill
Structural Capital	Information capital	IC
	IC rights	IP

	Instructions and methods of work	IC, EC
	System of the organization of the enterprise	EC
	Systematic knowledge	HR
Land plot	Rights to develop minerals	IP, SC
	Air rights	IP, SC
	Water space rights	IP, SC
Goodwill (business reputation)	Goodwill of the enterprise	HR, SC, MC, IC, OC
	Goodwill of professional practice	HR, SC, OC, EC
	Personal goodwill of a specialist (professional and spiritual qualities)	HR, SC, OC, EC
	Goodwill celebrities	HR, MC, EC
	Total value of the business as a going enterprise	HR, SC, MC, IC, OC

Table 2

An example of a pairwise comparison matrix of the hierarchy analysis method. The state of the clinic is characterized by a stable growth in profits. The clinic reached zero profit.

Intangible assets		a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9
a_1	Client lists	1	1/2	1/3	1/4	1/5	1/6	1/6	1/7	1/7
a_2	System of the organization of the enterprise	2	1	1/3	1/3	1/4	1/4	1/5	1/6	1/7
a_3	Information systems	3	3	1	1	1/2	1/4	1/5	1/5	1/6
a_4	Instructions and methods of work	4	3	1	1	1	1/3	1/4	1/5	1/6
a_5	Promotion: marketing research, advertising, exhibitions	5	4	2	1	1	1/2	1/3	1/5	1/6
a_6	Customer relations	6	4	4	3	2	1	1/2	1/3	1/4
a_7	Effective management	6	5	5	4	3	2	1	1/2	1/2
a_8	Selected and trained workforce	7	6	5	5	5	3	2	1	1
a_9	Individual know-how	7	7	6	6	6	4	2	1	1

Table 3

The Elasticity coefficients were calculated from the graphs of $E_x(y(t))$, $E_x(z(t))$ and $E_y(z(t))$ at points with empirical values of the parameters of clinical states.

Clinic state number	The age of the clinic t (years)	Share ratios of intangible assets from AHP, $X_i + Y_i = 1$		Elasticity		
		Additional, X_i	Basic, Y_i	$E_x(y)$	$E_x(z)$	$E_y(z)$
1	0	1	0	∞	$-4.8878 \cdot 10^{-3}$	0
2	2	0.68	0.32	$2.6082 \cdot 10^{3}$	$-8.1987 \cdot 10^{2}$	$-3.1435 \cdot 10^{-1}$
3	4	0.39	0.61	$-4.1190 \cdot 10^{2}$	$-\infty$	∞
4	5.7	0.16	0.84	$-1.0103 \cdot 10^{1}$	$-5.5932 \cdot 10^{1}$	5.5360
5	6.5	0.20	0.80	$2.3356 \cdot 10^{-1}$	1.0080	4.3160
6	8	0.24	0.76	$4.4533 \cdot 10^{-1}$	$4.9220 \cdot 10^{-1}$	1.1053

Figure 1

Condition surface and life line (red line) of a dental clinic.

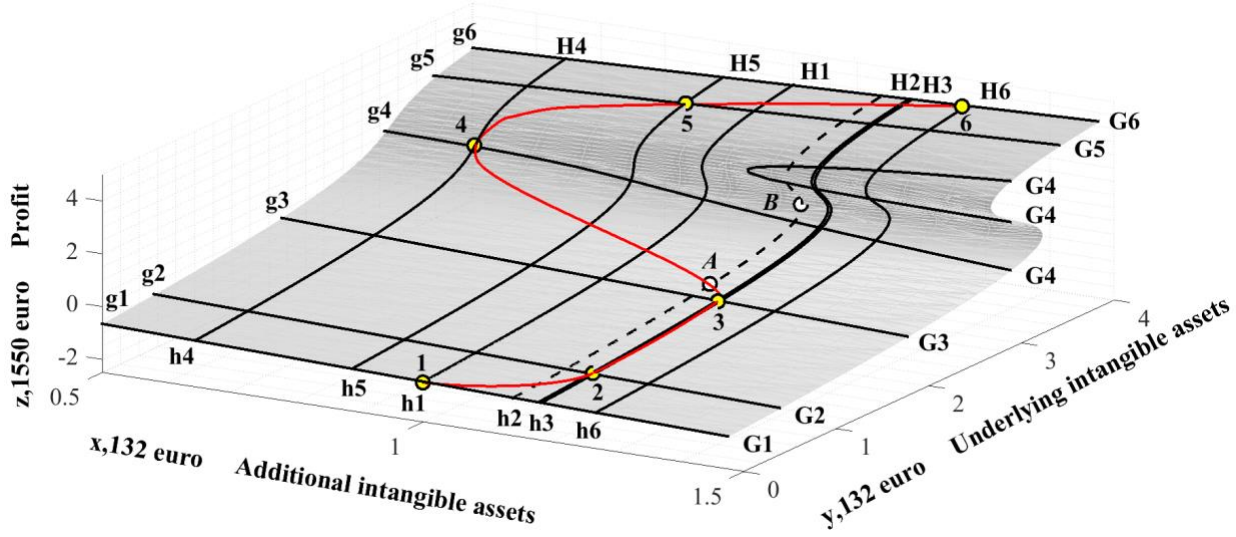


Figure 2

Reactions of profit z(t) to changes in the main intangible assets y(t).

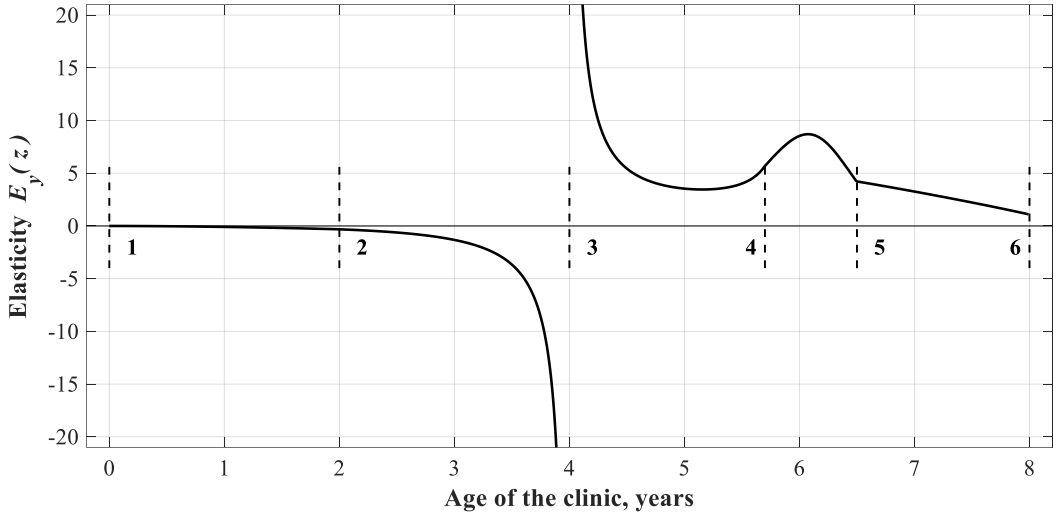


Figure 3

Response of profit z(t) to changes in additional intangible assets x(t).

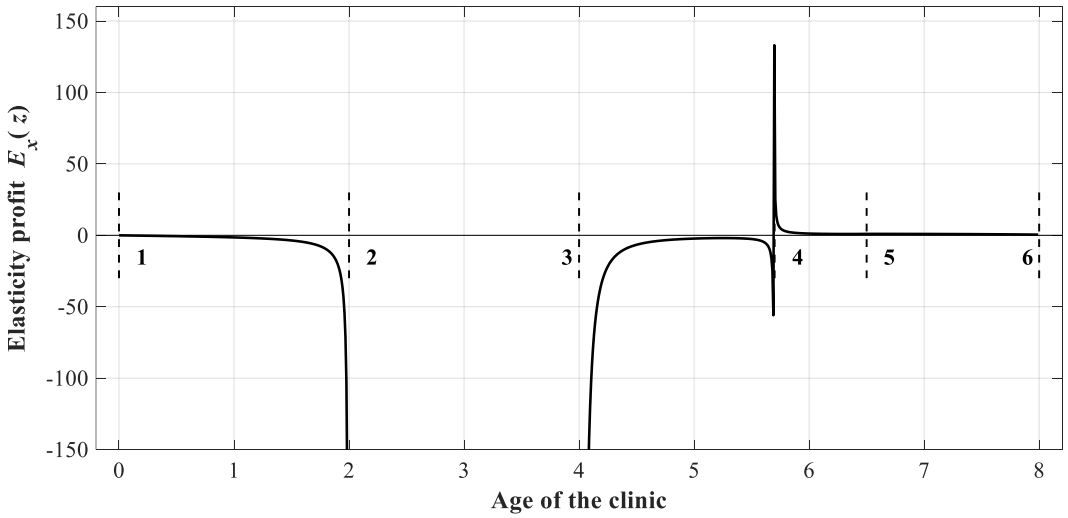
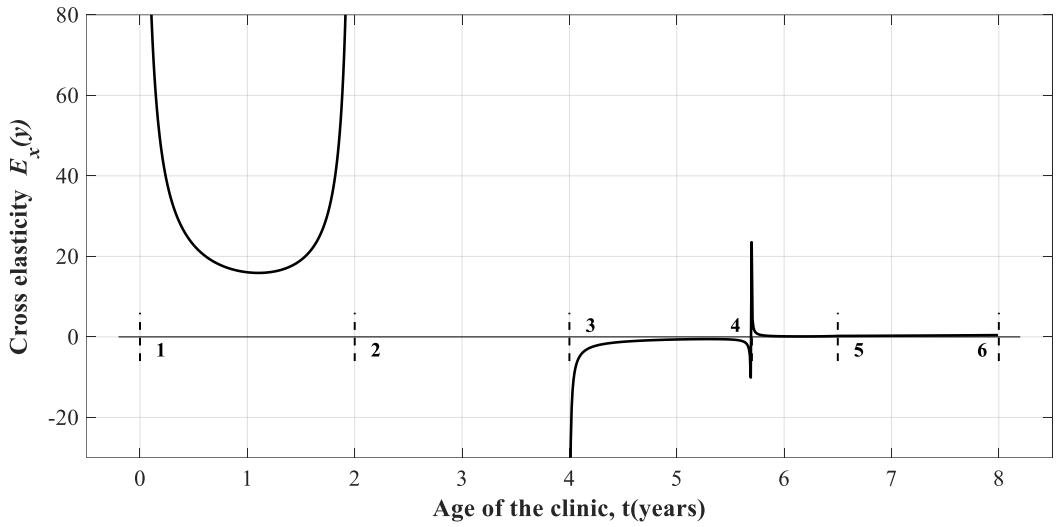


Figure 4

The reaction of the main intangible assets y(t) to the change in additional intangible assets x(t).



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Abstract

This paper explores the complex relationship between corruption and economic growth, investigating how certain key factors influence economic outcomes differently in the presence of corruption. The study focuses on economic openness, financial development, and exchange rate volatility as critical drivers of economic growth, which can also be attractive for corrupt activities. Using data from 194 countries spanning the years 2010-2019, the research employs dynamic panel data models; countries are grouped based on their level of corruption, utilizing the government integrity indicator from the Index of Economic Freedom. The study measures economic growth using the logarithm of real per capita GDP and considers control variables such as gross fixed capital formation, economic openness, government expenditure, financial development, and human capital. The findings highlight that the impact of these covariates on economic growth significantly varies depending on the level of corruption, shedding light on the nuanced interplay between corruption and economic development.

Keywords: corruption, economic growth, GMM models.

Introduction

Why some countries experience economic growth while others struggle to survive? Many factors have been pointed at, including the quality of the institutional framework. It is known that corruption can be perceived as a sign of institutional weakness that impacts the economic growth both directly and indirectly. Corruption deviates public resources to private accounts, usually in third countries, which reduces the already insufficient levels of public budget and represents an inefficient allocation of resources. But corruption can also compromise the ability of taking advantage of economics growth opportunities through excessive institutional controls under non-transparent conditions, limiting the access to credit or to foreign currency, or even denying access to international markets, all of which discourages domestic and foreign investment and promotes tax evasion.

This paper attempts to analyze how the effects of some relevant factors on the economic growth may change in the presence of corruption, particularly economic openness, financial development, and exchange rate volatility due to their important role in the economy and their special attractiveness for corruption activities. To do that, we use information from 194 countries observed over the period 2010-2019. As for the objective function, we estimate GMM dynamic panel data models using both the original GMM estimator (Arellano & Bond, 1991) and the System GMM (Blundell & Bond, 1998). The consistency of the estimators is proved based on first and second-order autocorrelation tests of the residuals, as well as the Hansen test of over-identification of restrictions. We consider logarithm of real per capita GDP as the dependent variable. As for the control variables, in addition to the exchange rate volatility, we consider gross fixed capital formation as a percent of GDP, the economic openness index, and government expenditure as a percent of GDP, all of the in logarithms, the financial development index, and a measure of the stock of human capital based on the average years of schooling a child can expect to reach given enrollment rates by age and life expectancy. As for the interaction between exchange rate volatility and financial development, the latter is categorized into three groups: high, medium and low developed financial systems based on the terciles of the distribution of the index. To evaluate how corruption affects the way some variables impact economic growth, countries are organized in two groups according to their level of corruption (high and low), based on the government integrity indicator of the Index of the Economic Freedom measured by the Heritage Foundation. Our results support the thesis the impact of the covariates on economic growth significantly vary according to the level of corruption.

Literature review

There is no clarity about the mechanisms through which corruption affects economic growth as well as the direction of its effect. Méon & Weill (2010), Li & Rengifo (2018), and Yapatake-Kosole & Ngaba (2020) highlight its benefits as a way to escape from legal and institutional rigidities and facilitate competition by offering lower prices and flexible environmental laws. However, the general perception is that corruption discourages investments and reduces productivity (Nguyen et al., 2014; Zakharov, 2019). Even though generalized, fiscal deficits and public debt are

common among high-corruption countries since their governments are likely to manage both fiscal and monetary policies in a discretional way and resort to devaluations to cover fiscal deficits. For example, monetary policy is used to finance the public budget, especially in the absence of independence of central banks (Acemoglu et al., 2008; Hefeker, 2010), leading to currency exchange crises. Corruption also promotes an excessive risk-taking environment for all economic actors, difficult an effective surveillance of factors triggering these crises and the implementation of mechanisms to alleviate them, and even influences the exchange rate policies (Haj et al., 2018). A long-lasting controlled and a highly corrupted exchange rate system can lead to a black market for dollars (Kulesza, 2017; Sáez et al., 2018), exacerbating the levels of exchange rate and price volatility (Castillo & Ramoni-Perazzi, 2017) and compromise the ability of an economy to react to financial shocks (Obstfeld et al., 2017).

Corruption associates with over-borrowing behavior which may affect the structural composition of capital inflows and lead to currency instability (Wei & Wu, 2002), and influence borrowing costs (Spyromitros, 2020). According to Sundararajan & Balifio (1991), the macroeconomic instability and the financial and currency exchange rate crises generally associated with corruption might feedback the regulatory framework, the central bank operating procedures, and the portfolio quality in the financial system to ensure the effectiveness of adjustment policies. This makes the level of financial development and its interaction with the exchange rate volatility a key combination to consider (Aghion et al., 2009). In other words, economic actors in countries with low levels of governance, may have learned to deal with this frequent instability and smooth its impact, probably with the guidance and support of international institutions and are likely to account for the costs of corruption in their investment decisions, especially in the presence of a weak or controlled financial sector (Ramoni-Perazzi & Romero, 2022).

Methodology

We consider the information provided by the World Bank's Economic Development Indicators for a set of N=194 countries annually during the period 2010-2019. Based on the government integrity indicator (intg) of the Index of Economic Freedom by the Heritage Foundation, countries were classified as having low (intg > 50) or high (intg <50) corruption governments.

To estimate how corruption changes the effect of the most frequent covariates on economic growth we estimate a GMM dynamic panel data model such as

$$lgdp_{it} = \alpha + \beta\, lgdp_{it-1} + \delta\, x_{it} + \mu_i + \lambda_t + \nu_{it}, \qquad (1)$$

with *lgdp* as the logarithm of per capita GDP real for country *i* in period *t* and *t-1* to account for the persistence of economic growth; x_{it} is a set of common control variables that includes the logarithm of gross fixed capital formation as a percent of GDP (*gfcf*), exchange rate volatility (*vol*), logarithm of the economic openness index (*leoi*), logarithm of government expenditure as a percent of GDP (*lgexp*), expected average years of schooling (*edu*), and financial development index (*fdi*); μ_i and λ_t represent country and time-specific effects, and ν_{it} is the idiosyncratic error term. We consider the original GMM estimator developed by Arellano & Bond (1991), as well as the System GMM developed by Blundell & Bond (1998). To prove the consistency of the estimators, the results of the first and second-order autocorrelation tests of the residuals are included, as well as the Hansen test of over-identification of restrictions. For the sake of robustness, we compare the results of different settings of the objective function (1).

Results

Considering an expanded period, our results show that the level of per capita real GDP significantly differ between the two groups with relatively faster growth and homogeneity among low-corruption countries (see Figure 1)

The positive effect the financial system on the economic growth also varies between the two groups, being higher in low-corruption countries. If fact, there are significant differences in the levels of development of the financial system (0.19 for high-corruption countries and 0.50 for the other group).

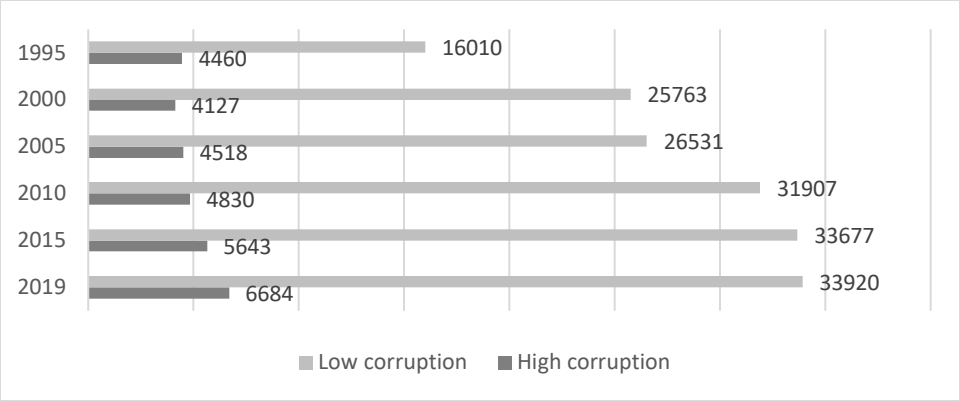

Figure 1. Average per capita real GDP by groups

Government expenditure proved to negatively impact the economic growth (predominance of the investment displacement effect), especially in low-corruption countries. The effect of educations remains positive and significant, relatively higher in low-corruption countries, indicative of the efficiency of their education system. Economic openness, less dynamic in high-corruption countries, relatively contributes more to the economic growth in this group. Finally, investment has a positive significant effect on economic growth, regardless of the level of corruption. Regardless of the model specification, group, and type of estimator obtained, the coefficients associated with the lagged dependent variable are statistically significant, which corroborates the persistence and justifies the decision to fit a dynamic model. The results are robust since they are observed in both types of estimators and under different specifications of the model (see Table 1).

Table 1. Estimates of the dynamic panel data models

	High corruption (1)				Low corruption (2)			
Variables	**1.1**	**1.2**	**1.3**	**1.4**	**2.1**	**2.2**	**2.3**	**2.4**
lgdp(-1)								
System GMM	0.961*	0.943*	0.947*	0.977*	0.966*	0.968*	0.982*	1.082*
Difference GMM	0.609*	0.650*	0.657*	0.883*	0.864*	0.848*	0.843*	0.815*
vol								
System GMM	-0.001**	-0.067*	-0.067*	-0.045**	-0.155*	-0.042**	-0.075*	-0.531*
Difference GMM	-0.111*	-0.071*	-0.068*	-0.065*	-2.330*	-0.318*	-0.859*	-2.006**
fdi								
System GMM		0.198*	0.184*	0.095*		0.012**	0.010**	0.171*
Difference GMM		0.109*	0.067*	0.046		0.006	0.008**	0.019

vol* mid fdi							
System GMM			-0.059***				-1.926*
Difference GMM		-0.034***				-0.065*	-0.001
		-0.198*	-0.200**			-0.887*	
vol * high fdi							
System GMM			-0.246				-1.056
Difference GMM		-1.005*	-0.019			-0.397	-0.271
		-0.653*				-1.497*	
lgfcf							
System GMM			0.070*				0.029*
Difference GMM			0.072*				0.054*
leoi							
System GMM			0.011*				0.010
Difference GMM			0.0254**				0.024*
lgexp							
System GMM			-0.038*				-0.090**
Difference GMM			-0.031*				-0.070*
edu							
System GMM			0.003*				0.002***
Difference GMM			0.009*				0.005**
AR(1) p-value							
System GMM			0.016		0.040		0.009
Difference GMM	0.022	0.024	0.023	0.034	0.026	0.050	0.036	0.011
	0.025	0.027	0.025		0.047		0.042	

AR(2) p-value								
System GMM				0.104		0.519		0.154
Difference GMM	0.875	0.656	0.657	0.171	0.424	0.329	0.573	0.152
	0.792	0.592	0.597		0.958		0.755	
Hansen p-value								
System GMM				0.916		1.000		1.000
Difference GMM	0.909	1.000	1.000	1.000	0.941	0.986	0.996	1.000
	0.994	0.974	0.440		0.936		1.000	
Countries	125	120	120	114	74	73	73	67

Note: The coefficients and robust standard errors were estimated using two-step GMM, including dichotomous variables for years. High *fdi indicates fdi* values in the last tercile of its distribution; mid *fdi* indicates values in the second tercile of its distribution, leaving the first tercile (low *fdi*) as the comparison group. In all cases, we reject the null hypothesis that all panels contain unit roots, according to a Fisher-type unit root test based on the ADF. Statistically significant at 1% (*), 5 % (**), and 10% (***). P-values for first and second-order correlation test for the residuals; p-value for Hansen over-identification test.

Conclusions

This paper analyzes how the effect of some common covariates on economic growth varies according the level of corruption of the government using a sample of 194 countries annually observed during the period 2010-2019.

A striking divergence is observed in real per capita GDP between low-corruption and high-corruption countries. In the 2010s, the average per capita GDP in low-corruption countries stood at $28,800, a figure approximately eight times higher than the $3,271 observed in high-corruption countries. Moreover, the low-corruption group exhibited relatively faster economic growth and greater economic homogeneity.

Exchange rate volatility consistently shows a statistically significant negative effect on economic growth. This negative impact is especially pronounced in low-corruption countries. This result is somewhat unexpected and suggests that low-corruption countries may not have as much experience in dealing with exchange rate volatility, unlike high-corruption countries that have learned to anticipate and protect themselves. It is suggested that the negative effect of exchange rate volatility diminishes in highly developed financial systems, particularly in low-corruption countries. Aghion et al. (2009) suggest that a more developed financial system can help economies mitigate the negative impact of exchange rate volatility. This is particularly true in low-corruption countries, where the financial system is better equipped to protect against such fluctuations. There are significant differences in financial development between high and low-corruption countries. A well-developed financial system is associated with lower corruption levels and can help control corruption.

The impact of education on economic growth is positive and appears to grow with the degree of government integrity. In low-corruption countries, education has a relatively higher positive effect on economic growth, indicating the efficiency of the education system in these countries. Government expenditure appears to have a negative effect on economic growth, particularly in low-corruption economies. This might be due to the diversion of resources caused by corruption, which weakens the overall impact of public spending on the economy.

Economic openness has a marginally significant effect on economic growth in high-corruption countries, but there are no conclusive results for other groups. This suggests that economic openness may contribute more to growth in

countries with higher corruption levels. Investments have a positive and significant effect on economic growth across all groups, regardless of corruption levels. This suggests that promoting investment can be a key driver of economic growth.

All in all, the results indicate that the impact of covariates on economic growth can vary depending on the level of corruption. Exchange rate volatility has a stronger negative effect on economic growth in low-corruption countries, while a well-developed financial system can help mitigate this impact. Other factors like education and investments consistently contribute positively to economic growth, with variations depending on corruption levels. These findings underscore the complex interplay between corruption, financial development, and economic growth. These results emphasize the importance of transparency in the administration of public resources and the role of the financial system in facilitating proper financial management.

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The Role of Adopting Block Chain Technology in the Performance Of Supply Chains

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Abstract
This study aimed to identify the role played by the adoption of block chain technology in the performance of the supply chain, and the researcher reviewed the previous literature related to this topic, as it was found from the results of previous studies that there is an important impact of adopting the technology of block chain in raising the performance of the supply chain.

Introduction

Today, the world is witnessing a fourth industrial revolution that brought about high-speed developments and transformations at the local and international levels. This revolution differs from its predecessors in three main dimensions: speed, breadth of scope, and the ability to radically change. One of the technologies produced by this revolution is Block chain technology. The so-called block chain, which is a digital technology that relies on recording data and information in a series of connected blocks in an encrypted and secure form.

Block chain technology has enjoyed global fame in recent years due to its enormous potential and diverse applications in several sectors, including the industrial sector, where industrial business organizations use block chain technology to improve their operations and increase their efficiency, thanks to the innovative solution provided by the block chain technology. This technology relies on a temporal sequence of data and information in a set of securely connected blocks, providing solutions to key challenges faced by industrial business organizations, such as traceability, transparency, and transaction verification (Queiroz et al., 2020).

On the other hand, the performance of supply chains is one of the most important processes necessary to achieve the objectives of business organizations in maximizing the value of assets, as good management of supply chains would reduce costs from the activities of organizations and increase their profitability, which leads to an increase in the efficiency of those organizations. Supply is an integrated network of operations and relationships between the elements of production and sale. Therefore, interest in managing supply chains and searching for ways to improve their performance has become one of the main tasks of managing business organizations by providing the necessary information for planning supply chain management and providing the information needed by decision makers. (Shaarawy, 2021)

Supply chains, in their simplest form, are a network of relationships between customers and suppliers. Each party in the chain is linked to adding additional value to provide the customer with the final product or service. These relationships are based on performance and trust, with a focus on delivery time, cost, and quality, which means from a management perspective. supply chains that the characteristics of the product or service satisfy a set of customer requirements, and that they are suitable for the intended use of those customers. Saberi et al., 2019).

Recently, industrial organizations have begun to invest in block chain technology to improve the performance of supply chains and increase the efficiency of operations, as the use of blockchain in supply chain management allows the creation of an immutable time record of all transactions and product details along the supply chain, enhancing transparency and minimizing Risks of fraud and data manipulation, leading to improved trust between supply chain participants and improved overall performance. (Zhang et al., 2021)

In addition, block chain technology helps simplify supply chain operations and increase their flexibility in industrial organizations, by improving cooperation between suppliers, manufacturers and distributors through the secure and immediate exchange of data and information, as this facilitates the tracking of products through the various stages of the supply chain, which allows verification of Product quality and compliance with environmental and social standards, and as a result, block chain technology enables improved performance of supply chains and enhanced sustainability in industrial organizations. (Kamble et al., 2021)

The Importance of Studying

The topic of this study is one of the modern topics, which will contribute to enriching libraries with its subject as a reference for the benefit of researchers and those interested in the field of block chain technology and the performance of supply chains. To advance research on block chain technology and expand our understanding of its implications for supply chain management operations.

The results of this study may contribute to raising the interest of those in charge of business organizations in general towards the importance of blockchain technology and its role in the performance of supply chains and the results of its applications and successes, as well as improving the quality of decisions related to supply chain management by providing detailed knowledge on how to use block chain technology to increase efficiency and transparency In addition to helping researchers and decision-makers identify opportunities for improvement and innovation in the supply chain thanks to blockchain technology.

This study seeks to identify the impact of blockchain technology on the performance of supply chains by reviewing the references, sources and literature of the study related to the adoption of the blockchain and its role in the performance of supply chains, and summarizing its findings.

Study Problem

As business organizations, especially industrial ones, rely on complex supply chains that form various partnerships with many suppliers, in light of unpredictable markets, intense competition, and the changing needs of customers, in an effort to meet the needs of local and international customers, which necessitates an awareness of Managers using modern and advanced technologies that contribute to improving the level of performance of supply chains with the aim of achieving success for the entire supply, which leads to achieving the goals of those organizations to survive and continue, and among these technologies is the block chain technology, as indicated by the study of Meidute-Kavaliauskiene et al. (2021) indicated that the use of blockchain technology led to an improvement in the level of performance of the supply chain, as indicated by the results of the study of Ayan et al. (2022) indicates that the use of blockchain technology has led to the sustainability of supply chains and improved their level of performance.

From the foregoing, the problem of the study emerges through the main question: What role does the adoption of blockchain technology play on the performance of supply chains?

Study literature

Blockchain technology has attracted great attention as an innovative technology to change the future, as this technology has revolutionized the field of services, and it is considered among the most powerful new technologies in the future, according to United Nations reports (Sandner et al., 2020).

Blockchain technology is one of the most powerful technologies that revolutionized the world of innovation within business organizations in the world. This foundational technology was created to upgrade the infrastructure of business organizations to include the quality of services and products provided, and thus improve the financial performance of these organizations (Ben Younes et al., 2021). .

The block chain technology is one of the latest innovations in computer science that has a global scope, as the block chain technology appeared at its inception in the year (2008) with bitcoin or encrypted currency (digital currency), and the innovation of bitcoin was its ability to combine encryption and the public ledger. The sophisticated distributor that would keep track of how each bitcoin was spent (Sabr et al., 2022)Block chain technology is defined as: “a distributive technology used to record transactions between parties without the need for an intermediary. This technology consists of a group of blocks connected to each other, where information is stored in the form of encrypted operations within the blocks. This technology is safe and transparent It is not subject to manipulation, and it is used in many fields such as digital currencies, electronic voting, and supply chain management (Sultana et al., 2022).

On the other hand, the performance of the supply chain is one of the most important issues in various industries, where supply chain management plays a decisive role in achieving competitive advantage in the global business environment for companies, and companies are interested in supply chains because of their need for

technologies, methods and methods that enable them to achieve their goals, and become able to Competition locally and globally, so supply chains have become one of the important competitive capabilities of companies (Beullens&Ghiami, 2022).

Supply chains are defined as: "criteria that help measure the efficiency and effectiveness of basic supply chain operations, including (planning, manufacturing, transportation, distribution, sales and service), and the performance of supply chains is a key indicator of corporate success, as it measures the achievement of customer requirements and the balance between cost and effectiveness across all elements. supply chain, including suppliers, manufacturers, distributors, and consumers" (Chopra &Meindl, 2020).

Block chain technology, also known as block chain, is a technology based on the distribution of encrypted records of transactions and information over a network of connected devices. It is an innovative technology that is used in many applications and sectors such as finance, insurance, real estate, energy, health and supply chain. In the context of supply chain, it is believed that Blockchain has the potential to improve performance through centralization and enhanced transparency, traceability and efficiency (Kshetri, 2018).

Decentralization helps improve cooperation between companies, suppliers, and the different parties involved in the supply chain by sharing information and knowledge in a secure and efficient way. In addition, companies can develop joint solutions to improve performance and address challenges such as reducing cost, increasing efficiency and sustainability, and decentralization allows for increased supply chain flexibility by reducing its reliance on intermediaries, paper-based transactions, and information systems integration (Tian, 2016).

Decentralization as one of the dimensions of block chain technology can also improve the ability of the supply chain to adapt to sudden changes and challenges, such as fluctuations in demand, delays in shipping, or unexpected events such as natural disasters and economic crises. Therefore, decentralization provides greater flexibility for companies to manage risks and continuously improve the performance of the supply chain. (Sabri et al., 2019).

One of the most important advantages of blockchain technology in the supply chain is improved transparency (Abeyratne&Monfared, 2016). By providing a reliable and permanent record of transactions and information, companies can monitor and track goods and services over time and all over the world (Kamath, 2018).

This type of transparency increases the confidence of companies and consumers in the quality of products and services provided and improves compliance with local and international laws and regulations (Apte&Petrovsky, 2016).

Real-time data is one of the important dimensions of block chain technology that can contribute to improving the performance of the supply chain, as real-time data allows companies, suppliers and all parties involved in the supply chain to access immediate information and transactions, which increases efficiency, coordination and flexibility in Supply Chain Management (Kamath, 2018).

Real-time data provides current information about stock levels, demand, and shipment status, allowing companies to improve their planning and execution and ensure demand is met more effectively. Real-time data also allows all parties involved in the supply chain to exchange information instantly and reliably, which helps in enhancing coordination and cooperation between suppliers and companies. and logistics (Saberi et al., 2019).

Real-time data provides immediate knowledge about current conditions and potential changes in the supply market, allowing companies to make better and more informed decisions. Moreover, real-time data can enhance efficiency and coordination among the parties involved and improve supply chain response to changes and challenges.

Traceability is an important dimension of blockchain technology that can improve supply chain performance. Traceability across the blockchain enables companies, suppliers, and consumers to securely, transparently, and efficiently monitor the movement of products and services through the supply chain (Tan et al., 2023). This enhances trust and cooperation between the parties involved and helps in improving adherence to local and international standards and regulations. Blockchain traceability enables all parties involved in the supply chain to monitor the source of products, track workflow, and transactions transparently and reliably, and helps ensure adherence to standards and

regulations related to quality, safety, security, and environmental and social responsibility in the supply chain (Sultana et al., 2022).

In general, block chain technology also contributes to improving the efficiency of the supply chain by simplifying and accelerating processes and transactions between companies and different entities (Kshetri, 2018). By reducing reliance on intermediaries, paper-based transactions, and integration of information systems, blockchain technology can save time and financial resources, and improve the overall performance of the supply chain (Tian, 2016).

Conclusion

The results of Tan et al. (2023) that integration in supply chain management mediates the correlation between the common vision in block chain technology (information exchange, business AI collection, and asset status knowledge) and supply chain performance. Also, the study of Markus and Buijs (2022) showed that block chain technology relies on many technological features, leading to the ability to maintain a shared and immutable ledger that can automatically execute smart contracts, is part of a broader business project that includes activities Others such as process mapping, digitization and data analysis, and that the basic features of block chain technology can directly affect the performance of the supply chain, as many of the improvements in supply chain performance that are usually achieved due to block chain technology.

The study of Jum'a (2023) concluded that the applications and use of the blockchain affect the performance of the supply chain, which improves the ability to achieve higher levels of productivity, lead times, customer service, and relations with the members of the supply chain, as shown by the study of Magd et al. (2023) that block chain technology has been widely applied in logistics and supply chain in various industries, resulting in improved operations and performance, while the study of Saleh et al. Product quality, and also increases the facility's response speed to changes in its external environment, and contributes to achieving an optimal product cost structure, which leads to cost reduction and greater productivity by allocating resources to activities with higher added value.

The results of the Al-Saghir study (2020) showed that there is a positive statistical correlation between the application of blockchain technology in tracking the manufacturing supply chain and activating the target costing method, and the open records accounting method as tools for interstitial cost management along the supply chain.

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Exploring Critical Factors For Tackling The Barriers In Organisational Knowledge Management

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Abstract:

Knowledge and the management of knowledge are essential in any organisation to promote productivity and the effectiveness of its resources. The study makes the case that managing certain business-related Critical Success Factors (CSFs) is essential for institutionalising Knowledge Management (KM) and even more so for the organisation's sustainability. By synthesising the results from several research studies to clarify the common characteristics that significantly influence organisational KM practices, this study investigates which CSFs are critical to tackling the barriers to KM. A systematic literature review was conducted using the PRISMA protocol to achieve the above aim. A comprehensive search was conducted on several academic databases, and 39 articles and books were selected for review. The findings indicate that the most common KM CSFs are people, technology, processes, culture, structure, strategy, and trust. From a strategic standpoint, although external challenges and opportunities influence organisational design and plans, KM dictates how People, Processes, and Technology (PPT) are structured to support organisational profitability, innovation and growth. This article argues that KM should thus be managed as a strategic process for locating, choosing, organising, sharing, and transferring knowledge and, as a strategic enabler, be instrumental in managing CSFs, crucial to nurturing a culture of trust, collaboration and innovation.

Keywords: *Knowledge, Knowledge Management (KM), People, Processes and Technology (PPT), KM Critical Success Factors, Culture, Trust, Innovation*

Methodology

This study aims to define Knowledge Management (KM), identify obstacles that impede its implementation, and determine the Crucial Success Factors (CSFs) necessary for effective KM. A Systematic Review and Meta-Analysis (PRISMA) of peer-reviewed journals, books, and conference papers from databases such as Web of Science, Scopus, and Google Scholar was conducted to achieve this goal. The research protocol, depicted in Figure 1, outlines the keywords such as Knowledge Management, Critical and Key Success Factors, Challenges, Barriers, and Obstacles. Keywords were employed to minimise bias, enhance reliability, and facilitate the study's communication (Page et al., 2021). Research notes, readers' comments, and editors' comments were excluded based on eligibility criteria, and only studies with a KM perspective were considered. The 83 articles initially identified were screened for duplicates, and the remaining 83 underwent further analysis using thematic analysis to identify key research areas and investigate techniques for studying KM. Boolean operators (AND, OR) were used to refine the search and ensure inclusiveness. While conducting the Systematic Review and Meta-Analysis, the focus was on articles published between 2000 and 2023. However, some sources were also identified that were deemed significant and subsequently referenced to provide a historical perspective to the reasoning proposed. Out of all articles evaluated, only 38 were found to be relevant to the research conducted.

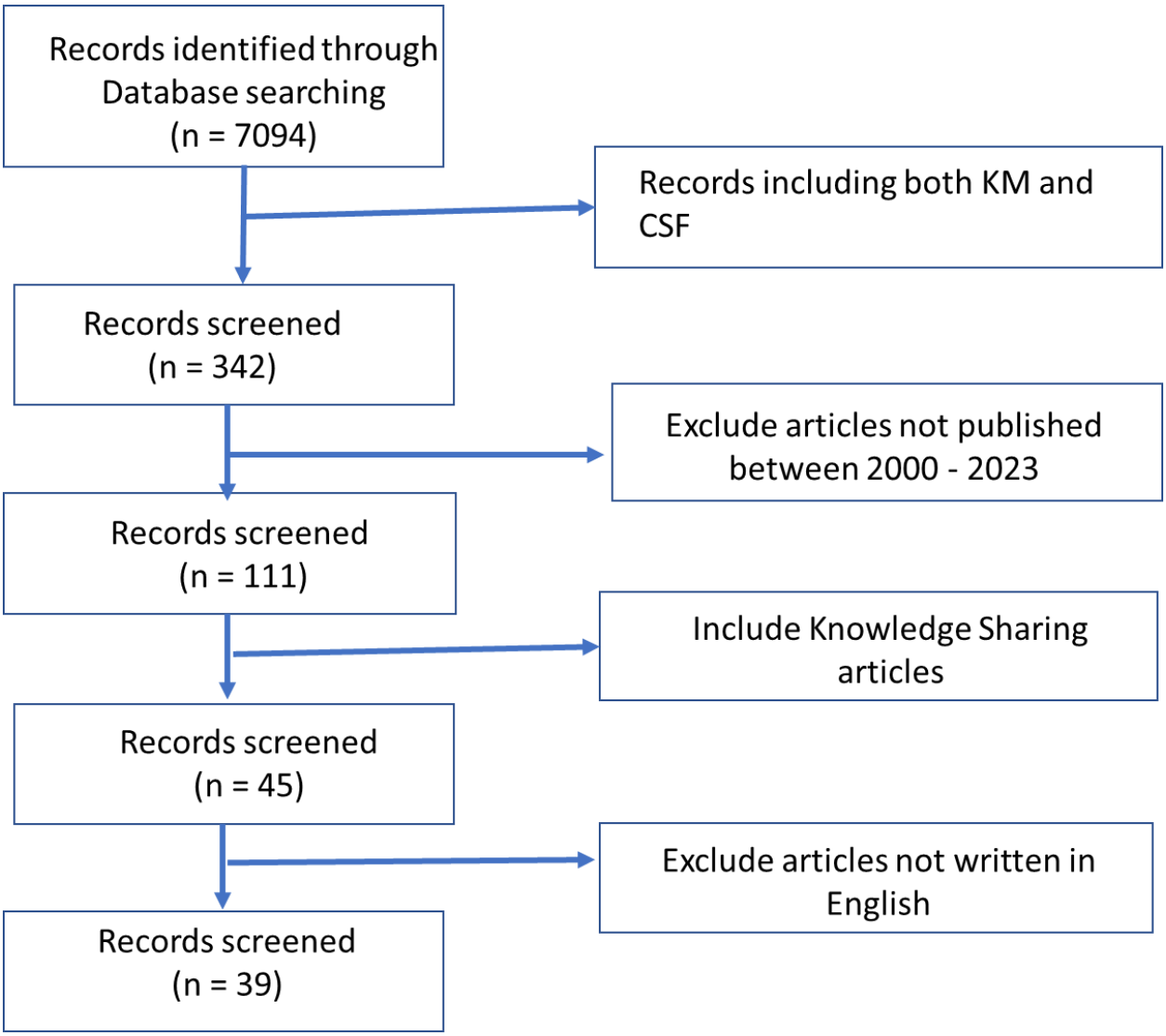

Figure 1: The PRISMA selection process of relevant literature

Screening and Selection:

A two-stage screening process was followed to select relevant articles. Firstly, titles and abstracts were screened to exclude any irrelevant articles. Full-text articles were assessed for eligibility based on research objectives and relevance. Discrepancies were resolved through researcher discussion and consensus. A standardised data extraction procedure was followed for consistency in extracting pertinent information. This procedure included author(s) names, publication year, key findings, conclusion, and identified critical success factors (CSFs). Finally, extracted data were organised and summarised in Table 2 for a comprehensive overview of CSFs in KM.

N	Authors	KM Factors	Summary of KM Factors
1	Nonaka and Konno (1998), Snyman and Kruger (2001), Sunassee,	**Strategy, Alignment, Maturity**: **Conclusion**: Knowledge Management Strategy should be aligned with the	**a. Strategy** i. Measurements ii.Motivational

	and Sewry (2002), Alazmi and Zairi (2003), Smith and Schurink, (2005), Tian, Nakamori, and Wierzbicki, (2009), (B, aykiz, 2014), Moscoso-Zea, Luján-Mora, Cáceres and Schweimanns (2016). Alkatheeri (2018), North and Kumta (2018), Akhavan and Philsoophian (2018), Hajric, 2018 and Demchig (2020), Ellemers, 2021.	business strategy and be centred on people **Findings and deductions:** Top management must prioritise activities to encourage knowledge sharing and independent thinking by aligning business and IT strategies. Alignment through top management's commitment to the business and KM vision and mission guarantees that the KM process is carefully planned, carried out, and controlled. It also guides the creation of a successful and mature KM system.	**b. Technology** i. Infrastructure ii. Information Technology **c. People** i. Management ii. Leadership iii. Human Resources. iv. Training **d. Processes Structure** i. Top management **e. Culture and Trust** **f. External Forces**
2	Fahey and Prusak, (1998), Snyman and Kruger (2001), Alazmi and Zairi (2003), Smith and Schurink (2005), Hsieh, Lin, and Lin (2009), Tian, Nakamori, and Wierzbicki, (2009), Baykiz (2014), Moscoso-Zea, Luján-Mora, Cáceres and Schweimanns (2016), Mthembu and du Plessis (2018), Alkatheeri (2018) and North and Kumta (2018), Demchig (2020), Jovanovic and Hinchcliffe, (2021).	**Structure: Process, Technology and People**: **Conclusion**: Technology advances Knowledge Sharing and Management **Findings and deductions:** Technology is crucial for modern enterprises to achieve their goals, prioritise human interactions, and operate across diverse socioeconomic strata. Efficient knowledge management processes are critical for connecting employees, facilitating knowledge exchange and aligning KM with organisational business processes to optimise people, technology, and business operations. IT-powered KM solutions are especially beneficial in generating scientific knowledge within an organisation, contributing significantly to bolstering productivity and ensuring success.	
3	Mthembu and du Plessis (2018), Sunassee, and Sewry (2002), Tong and Mitra (2009), Mthembu and Du Plessis (2018), Alkatheeri (2018) and North and Kumta (2018), Hajric, 2018	**Culture and Trust :** **Conclusion:** Culture and Trust facilitate effective knowledge-sharing. A positive organisational culture promotes successful KM. **Findings and deductions:** Trust is crucial for effective workplace knowledge sharing. Understanding benevolence-based and competence-based trust is critical. Creating a knowledge-sharing culture requires a supportive environment that fosters collaboration, knowledge-sharing, and learning. Culture is vital in promoting	

		knowledge sharing and building a KM-friendly workplace.	
18	Van Assen, Van Den Berg, and Pietersma, 2009	**Internal and External Forces** **Conclusion**: Successful KM is promoted by coordinating external and internal forces **Findings and deductions:** Corporate strategies require knowledge of internal and external factors. Competitive intelligence helps inform decision-making. SWOT, PESTEL, and Porter's Five Forces connect KM plans with the market and improve competitive advantage.	

Understanding and addressing the critical success factors (CSFs) affecting KM has proven more challenging than initially anticipated. Upon analysing Table 2, it became clear that organisations can create a dynamic knowledge-sharing ecosystem by focusing on internal CSFs such as People, Culture, Technology, Processes, Structure, and Trust. From this perspective, KM is somewhat similar to Information Management, which is concerned with locating, selecting, organising, sharing, and transferring knowledge within the organisation, as Wilson (2002) argued. However, a deeper analysis revealed that for KM to drive innovation and enhance organisational performance, as proposed by Kruger and Snyman (2004), it requires more than managing factors such as People, Processes, Culture, Trust, Structures, and Technology. It also necessitates the ability to align, govern, and manage strategic forces.

The 42 articles reviewed indicated that to overcome the barriers that affect KM, particularly its implementation, it is necessary to revisit the historical background of KM, its definition, and what it is and is not. Therefore, this article aims to provide a more comprehensive perspective on KM CSFs by delving deeper into the specific factors that are universal to KM and how to structure these factors from a strategic standpoint to foster an organisational culture of trust, collaboration, and innovation. An environment where KM is viewed as a holistic and strategic business enabler.

Historical Perception

In the early 2000s, Neve introduced the concept of KM, which aims to convert tacit knowledge into explicit knowledge that can be shared and stored. This transformation helps organisations develop competencies and capabilities, ensuring long-term efficiency and effectiveness. By using knowledge efficiently, KM helps organisations avoid duplication of effort (Neve, 2003). According to Tiwana, it is the most effective tool for collecting, recording, organising, filtering, analysing, retrieving, and disseminating organisational know-how. Initially, the primary purpose of KM was to extract knowledge from the entity that created it and make it independent for reuse within the organisation. However, Tiwana suggests that KM should also have a strategic impact, as developing new products and services relies heavily on leveraging and growing an organisation's knowledge base (Tiwana, 2009). Despite the growing recognition of the importance of KM, authors like Wong and Aspinwall (2004) cautioned that few reported case studies focus on the successful adoption and implementation of KM.

Although many experts recognised the value of KM, there were still some who remained sceptical. Wilson (2002) contended that KM is simply a marketing ploy to promote data and Information Management (IM) products and services. Later scholars, like Kruger and Johnson (2009), argued that KM can only be beneficial when applied and aligned with the organisation's business strategy. Similarly, Wawundila and Ngulube (2011) maintained that knowledge retention only becomes valuable when knowledge is managed as a strategic resource. These authors stressed that managing knowledge as a strategic resource and aligning KM with the organisation's business strategy is crucial for its effectiveness.

During the 2010s, scholars Turban, Sharda, and Delen (2011) and Wawundila and Ngulube (2011) brought attention to the issue of knowledge retention in organisations, which was becoming increasingly important due to the ageing workforce, shrinking talent pool, and demographic changes. However, research by Lopez-Nicolas and Merono-Cerdan

(2011) revealed that many KM systems replacing IM systems had a failure rate of over 80%. They attributed this to an over-reliance on information technology, inappropriate KM strategies or processes, or a lack of understanding of the consequences of KM. Lopez-Nicolas and Merono-Cerdan (2011) concluded that despite advancements in knowledge-sharing technologies, many top and middle managers were disappointed in KM's inability to translate knowledge into action, foster organisational expertise, and drive success. This sentiment was shared across various industries.

Knowledge And Knowledge Management

According to the research conducted by Fahey and Prusak (1998), managers during the 1990s faced difficulties in distinguishing between data, information, and knowledge. The authors noted that managers' education, training, and organisational experience did not adequately equip them to comprehend the concept of knowledge. As a result, managers often perceived focusing on these distinctions as a distraction from their primary responsibility of managing. The authors emphasised that the work environment could become dysfunctional without a firm grasp of knowledge (Fahey and Prusak, 1998). Unfortunately, according to Alshahrani (2018), there hasn't been enough schooling on the difference between knowledge, data, and information since these statements were made.

Alshahrani (2018) explains the complex and ever-changing relationship between data, information, and knowledge. While data and information are essential building blocks for knowledge, they also stem from knowledge. As a result, KM is complex since it also addresses data and IM (Kruger and Johnson 2009). Initially, the concepts of information and knowledge were used interchangeably in information systems and science domains. As a result, Wilson (2002), in the early 2000s, proposed that proper definitions must be found to distinguish between knowledge and information and warn if this is not done, one of these terms will become a synonym for the other, confusing anyone trying to figure out what each term means. Wilson defines knowledge as "what we know." He argued that "knowledge" refers to the mental processes of perception, understanding, and learning that only occur in the mind, even though they require connection with the outer world and others. For example, Wilson argues that we can only express what we know by speaking signals of spoken, written, pictorial, gestural, or even through body language - whenever we want to explain what we know. According to Wilson (2002), these communications do not convey knowledge; they include information that a knowing mind can ingest, grasp, and incorporate into its knowledge systems.

In response to Wilson's arguments, Bratianu (2010) argued that Wilson refers to personal knowledge, which exists only in individuals' minds. Bratianu (2010) states that knowledge goes beyond data and information to enable innovation. As Bratianu explains, organisational knowledge encompasses not only the knowledge that resides within employees' minds but also other assets such as documented knowledge, videos, patents, and other materials that can be recreated in other minds through reading and other activities. In essence, the economy comprises the knowledge assets that organisations possess. Bratianu argues that innovative sources of new knowledge determine the future value of organisations and warns that when knowledge sources do not apply knowledge assets creatively, it means nothing. Of interest is that Le and Lei (2019) recently stated that while it is knowledge networking that identifies new markets, only research and innovation create new ideas. Le and Lei (2019) thus warn that the most critical factors in unlocking strategic value are the capacity to create, gather and transmit (generate and share) knowledge and, ultimately, to utilise knowledge. KM should, therefore, focus on managing patents, know-how, technologies, or brands and applying knowledge assets through knowledge sources. These should be monitored and measured for success. Unfortunately, the current view of KM focuses more on the management of knowledge than on the application of knowledge (Belanger and Van Slyke, 2012; North and Kumta, 2018).

Barriers To Organisational Knowledge Management

According to Smuts, Van Der Merwe, Loock, and Kotze (2009), organisations must overcome knowledge-sharing obstacles such as organisational hierarchy, geographic limitations, human nature, and personality types to apply knowledge successfully. These authors warn that the effectiveness of the company's overall KM program depends on encouraging people to contribute expertise throughout the organisation. An organisation must address all obstacles hindering knowledge sharing and application to effectively use intangible assets, the cornerstone of value creation. A typical KM obstacle is the unwillingness to share knowledge, driven by organisational structure, compensation, trust issues, and individual phobias. According to Snyman and Kruger (2001), technology should support interpersonal communication while being crucial for knowledge identification and dissemination. The influence of technology on

human behaviour, particularly during the COVID-19 pandemic, highlights the necessity of maximising the interaction between people, processes, and technology in KM (Jovanovic and Hinchcliffe, 2021). Organisations stress the need to manage knowledge workers to encourage information sharing, creativity, and independent thought, ultimately fostering effective knowledge management and organisational success.

On sharing knowledge, Goh and Hooper (2009) believed that due to a silo-type structure that causes people to hoard know-how, knowledge does not flow well between members inside an organisation. The idea that knowledge equals power is, according to these authors, one of the most common roadblocks to KM. They discovered that remuneration, organisational structure, time and resources, training and education, information technology, management practices, information quality, information access, information security, people's beliefs, fears, attitudes, and information awareness all contribute to an unwillingness to share knowledge. According to their study, some employees believed sharing would take control, competitiveness, and authority away from them. They also noticed that these individuals lacked trust in their knowledge and the information they supplied to others. They were also terrified of making mistakes, being exposed or criticised, and having their effort taken credit for by others (Goh and Hooper, 2009).

Of interest is that Hajric (2018), somewhat aligned with the ideas of Goh and Hooper (2009), found two additional factors that affect knowledge sharing and application: causal and resultant factors. Causal factors, such as improper organisational structure, i.e., old boys' network, are the underlying issues inside the organisation that result in unsuitable settings for KM; these are not usually obvious and cause various symptoms known as resultant factors. Hajric (2018) states these factors are based on extensive empirical evidence and theoretical discussions linking them to KM failure. In short, Hajric argues that causal factors often have no demonstrable benefits, are inadequately supported by management, have insufficient managerial and worker knowledge skills, and speak to cultural issues in the workplace and ineffective organisational structures. Concerning resultant factors, there is a lack of widespread participation; usability is lacking; determining requirements are overemphasised; implementation of technology is not up to par; and knowledge loss results from personnel departure and retirement (Hajric, 2018).

Finally, as stated by April and Izadi (2004) and Kandadi (2006), KM is vital for organisations as it fosters creativity, facilitates the efficient utilisation of intellectual resources, and simplifies informed decision-making. After examining the factors affecting KM through the perspectives of what knowledge is, differences between data, information, and knowledge, and barriers to KM, it became clear that the success of KM depends on a comprehensive approach that integrates critical internal assets and resources such as Technology, People, and Processes, while also considering the influential factors of culture, trust, and structures. The following sections delve deeper into the literature surrounding these issues, starting with technological elements.

Technology

Many executives struggle with justifying significant IT expenses by demonstrating how IT can help produce and utilise knowledge in innovative and effective ways. This lack of satisfaction is due to a lack of understanding of IT management (Fahey and Prusak, 1998; Snyman and Kruger, 2001). To ensure that relevant information is accessible in a timely and cost-effective manner, organisations must effectively capture, structure, and present their knowledge in a structured data environment that is easily accessible to employees (Smith and Schurink, 2005). Essentially, IT-based KM should support and enhance an organisation's knowledge life cycle in the business area. Thus, although IT is a powerful tool for transmitting and sharing knowledge, it should not replace the importance of engaging in rich dialogue for effective communication and learning. Instead, IT should complement and enhance individual, group, organisational, and inter-organisational knowledge exchange (Fahey and Prusak, 1998; Nonaka and Konno, 1998; Snyman and Kruger, 2001). Technology should facilitate identifying, creating, and disseminating knowledge among organisational elements (Snyman and Kruger, 2001; Demchig, 2020). Its role in infrastructure and architecture is to support knowledge repositories, improve access to information, and create a conducive environment for knowledge sharing, where knowledge-enabling tools benefit the process of scientific knowledge creation in an organisation (Tian, Nakamori, and Wierzbicki, 2009; Hsieh, Lin, and Lin, 2009; Baykiz, 2014; Moscoso-Zea, Luján-Mora, Cáceres; Schweimanns 2016; Mthembu and du Plessis 2018).

Demonstrating the value of IT to KM lies in its ability to facilitate knowledge sharing and creation. However, this requires adequate **training** of employees to use sophisticated tools, which can enhance the flow of information and knowledge within an organisation. Technology is undoubtedly crucial for identifying, creating, and sharing

knowledge. However, it should not replace interpersonal communication's valuable interaction and connection. Instead, technology should enhance communication between individuals, groups, and organisations to promote effective KM. Authors cited such as Tian, Nakamori, and Wierzbicki (2009), Alkatheeri (2018), and Jovanovic and Hinchcliffe (2021), all demonstrated a scholarly connection between people, processes, and technology in enhancing KM. This connection again highlights the interdependence of these factors in promoting innovation, adequate knowledge flow, and achieving organisational success.

In conclusion, technology is critical in improving KM strategy as it is an efficient way of capturing, storing, transferring, and distributing knowledge (Alkatheeri, 2018). It is a tool that can benefit goal-driven organisations that prioritise service delivery and are people-oriented, regardless of their socioeconomic status. As Jovanovic and Hinchcliffe (2021) argue, in today's world, technology still plays a crucial role in spearheading knowledge accumulation, storage, sharing, and dissemination.

People

The concept of a "knower" raises concerns about the origin of knowledge, as it is generally agreed that knowledge cannot exist outside of human minds. However, it can be embedded in organisational assets such as procedures, routines, documents, and networks. Nevertheless, Jovanovic and Hinchcliffe (2021) argue that people are still the sources and keepers of knowledge, and organisations should prioritise individuals in their KM strategies. To manage knowledge effectively, organisational leaders should identify individuals with specific skills and guide corporate KM strategy. It is essential to recognise that technology significantly impacts people and their work, as Fahey and Prusak (1998), Sunassee and Sewry (2002), Smith and Schurink (2005), Moscoso-Zea, Luján-Mora, Cáceres and Schweimanns (2016), and Jovanovic and Hinchcliffe (2021) assert. The COVID-19 pandemic has provided evidence that reliance on technology has grown due to lockdown measures. Without a "knower," knowledge becomes merely data, emphasising the importance of human intervention in knowledge creation. To manage knowledge in an organisation, knowledge workers must be addressed in ways that secure access to knowledge assets and provide opportunities for knowledge sharing, individualism, innovation, and independent thinking. Therefore, KM processes and procedures should be in place to connect people and align KM with organisational business processes. This requires optimising people, technology, and business processes, as Smith and Schurink (2005), Baykiz (2014), Mthembu and du Plessis (2018), Demchig (2020) and Jovanovic and Hinchcliffe (2021) suggested.

Processes

As early as the ninety nineteens, Nonaka and Konno (1998), and later Smith and Schurink (2005), Smith and Schurink (2005), Tian, Nakamori, and Wierzbicki (2009), and Moscoso-Zea, Luján-Mora, Cáceres and Schweimanns (2016), argue that effective KM processes and procedures are crucial for connecting employees, facilitating knowledge exchange, and aligning KM with organisational business processes to achieve optimisation across people, technology, and business operations. Alkatheeri (2018) emphasises the complex nature of KM processes, highlighting the interaction between people, processes, and technology when managing and utilising knowledge within organisations. Alkatheeri (2018) further explains that KM processes involve the acquisition or location of expertise through employees and business partners, the conversion of knowledge and structuring in a way that facilitates KM distribution in the organisation, the application of knowledge to adjust the mission and strategy of the organisation to solve business problems and produce efficiency, and the protection of knowledge from inappropriate use or unauthorised accessibility. Effective KM processes and procedures are necessary for organisations to connect employees, facilitate knowledge exchange, and align KM with business processes to optimise people, technology, and business operations (Baykiz, 2014; Mthembu and du Plessis, 2018; Demchig, 2020).

Organisational Structures

Traditional top-down structured organisations prefer vertical communication to network or matrix-structured organisations. According to Baykiz (2014), this limits systems connectivity and collaboration effectiveness within traditional bureaucratic organisations where knowledge sharing and innovation are often not promoted. Many interpersonal communication barriers and bureaucratic tendencies can be decreased thanks to sharing knowledge, formal or informal, among employees and clients (Baykiz, 2014). Sharing knowledge within an organisation can be enhanced if organisational issues and structures do not restrict the capacity of team members. Authors such as

Alkatheeri (2018) argue that knowledge sharing must be expanded to involve all sides of the organisation through proper team planning. As such, the work environment needs to be restructured to ease access and link employees with one another to provide knowledge sharing. Establishing such communities of practice has been recognised as a catalyst for enhancing organisational skills through enhanced knowledge transfer (Alkatheeri, 2018). Thus, restructuring requires the development of units of work, projects, teams, and communities of practice to connect people to share knowledge and best practices (Snyman and Kruger, 2001; Hajric, 2018; Alkatheeri, 2018).

To support the environment and context in which KM processes occur, it is necessary to conclude that the organisational structure should promote a knowledge-sharing culture (Snyman and Kruger, 2001; Smith and Schurink, 2005). Alkatheeri (2018) thus stresses that knowledge transfer is more achievable through decentralised organisational systems that encourage employee interaction, communication, and inter-departmental informal meetings. Such interactions are highly recommended for facilitating knowledge sharing. The author also suggests that the organisational structure best suited for KM is flexible, adaptable, promotes communication, and responds quickly to any changes. Such reorganisation involves the creation of groups, teams, and communities of practice that allow individuals to interact and share knowledge and best practices. Additionally, it highlights the need for modifying procedures and technology to support a contemporary organisational environment that requires integrating people, processes, and technology (Hajric, 2018; Demchig, 2020).

Culture

According to Snyman and Kruger (2001), Sunassee and Sewry (2002), Smith and Schurink (2005), Tong and Mitra (2009), Hsieh, Lin, and Lin (2009), and Alkatheeri (2018), organisational culture is a crucial factor in KM success. However, they caution that developing a supportive corporate culture can be challenging. Similarly, Smith and Schurink (2005) emphasise the importance of a collaborative and sharing culture for successful KM. To achieve this, KM must become an integral part of the organisation's culture and infused into all its operations. Smith and Schurink (2005) warn that creating such a culture takes time, and cultural variables that facilitate knowledge can change the types of employees a firm hires and the reasons they come to work.

Nevertheless, a firm can build a knowledge culture in the short term using education, reward programs, and management leadership. Management should also recognise employees' knowledge-creation efforts through a fair and consistent incentive and reward program. However, avoiding actions that can stifle knowledge sharing, such as rash downsizing and hostile mergers or acquisitions, is essential. Culture thus establishes the work mood in an organisation. If knowledge culture is built in a workplace, workers feel comfortable across the immediate environment. Organisational culture leads to successful business where employees think, feel relaxed, and commune with each other to promote expert growth. In addition, employees become shareholders of the organisation's knowledge base in a culture where knowledge is shaped, stored, developed, and distributed (Snyman and Kruger, 2001; Baykiz, 2014; Hajric, 2018).

Developing a knowledge-sharing culture within an organisation is vital for enhancing knowledge management (KM) efficiency. It involves combining individuals' and groups' knowledge with macro-management elements. According to North and Kumta (2018), a results-based and job-oriented culture positively affects employees' intention to participate in KM processes. However, they also caution against too tightly controlling the culture, negatively impacting participation in KM processes. Similarly, Alkatheeri (2018) emphasises that knowledge is significantly shared and connected with how well the cultural tendencies align with organisational performance and KM effectiveness. Corporate culture plays a crucial role in KM since it identifies the values, beliefs, and norms that generate knowledge through sharing and using know-how within an organisation. In essence, fostering a knowledge-oriented culture leads to enhanced effectiveness and the dissemination of knowledge in KM settings, as supported by academic research from experts like Davenport and Prusak (1998), Alkatheeri (2018), and North and Kumta (2018). These scholars emphasise the cruciality of organisational culture in KM, as it shapes the norms, values, and approaches that encourage the sharing and application of knowledge among team members. Their work underscores the essential role played by culture, individuals, procedures, and technology in the triumph of KM.

Trust

Sharing knowledge effectively in an organisation requires trust and a supportive organisational culture. Studies conducted by Tong and Mitra (2009) and Mthembu and Du Plessis (2018) have shown that high interpersonal trust encourages employees to share their knowledge. Trust is essential in knowledge management, reflecting people's confidence in their shared ability. Tong and Mitra (2009) describe trust as the willingness of a party to be vulnerable, while Mthembu and Du Plessis (2018) expand on this definition, stating that trust is the extent to which an individual acknowledges another person's intentions as honourable. There are two types of trust: benevolence-based and competence-based. Benevolence-based trust is more common and refers to the belief that an individual will not intentionally harm another. However, competence-based trust, vital for knowledge sharing, is the foundation of relationships in which individuals believe that another person is an expert in a particular area of specialisation (Mthembu and Du Plessis, 2018).

Strategy and External Forces

As Sunassee and Sewry (2002) and Smith and Schurink (2005) emphasise, efficient knowledge utilisation is crucial for organisations to achieve their business objectives. Being strategic, Snyman and Kruger (2001), Smith and Schurink (2005), Tian, Nakamori, and Wierzbicki (2009), Alazmi and Zairi (2003), and later Belanger and Van Slyke (2012), Baykiz (2014), Alkatheeri (2018) and Demchig (2020); warn that KM must align with an organisation's strategy. However, to maximise the strategic impact of KM, it is essential to align KM strategy with the corporate strategy and with organisational structures, business processes, and technology. Their research highlights the complex interdependence of people, processes, and technology in ensuring the alignment of KM strategies with the elements above for strategic impact within an organisation. Crafting a successful business strategy thus involves analysing an organisation's strengths and weaknesses alongside external factors, such as political, economic, social, ecological, and legal forces, as well as competitive forces outlined in Porter's Five Forces model. To do so, managers must clearly understand internal and external factors impacting the organisation. This understanding has led to the development of concepts like Business Intelligence (BI) and Competitive Intelligence (CI). In the late 1990s and early 2000s, scholars like Nonaka and Konno (1998), Sunassee and Sewry (2002), and Smith and Schurink (2005) defined KM strategy as a high-level plan that leverages knowledge to fulfil an organisation's mission, vision, and objectives while addressing opportunities and threats presented by internal and external forces (Van Assen, Van Den Berg, and Pietersma, 2009). They contend that KM strategy must closely align with corporate strategy and deliver concrete benefits to an organisation.

In summary, to ensure success, organisations must ensure that their knowledge strategy and program align with corporate goals and that all approaches, technologies, resources, roles, skills, and cultures support and contribute to the business's objectives. While the Knowledge strategy is a dedicated tool organisations use to plan, implement, and control management actions regarding business-relevant knowledge, the KM strategy should plan the KM process and provide direction for the design of the KM system. Business leaders should thus establish KM strategies aligned with organisational structures, processes, and infrastructure/technology (Alazmi and Zairi, 2003; Alkatheeri, 2018).

A holistic through-life approach

After analysing 42 articles, books, and other reliable sources, it was found that the most common CSFs for KM are people, technology, processes, culture, structure, strategy, and trust. While KM shares similarities with Information Management, it differs in its ability to manage tacit knowledge to drive innovation. As the driving force behind innovation, KM is structured differently from Data and Information Management and aligned to organisational strategies and plans to foster a culture of trust and collaboration. Unfortunately, it was found that existing literature does not offer such a comprehensive approach. We have synthesised the research findings to address this gap and developed a sequential through-life approach that integrates common KM CSFs. Please refer to Figure 1 for a visual representation.

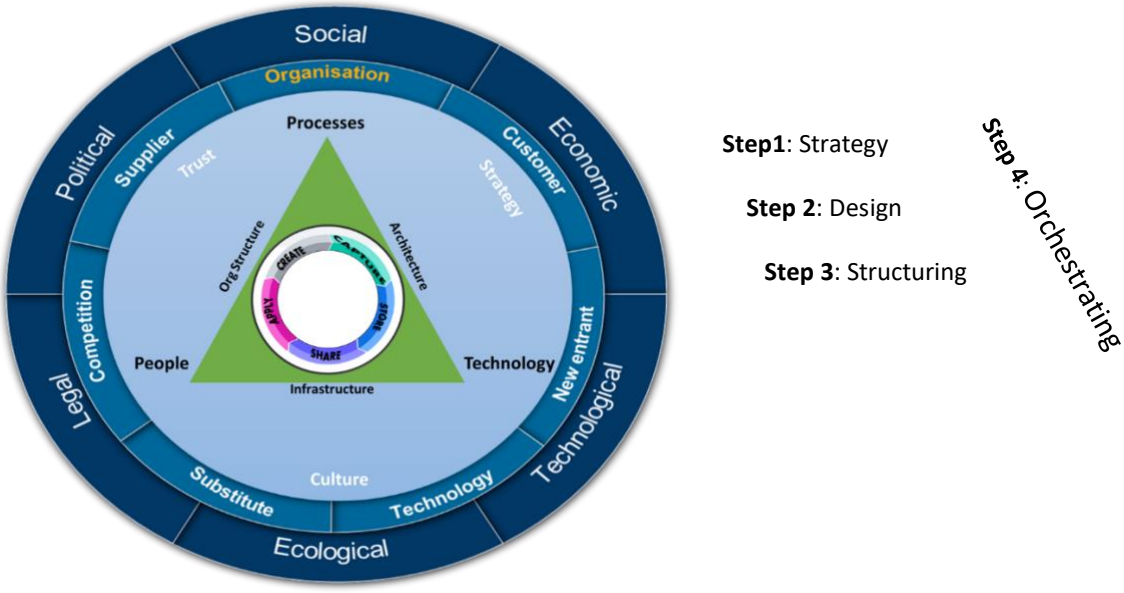

Figure 1: A holistic through-life approach to Knowledge Management

It was argued that KM Maturity refers to an organisation's ability to effectively manage knowledge creation, capture, storage, sharing, and application over time (Kruger and Snyman, 2005; Kruger and Johnson, 2009; and Akhavan and Philsoophian, 2018). This ability relies on the holistic management of Critical Success Factors (CSFs) that are internal and external to the organisation. CSFs are crucial for an organisation's survival and goal achievement, and understanding them is vital when developing strategies. An assertive approach entails sequentially integrating common KM CSF throughout an organisation's lifecycle, starting with formulating strategies to mitigate risks and seize opportunities presented by both Macro and Micro industry forces. It progresses to developing KM Visions, Missions, Plans, Policies, and Governance, then building assets and resources such as People, Processes, and Technology to support KM. Establishing links between PPT through organisational Architectures and Infrastructures is also necessary, and finally, maintaining KM assets, structures, resources, and infrastructures over time. Concurrently, it is essential to orchestrate trust and cultural structures to capture the strengths of KM assets and mitigate the weaknesses, enhancing knowledge capture, storage, and sharing. Knowledge Management involves a systematic approach that starts by formulating a strategy and developing KM plans, policies, and governance. This approach paves the way for creating and maintaining KM processes, people, and technology. Simultaneously, endeavours are undertaken to cultivate a culture of knowledge sharing by coordinating various factors and building trust, as illustrated below.

Step1: Strategy

Organisations must initially align their KM practices with business objectives to establish a productive relationship between knowledge management (KM) and business strategy. This alignment entails obtaining a thorough understanding of both the macro-level PESTEL factors (political, economic, social, technological, ecological, and legal) and the micro-level industry factors (suppliers, customers, new entrants, substitute products, and competition) (Van Assen, Van Den Berg, and Pietersma, 2009). Organisations should analyse this information using SWOT analysis, business intelligence (BI), and competitive intelligence (CI) reports and leverage it to drive innovation. Once an organisation has sufficient knowledge to make informed decisions, further KM initiatives should be integrated into its corporate strategies and enforced through governance processes (Kruger and Snyman, 2005; Smith and Schurink, 2005; Akhavan and Philsoophian, 2018).

Step 2: Design

The role of people as the primary source of knowledge cannot be overstated. Organisations and governing bodies should prioritise managing knowledge workers to ensure secure access to knowledge resources that promote creativity,

independent thinking, and knowledge sharing. Efficiently utilising people is critical to successful knowledge management, as is developing KM plans that align with an organisation's structures, procedures, and technology/infrastructure. This alignment guarantees that all KM processes are planned, carried out, and controlled effectively. It also guides the creation of a successful KM structure that includes necessary KM processes, people, and technological systems. KM should be treated as a deliberate discipline that improves organisational performance by emphasising the gathering, transforming, sharing, and application of knowledge (Nonaka and Konno, 1998; Ellemers, 2021). Organisations should formulate a KM Vision and Mission statement that demonstrates the appreciation of individuals and groups, promotes information exchange, and incorporates diverse perspectives to establish a solid foundation for effective KM decision-making processes (Ellemers, 2021).

Effective structuring of the People, Processes and Technology (PPT) dimensions is crucial in the context of KM (Fahey and Prusak, 1998; Moscoso-Zea, Luján-Mora, Cáceres and Schweimanns, 2016). It's important to align these factors with the organisation's business strategy by developing a knowledge strategy, KM plan, policies, and governance system to ensure the successful implementation of KM practices and structures. Structuring aims to identify and address the strengths and weaknesses of Critical Success Factors (CSFs) of KM practices and structures, which facilitate the successful utilisation and dissemination of knowledge throughout the organisation (Smith and Schurink, 2005; Belanger and Van Slyke, 2012; Jovanovic and Hinchcliffe, 2021).

Step 3: Structuring

According to Smith and Schurink (2005), effective knowledge management (KM) is critical for connecting employees, facilitating knowledge exchange, and aligning KM with organisational business processes to optimise people, technology, and business operations. Alkatheeri (2018) adds that KM processes involve acquiring or locating knowledge through employees and business partners, converting and structuring knowledge to facilitate distribution, applying knowledge to adjust organisational mission and strategy, and protecting knowledge from inappropriate use. Baykiz (2014) and Jovanovic and Hinchcliffe (2021) emphasise the impact of technology on humans, highlighting the need for KM methods that prioritise knowledge workers and support knowledge exchange, innovation, and independent thinking. Snyman and Kruger (2001) and Tian, Nakamori, and Wierzbicki (2009) argue that technology should facilitate identifying, creating, and disseminating knowledge, creating a conducive knowledge-sharing environment. North and Kumta (2018) suggest a strategic approach is necessary to foster information and knowledge exchange and ensure interplay between individual and organisational learning processes. In conclusion, research shows that effective KM processes and procedures involving people, procedures, and technology are crucial for organisations to optimise their operations and achieve their goals.

Step 4: Orchestrating

Organisations that can quickly adapt to external changes are better equipped for effective knowledge management. To achieve this effectiveness, a culture of knowledge-sharing and collaboration among employees should be fostered by aligning the organisational structure with the desired knowledge-sharing culture (Tong and Mitra, 2009; Alkatheeri, 2018). While recent authors such as Moscoso-Zea, Lujan-Mora, Caceres, and Schweimanns (2016) have identified technology, people, and processes as crucial elements in supporting KM, earlier works by authors such as Smith and Schurink (2005) and Belanger and Van Slyke (2012) advocated for identifying essential KM factors for organisational survival and objective achievement. According to Smith and Schurink (2005), these factors should provide an environment and shape the application of knowledge, including culture and trust, which, as argued by Alkatheeri (2018), significantly contribute to employee efficiency, knowledge transfer, and knowledge dissemination. Tong and Mitra (2009) further explain that trust-building between individuals leads to confidence in shared knowledge and supports a culture of efficient knowledge-sharing.

Creating a knowledge-sharing culture involves rewarding and motivating staff to collaborate, share knowledge, and learn from each other. Culture is critical in promoting knowledge sharing and cultivating a KM-friendly environment (Alkatheeri, 2018). Understanding the differences between benevolence-based and competence-based trust is vital, as these impact the dynamics of knowledge exchange in organisations (Tong and Mitra, 2009; Mthembu and Du Plessis, 2018; North and Kumta, 2018).

Conclusion

This article argues that Knowledge Management is a strategic, step-by-step approach to enhancing the use of people, processes, and technology to identify, capture, organise, disseminate, and transfer expertise. KM's value lies in its ability to identify new markets, generate new ideas, products, and services, and foster a culture of knowledge-sharing built on trust and goodwill. While similar to Information Management (IM), KM goes beyond IM and technology to create, utilise, and apply ideas. This uniqueness requires that KM be treated and managed differently and separately from Information and Data Management. To achieve success, organisations must align their KM strategies with their goals, visions, and strategies and actively structure people, processes, and technology towards an innovative and knowledge-sharing culture Alkatheeri (2018), North and Kumta (2018). This culture of trust and sharing is built through institutionalising tailor-made governance and corporate policies that reward individuals for their contributions. The goal of KM is to create a strategic environment that fosters a culture of trust and sharing, where knowledge creation and sharing are rewarded to benefit the organisation and the individual (Alkatheeri, 2018; North and Kumta, 2018).

Limitations To The Study

Despite the theoretical and practical implications of the current study, there are still some limitations to consider. While no single strategy can address all critical factors, certain elements are so fundamental and holistic that they are essential for the development of KM. It is worth noting that the authors do not suggest that these CSFs are all-encompassing or universally applicable. Instead, they serve as a starting point for establishing a baseline of success factors. Further research and individual attention must determine criteria tailored to an organisation's unique needs.

Biographies

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