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Antecedents and outcomes of green information technology Adoption: Insights from an oil industry

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A B S T R A C T

Growing environmental concerns have led to increased demand for 'green' or environmentally friendly business. This has resulted in growing interest in the research of Green Information Technology (GIT). However, to date, such research has had a disproportionate emphasis on organisational antecedents while often overlooking outcomes. The current study aims at giving a better insight into the state of GIT adoption among oil companies in Sudan. If these companies were to adopt a green business model, it would significantly impact the environment given that they typically contribute significantly to environmental degradation. To this end, this study a) determines the level of awareness of GIT adoption among employees of oil companies in Sudan, b) identifies the key factors affecting the GIT adoption, c) examines the effect of training, top management support, perceived ease of use, perceived usefulness, relative advantages, and GIT behaviour on GIT adoption, and (d) examines the effect of GIT adoption on outcomes, namely business performance, competitive advantage, and process innovation. From a sample of 292 respondents, the result revealed that top management and GIT behaviour were two of the four antecedents not supported by data, thereby rendering them insignificant. Surprisingly, the survey data supports all three hypotheses that recognise a positive relationship between GIT adoption and the outcomes. This study provides important empirical evidence from oil companies that lack a green adoption policy that encourages them to consider joining the green bandwagon. The study concludes that most respondents are aware of GIT.

1. Introduction

Going green is a fundamental concern of today's world (Clark et al., 1994; King and Lenox, 2001; Watson et al., 2010; Molla et al., 2014; Johshi and Rahman, 2015; Hornmoen, 2018; Ojo et al., 2019). There is heightened environmental awareness and a rigorous drive across individuals, groups, organisations, industries, and governments globally to be greener and environmentally sustainable (Omer, 2008; Messerli & Murniningtyas, 2019). The mounting strain on the environment and erratic weather patterns have manifested in a series of crises that have emphasised the urgent need to develop systems and technologies for more sustainable economic practices and lifestyles (Murugesan, 2010; Thornton et al., 2014; Xie et al., 2019). As stated by (Murugesan, 2008; Jenkin et al., 2011), this includes to reduce the electric power, green petroleum, and IT hardware consumption. Vykoukal et al. (2009) emphasized that the IT disposal and production is another major source of environmental

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problems; therefore, the green wave has recently swept the business domain and IT industry. Some studies (Agarwal & Nath, 2011; Sarkis et al., 2013; Debnath et al., 2016) assert that the significant consumption of electricity computers and other IT accessories have a considerable effect on green practices and environmental issues.

According to Saha (2014), the global drive to go green across all sectors of the economy, production systems and lifestyles have resulted in sustained efforts to produce green products, technologies and services. This sustained drive promises a reduction in global greenhouse gas levels and supports a cleaner and cooler atmosphere. Green IT (GIT) initiatives are supported by political and social pressures, government regulation, corporate governance, the waste disposal's rising cost, and public perceptions (Harmon & Auseklis, 2009; Unhelkar & Trivedi, 2011; Weng et al., 2017). In reference to the oil industry, it is a foundation of the global economy while also being a leading polluter. As such, it is an engine of the global economy (Hornmoen, 2018). According to (BP SRWE, 2018), oil industries delivering over fifty % of international fuel consumption and hydrocarbons can remain the largest energy source in 2035.

The literature on IT in the context of business has largely focused on performance (Han et al., 2010; Luftman et al., 2017; Mao & Wang, 2019), with minimal research exploring how GIT contributes to organisational success outcomes (e.g. Brooks et al., 2108; Baggia et al., 2019). Furthermore, managers shall identify the adoption determinants and the successful initiatives of the GIT (Ainin et al., 2016). Despite carry out various empirical pieces of research on the antecedents of GIT adoption in developing countries (Azad et al., 1998; Hanne, 2011; Molla & Abareshi 2012; Deng & Ji, 2015; Matatiele & Gulumian, 2016; Guo, Qu, Wu & Gui, 2018; Ahmad et al., 2019), this paper concentrates on the state of Sudan, as it is less considered regarding GIT adoption. Very few studies touches explored the GIT adoption on outcomes such as performance. It thus becomes interesting to explore outcomes of GIT in a developing country context. This research paper has two goals. First, the antecedents of GIT adoption are analysed. Second, the outcomes of GIT adoption within the oil industry of Sudan are examined. There are demands to investigate both the antecedents and outcomes of GIT adoption in the developing country context (Gholami et al., 2013; Jaiswal & Singh, 2018). This demand arises from the scarce literature investigating the antecedents and outcomes of GIT adoption in an integrated model. Most shreds of research are also conducted within the developed nations and states, and there is an absence of such analysis on such a model. Combining both antecedents and outcomes in a piece of research furnishes a broader overview of the adoption of the GIT in oil companies. This explanatory work examines the antecedents and outcomes of GIT adoption and broadens the scope of previous research. First, it assists in understanding the individual employees' behaviour towards GIT adoption. Second, it provides the oil industry with practical advice for implementing the GIT strategy according to the output of empirical evidence that stems from the structural relationship between antecedents, GIT adoption, and outcomes (business performance, competitive advantage, and process innovation). In the following sections, the related literature review and study variables are identified, the associated hypotheses are elucidated, and the methods together with data analysis, findings, implications, limitations, and conclusion are also described.

2. Literature Review

The rapid advancement in information system technologies has recently created new social and business trends. As such, information systems play a vital role in producing business and economic opportunities (Savino, 2009; Ricciardi et al., 2018 Anthony et al., 2019). GIT has arisen as a major concern for both business and IT directors either from environmental or economic viewpoints (Watson et al., 2010; Kanchanapibul et al., 2014; Joshi & Rahman, 2015). Studies in developed and developing contexts pay attention to GIT (Hutchinson & Chaston, 1998; Chen, Watson et al., 2011; Lei & Ngai, 2013; Asadi et al., 2018). The impact oil companies have on the environment is a growing concern globally (Nriagu et al., 2016). Currently, seldom do managers of oil companies have comprehensive environmental plans or implement them in their entirety (Delmas and Toffel, 2004). Their failure or reluctance to do so is often attributed to the cost of environmental management and the absence of an immediate and commensurate economic return (McKeiver and Gadenne, 2005; Miroshnychenko et al., 2017).

Oil companies differ from large companies in several ways. These include differences in economies of scale and resources to manage their environmental footprint (Condon, 2004; Walker et al., 2007; Cameron and Stanley, 2017). Despite the different approaches to environmental adoption, several studies have sought to explain the motivations behind the choice of adoption and the rationale for environmental adoption (Lepoutre and Heene, 2006; Moorthy, 2012; Joshi and Rahman, 2015; Huq and Stevenson, 2018). According to Murugesan (2008, p. 26), "GIT is defined as the study and practice of designing, manufacturing, using and disposing of IT equipment such as computers, servers, monitors, printers, storage devices, and networking and communications systems efficiently and effectively with no or minimal environmental impact". Pertaining to the perspective of the oil companies via their managers, these companies do not regard environmental issues as a significant concern to their business due to the lack of knowledge regarding environmental settings and its relationship to profit (Mohiuddin et al., 2018).

Previous adaptations of the most cited information system models, i.e. Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM) have explained attitude and behaviour toward environmental practices. For example, based on the above theories, many studies have investigated the influence of various antecedents affecting technology adoption (Lai, 2017). However, Venkatesh et al. (2003) argued that IT adoption models can predict and expound individual acceptance of novel and fresh technologies. In fact, nearly 40% of information systems research has utilised TAM (Siyal et al., 2019).

Numerous pieces of research have explored the adoption factors and GIT followed by emergent trends of "go green" (Melville, 2010; Ishak & Ahmad, 2011; Molla & Abareshi; 2012; Khare, 2015; Deng & Ji, 2015; Martenson, 2018; Baggia et al., 2019). In line with Murugesan (2010), Chou and Chou (2012) postulate a revisit for making the whole IT life cycle greener and creating measurements on GIT initiative outcomes. The objectives were to reduce power consumption, lower costs, environmental effect, and carbon emissions, and improve the performance of the systems. In the same vein, Vykoukal et al. (2009) emphasised the significance of ecologically sound adoption particularly in the IT industry thanks to the substantial power consumption of IT hardware that requires major electricity amounts, creating an uneasy burden on the environment and power grids. In the context of green computing, the influence of past personal and social environmental norms, social influence, environmental attitudes, and green self-identity on consumers' green buying behaviour in India were examined (Khare, 2015). It was concluded that the decision of purchasing a green product was significantly impacted by peer influence, green self-identity, and green buying behaviour.

Dezdar (2017) assessed the extent to which countries that were aware of GIT. From a sample of 633 valid questionnaires, he found positive relationships of intention to use GIT with GIT-based attitude, GIT-based subjective norms, GIT-based perceived behavioural control, consideration of future openness and consequences. Furthermore, Li et al. (2019) assessed the effects and determinants of high management support for green adoption from a sample of 148 Chinese firms. The study found that top management support is positively associated with green culture and adoption and that green culture helps in executing green adoption. In the context of education in a developing country, Hernandez (2020) explored the GIT adoption of the Philippines and found that in higher education organizations of education, the adoption of GIT included digital and paperless archiving systems, and awareness programs of GIT and sustainability.

To summarise, the literature has several limitations. First, there is a lack of empirical studies analysing the antecedents and outcomes of GIT adoption. Second, the specific aspects of the oil industry as an important context of green adoption and sustainability are not addressed in the GIT literature. Third, there is no study that examines the effect of GIT adoption on multiple outcomes. To address these limitations, this work proposes and tests a model that enables understanding the GIT adoption antecedents, incorporating the results of such adoption based on technology acceptance frameworks (e.g. TAM & TPB).

3. Research Model & Hypotheses Development

Given the past review of the related studies, as this paper examines the relationship between antecedents, outcomes, and the extent of GIT adoption in the oil industry, it fills the gap in GIT literature and assists in enhancing the information system and technology acceptance domains. The antecedents in the proposed model are top management support, green training, relative advantage, GIT behaviour, and the outcomes are business performance, competitive advantage, and process innovation. Overall, Fig. 1 shows the adopted seven hypotheses.

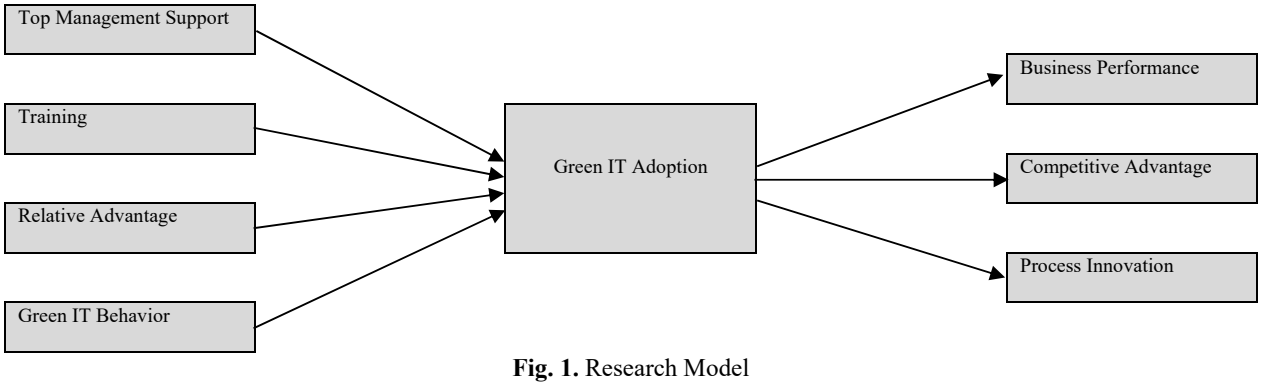

Fig. 1. Research Model

3.1 Antecedents of Green Information Technology Adoption

3.1.1 Top Management

According to Jeyaraj et al. (2006), the support by top management of GIT adoption is among the best predictors of organisational adoption of innovative information systems. They are instrumental in effecting change throughout the organisation (Thong, 1999). This support could manifest in their encouragement of green practices, environmental regulations, introducing a rewards system for environmentally friendly behaviour, or green training or education (Zailani et al., 2014). Mithas et al. (2010) further support the key role played by top management to ensure the successful adoption of GIT and realise organisational change. Given the above argument, hypothesis (1) is read:

H_1: *A significant and positive relationship exists between the GIT adoption level and green training.*

3.1.2 Green Training

For Liebowitz (2010), training prepares employees with the knowledge and skills to innovate. Also, Galbreath (2006) asserts that it is the employees who run an organisation, and as such, changes in their skills and outlooks will effect change in the organisation, confirming them as the most valued assets of any organisation. Education employees on environment-related issues will help shape their attitudes, behaviours, knowledge, and skills towards becoming more environmentally conscious and responsible (Zoogah, 2011; Yaseen,2009). Highly trained and skilled employees are also more likely to perform better and as a result are better positioned to achieve organisational goals and objectives. In short, Lin and Ho (2011) show that green training is critical to implement the successful GIT. Accordingly, hypothesis (2) is read:

H_2: *A significant and positive relationship exists between the GIT adoption level and green training.*

3.1.3 Relative Advantage

As the relative advantage of GIT covers both the economic and environmental performance, which is welcomed by a wide range of organisational stakeholders, the recognition of the relative advantage of GIT will make the decision-makers think that their actions in environmental preservation will be less constrained by the stakeholders in the organisation (Zhang et al., 2019). Moreover, the recognition of the relative advantage of GIT will give the decision maker a feeling of control because GIT can be considered as the solution for tackling the focal issues (Jackson & Dutton, 1988; Clarke et al., 1994). Relative advantage is the perception of the amount of the focal innovation used to bring more advantages than other substitutes (Lin & Ho, 2011). Since the intention to adopt technology is usually driven by the perception on the benefits of adoption (e.g., Mehrtens et al., 2001; Lee & Shim, 2007; Alziady & Enayah, 2019), the intention to GIT adoption should also be driven by the perception on the benefits of GIT. The relative advantage of GIT brought to the discussion usually includes the improvement of environmental and economic benefits, alongside reputation (Butler, 2010; Melville, 2010; Weng et al., 2017). Accordingly, hypothesis (3) is read:

H_3: *A significant and positive relationship exists between the GIT adoption level and relative advantage.*

3.1.4 Green IT Behaviour

Attitude is an efficient trait of high-ranking directors that measures the level of their GIT-based awareness and interest (Gholami et al., 2013). Previous studies showed that behaviour is an important factor for G IT adoption from both managers and employees (Chen et al., 2008; Bultler, 2011; Yaseen et al., 2010; Gholami et al., 2013 Ting et al., 2019). Precisely speaking, green employees' behaviour is a significant element in the company GIT practices (Norton et al., 2015; Iqbal et al., 2018). Consequently, hypothesis (4) is read:

H_4: *A significant and positive relationship exists between the GIT adoption level and relative advantage.*

3.2 Outcomes of Green Information Technology Adoption

3.2.1 Business Performance

In line with the resource-based view, organisations strategize ways to increase their value by optimising their use of resources and gain a competitive advantage (Ployhart, 2012). Studies have shown that failing to adopt GIT can be costly as they become less competitive. As argued by (Porter & van der Linde, 1995), first-mover advantage organisations are able to charge higher prices as they align with the policies of other organisations. Furthermore, firms, which spend higher on GIT, can save costs using the measures to implement GIT. They save costs by reducing costs of utility and energy, waste disposal, paper and supplies, and other tangible cost resources and savings (Hedwig et al. 2009; Watson et al. 2010). Other firms are then inclined to purchase the products and services produced by organizations that are markedly different and more environmentally responsible. Producing "greener products" with less carbon footprint employing GIT helps firms increase their revenue. The adoption of GIT constructs a climate in the organisation to adopt greener products in the whole value chain (Raisinghan & Idemudia, 2019). In chemical and manufacturing sectors and industries, for example, sales per capita, the gross profit margin, employee productivity, and overall business competitiveness are increased by green initiatives (Eiadat et al., 2008; Darnall et al., 2010; Zeng et al., 2011; Fousteris et al., 2019). In line with the argument above, hypothesis (5) is read:

H_5: *A significant and positive relationship exists between the GIT adoption level and business performance.*

3.2.2 Competitive Advantage

This advantage provides a company with superiority over its competitors to regularly earn profits (Porter, 1985; Porter & Van Der Linde, 1995; Ma, 2000, Cater, 2017). Various approaches are used by business firms to gain a competitive advantage over competitors alternating from differentiations, low costs, and focus strategies (Collin & Porter, 1985). In line with Chen

et al. (2006), Allahham and Ahmad (2024) showed that GIT adoption based on green innovation significantly contributes to benefitting the competitive advantage of the company. Hence, hypothesis (6) is read:

H_6: *A significant and positive relationship exists between the GIT adoption level and business performance.*

3.2.3 Process Innovation

Green innovation is categorized into green process innovations and green products (Chen, 2008). From a process perspective, "Green innovation is to adapt to the manufacturing process that decreases the negative influence on the environment during material acquisition, production, and delivery" (Chiou et al., 2011, p. 2). The literature indicates a positive relationship between process innovation and IT (Daoud et al., 2023). Also, GIT is a process which if introduced to the organisation can lead to innovation. The empirical results of Nanath and Pillai (2016) demonstrate that businesses are required to invest additional resources and funds to improve implementing the GIT since it is positively related with process innovation performance and green products. Accordingly, hypothesis (7) is read:

H_7: *A significant and positive relationship exists between the GIT adoption level and process innovation.*

4. Methods

This study collected the data using the survey method, which was then tested using SEM (Hair et al., 2010). The unit of analysis was individual employees of the four big oil companies in Sudan with prior technology experience. Previous experiences were essential as the green IT behaviour and relative advantage levels in the proposed model can only be captured from frequent technology usage.

4.1 Measures

A series of personal interviews with three green IT practitioners from the Sudanese oil industry are conducted to evaluate the external validity of the proposed research model. The related literature review and the remarks collated from interviews have created a survey instrument. The item-based measurement uses a 5- point Likert scale (1 to 5) varying from "strongly disagree" to "strongly agree" as shown in Table (1). The survey items were designed by adapting present measures validated by previous pieces of research. The instrument was pre-tested by three scholars with important expertise in the GIT area. The survey was also tested on fifth-year MIS students enrolled in at Ahfad University for women in Sudan. To the highest possible level, existing scales in the literature are used to adapt measurement items.

Table 1
Study Variables and Related Literature

Construct	Code	No. of Items	Source
Top Management Support	Support	6	Bajwa and Rai (1994)
Training	TRA	5	Igbaria et al. (1995)
Green IT Behaviour	GITBeh	6	Chow and Chen (2009)
Relative Advantage	RA	5	Venkatesh et al. (2003)
Green IT Adoption	GITAdp	7	Moore and Benbasat
Competitive Advantage	CA	9	Sethi and King (1994)
Business Performance	BusPer	7	Le Cornu and Luckett (2000)
Process Innovation	PsInnv	7	Avlonitis et al. (2001)

4.2 Data Collection Procedure

The sampling frame adopted includes oil companies in Sudan. The selection of this industry is thanks to its important influence on the environment and economic development in Sudan. The targeted respondents were employees of the four big oil companies based in Khartoum, the capital city. These employees were selected as the participants as they were directly associated with the GIT adoption and therefore had experience and knowledge in this matter. They are also familiarized with the processes of their businesses. 500 structured questionnaires were distributed to the targeted participants. Only 292 questionnaires were returned with a 59% response rate and used for the analysis using structural equation modelling (SEM).

Due to the nature of the research, the questionnaire is constructed in four sections. The first section comprised descriptive data of the sample companies, including the suitability of the respondents to complete the questionnaire with questions pertaining to position, age, and experience. The second section assessed the four adopted antecedents: top management support, green training, relative advantage, and GIT behaviour. The third part consisted of the extent of GIT adoption. The last part was the measurement of outcomes variables: business performance, competitive advantage, and process innovation.

5. Analysis & Findings

5.1 Demographics

This part depicts the respondents' demographic profile. Female respondents made up 29% of the sample, while males made up 71%. Females can be regarded as part of a minority group in the oil industry. In terms of age, 40% are aged 25 years up to 45 years, and 14% are aged 46-55 years. Most respondents (70%) specified that they had been directly involved in GIT many times a year. This was followed by 10% who had practised a few times a year, while the remaining 20% practised GIT extensively throughout the year. Most of the respondents (89%) stated that their companies were partially committed to GIT adoption.

5.2 Validation of Measurement Model

Next, a test of the discriminant validity is presented. According to Fornell and Larcker (1981, p. 1) define "Discriminant validity is the extent to which the measures are not a reflection of some other variables and is indicated by the low correlations between the measure of interest and the measures of other constructs". Comparing the squared correlations between the AVE for a construct and other constructs is used to examine the discriminant validity. Table (2) shows that the squared correlation for each construct is less than the average variance extracted by the indicators measuring that construct indicating adequate discriminant validity (Hair et al., 2010). In sum, the measurement model confirmed discriminant validity and adequate convergent validity. This indicates that all measurement items have exceeded the recommended cut off point (i.e. 0.615-0.965).

Table 2
Factor Loading of the Study Model Variables

Construct	Code	Loadings
Top Management Support	Support1	.861
	Support2	.919
	Support3	.817
	Support4	.828
	Support5	.883
Training	TRA1	.735
	TRA2	.873
	TRA3	.801
	TRA4	.926
	TRA5	.802
Green IT Behaviour	GITBeh1	.904
	GITBeh2	.767
	GITBeh3	.965
	GITBeh4	.848
	GITBeh5	.811
	GITBeh6	.965
Relative Advantage	RA2	.919
	RA5	.926
Green IT Adoption	GITAdp1	.907
	GITAdp2	.857
	GITAdp3	.900
	GITAdp4	.825
	GITAdp5	.903
	GITAdp6	.861
	GITAdp7	.874
Competitive Advantage	CA1	.882
	CA2	.828
	CA3	.853
	CA4	.878
	CA5	.789
	CA6	.732
	CA7	.877
	CA8	.846
Business Performance	BusPer1	.905
	BusPer2	.930
	BusPer3	.896
	BusPer4	.905
	BusPer5	.852
	BusPer7	.734
Process Innovation	PsInnv1	.709
	PsInnv2	.638
	PsInnv3	.615
	PsInnv4	.930
	PsInnv5	.896
	PsInnv6	.905
	PsInnv7	.852

Table 3
Discriminant Validity of Constructs

	PsInnv	TRA	Support	GIT Beh	RA	GIT Adp	CA	BusPer
Process Innovation	0.866							
Training	0.574	0.784						
Top Management Support	0.772	0.677	0.765					
G IT Behaviour	0.838	0.572	0.792	0.757				
Relative Advantage	0.833	0.482	0.797	0.954	0.855			
G IT Adoption	0.842	0.567	0.808	0.935	0.969	0.784		
Competitive Advantage	0.934	0.565	0.833	0.936	0.935	0.945	0.814	
Bus Performance	0.983	0.568	0.774	0.804	0.781	0.806	0.921	0.882

Note: Significance of Correlations: † p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

The composite reliability values ranging from 0.875 to 0.961 are greater than the acceptable threshold value of 0.7. Similarly, the AVE values ranging from 0.585 to 0.977 have exceeded the 0.5 recommended value. In light of these findings, the reflective variables' convergent validity is confirmed. In addition, as shown in Table 3, discriminant validity is measured by comparing the magnitude of the pair of correlations among variables with the magnitude of the square root of the AVE for the corresponding variables. Moreover, Fornell and Larcker (1981) confirmed that the square root values of the AVEs are greater than the pair of correlations among the variables.

Table 4
Composite Reliability and Average Variance Explained for the Study Variables

	CR	AVE	MSV	MaxR(H)
Top Management Support	0.875	0.585	0.694	0.889
Training	0.887	0.612	0.638	0.89
GIT Behaviour	0.884	0.575	0.911	0.92
Relative Advantage	0.891	0.731	0.939	0.895
GIT Adoption	0.917	0.615	0.939	0.931
Competitive Advantage	0.940	0.662	0.894	0.943
Business Performance	0.961	0.779	0.966	0.962
Process Innovation	0.954	0.749	0.966	0.957

Structural Model

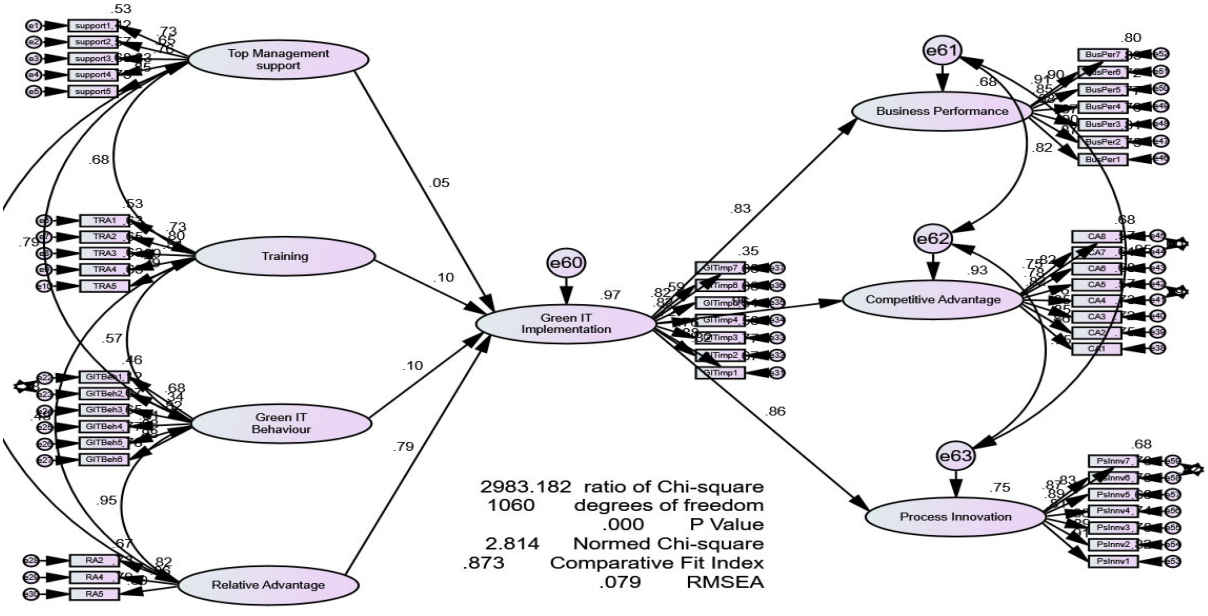

Fig. 2. Structural Model

As gleaned from Table 5, all the hypotheses had been supported except for H1and H4. The structural model analysis was conducted to test our hypotheses regarding GIT adoption (refer to Figure2). The results revealed the antecedents variables, training (H2) (ß = 0.531, P=0.000<0.05, accept) and relative advantage (H4) (ß = 0.56, P=0.325> 0.05, accept), have significant effects on GIT adoption while top management support (H2) (ß = 0.56, P=0.325> 0.05, reject) and GIT behaviour (H4) (ß = 0.027, P=0.617> 0.05, reject). Also, the result showed that the subsequent adoption of FinTech significantly impacts the innovation outcome, product innovation (H8) (ß = 0.679, P=0.000< 0.05), process innovation (H9) (ß = 0.739, P=0.000< 0.05, accept), and innovation capability (H10) (ß = 0. 698, P=0.000< 0.05, accept).

Table 5
Path Coefficients and Hypothesis Testing

			Estimate	S.E.	C.R.	P
GITAdp	←	Top_Management_Support	.042	.052	.812	.417
GIT_Adp	←	Training	.086	.043	2.015	.044
GIT_Adp	←	GIT Behaviour	.080	.149	.534	.593
GIT_Adp	←	Relative Advantage	.654	.173	3.788	***
Business Performance	←	GIT_Adp	1.063	.102	10.372	***
Competitive Advantage	←	GIT_Adp	1.190	.111	10.734	***
Process Innovation	←	GIT_Adp	1.043	.102	10.203	***

6. Discussion of Main Findings

This research hypothesised a positive effect of top management support on GIT adoption (H1). The finding indicated that P-value was (0.417) more than the beta value (0.05), meaning that the hypothesis is rejected. This is proven by Orlikowski (1993) and Liang et al. (2007) who concluded that top management support is a contributory component for acquiring and diffusing innovation. The senior management guides the organisation and is instrumental in shaping its operations. They develop strategies to achieve organisational goals (Thiesse, 2011). According to Jeyaraj et al. (2006), top management support is a crucial antecedent of IT adoption in organisations. Unlike the extant literature (e.g. Deng & Ji, 2015; Chong & Olesen, 2017), this study found an insignificant relationship between GIT adoption and top management support. One explanation is that some managers are keen on avoiding upfront costs related to constructing their IT infrastructures (Bose & Luo, 2012). Another possible explanation is that managers and government bodies in the context of a developing country could be barriers in implementing GIT strategy (Darko et al., 2018).

This research hypothesised the positive effect of training on GIT adoption (H2). The result showed that the P-value was (0.044) less than the beta value (0.05), which means the hypothesis is accepted. Liebowitz (2010) found that training prepares employees with the knowledge and skills necessary to innovate and achieve organisational goals and objectives. Training also enhances the competitiveness of the organisation (Ni et al., 20٢٣) and encourages innovation (Zakaria, 2012).

This research hypothesised a positive effect of relative advantage on GIT adoption (H3). The result showed that the P-value was (0.000) less than the beta value (0.05), which means the hypothesis is accepted. In line with extant studies (Laratta, 2010), this study confirms that relative advantage remains a significant predictor of the innovation adoption rate. Although relative advantage is measured in financial terms, satisfaction, social status, and comfort are also essential factors. The level of objective advantages of innovation has a significant effect, impacting the innovation adoption. Ahmad (٢٠٢٤) argued that the perceived relative advantage is positively associated with the increasing adoption rate of technological innovation.

This research hypothesised a positive effect of GIT behaviour on GIT adoption (H4). The finding indicated that the P-value of (0.593) was greater than the beta value of (0.05), meaning that the hypothesis is rejected. Kollmuss and Agyeman (2002) acknowledged that the degree of household or individual behaviours substantially impacts the environment. Yet, it is challenging for people to relate behaviour and personal consumption to problems with huge levels such as pollution, climate change, and natural resource reduction. In developing countries as supported by Mishra et al. (2014), lack of awareness significantly impacts attitude towards the GIT adoption.
Subsequently, some organisations may not properly realise the potential value of green IT (Dezdar, 2017). The current findings support the suggested Hypotheses H5, H6, and H7, demonstrating a positive relationship between GIT adoption and business performance, competitive advantage, and process innovation, respectively (P-value 0.000 < beta value 0.05). All three hypotheses of the outcomes were supported by the data and accepted. Likewise, these results support the findings drawn from previous research.

This study confirms that GIT adoption remains one of the significant predictors of business performance. Like other IT investments (Mithas & Rust, 2016), GIT can affect firm profitability through its effect on revenue growth. Additionally, firms with higher levels of Green IT practices can rationalise their production and operational processes to decrease environmental impacts (Ainin et al., 2016). In addition, Miroshnychenko et al. (2017) revealed that firms with higher levels of GIT spending and adoption could separate their products on their environmentally friendly business performance outcomes.

The result of this research goes in agreement with the extant study for a positive relationship between competitive advantage and GIT adoption (Cheng, et al.,2023). GIT adoption is a significant enabler reflected in increased competitive advantage and performance. By adopting GIT, the company distinguishes itself from others to create a competitive advantage (Alziady & Enayah, 2019). This study confirms that GIT adoption is regarded as one of the prominent enablers of process innovation. Like previous research (Abualloush et al., 2017), this study shows a positive relationship between process innovation and GIT

adoption. Porter and Kramer (2007) argued that study has confirmed that speaking of the concerns of GIT adoption is essential to the long-term existence of businesses. Furthermore, considering process innovation via GIT adoption will recognise not only environmental protection but also support innovative processes that enhance user-friendly products and services for society.

To end with, the current research findings demonstrate significant differences from the previous literature in the effect of top management support and GIT behaviour on GIT adoption. It is also emphasized that despite the similarity of the findings to preceding studies, the research context differs, as this study contextualises and empirically tests a model demonstrating that GIT adoption is impacted by top management support, training, relative advantage, and green IT behaviour. Consequently, the GIT adoption impacts business performance, competitive advantage, and process innovation.

7. Implications

This research includes quite a few implications. It empirically examines GIT adoption from an oil industry in a developing country context (Sudan). And so, the research represents one of the rare empirical pieces of research that investigate both GIT antecedents and outcomes (Brooks et al. 2018; Farahat, et al., 2019). By this investigation, the study explains the reasons for the GIT adoption, practices, and investment. The outcomes of this research increase understanding of green practices concerning the effect of green training and relative advantage of GIT adoption on business performance, competitive advantage, and process innovation. Furthermore, the GIT adoption research model of this research could be adapted in further developing nations and states to verify its replication or suitability for scholars concerned about cross country data for GIT adoption.

The research has implications for directors and practice, too. Directors could utilise the study model to assess the GIT adoption within their organisation. By investigating both antecedents and outcomes, the findings of this research will give senior and executive managers a roadmap that GIT adoption can affect business performance, competitive advantage, and process innovation. What is more, the research demonstrates the availability of positive antecedents linked with the GIT adoption. As a result, with the support of top management to adopt GIT practices, the organisation could gain from GIT investment.

The results of this study also benefit policymakers. They could adopt green initiatives within their organisation by designing training programs for seniors about the importance of environmentally friendly practices, particularly GIT adoption. The findings may also have implications for managers, GIT suppliers, and practitioners within the oil industry. The executives are more likely to respond to innovative products and user-friendly technologies. However, it is crucial when the oil companies establish a GIT plan and approach to fit in practices, allowing them to continue environmentally friendly in creating value, gaining competitive advantage, and producing green products.

8. Limitations & Future Work

As with any research, the current research limitations pave the way for novel avenues for future research. Being conducted in Khartoum, the study sample was limited to employees in several oil companies. In this case, attention shall be paid when generalising the results to other contexts in other industries. Future work on new industries and states investigates whether the antecedents and outcomes model deployed in this research can be applied in new contexts. Also, in light of the research design quantitative nature, this research centres on the impact of the independent variable's "antecedents" on the dependent variable "outcomes". A longitudinal flavour over time can be taken in future research. Regardless of these limitations, this research highly contributes to the GIT research area, opening countless prospects to find an increased understanding of the research area and assisting scholars to recognize possible concentrations in future research work.

9. Conclusion

In a nutshell, unlike prior research that addresses the different antecedents of GIT adoption from a single view, the present study examines combined effects of various GIT adoptions on business performance, competitive advantage, and process innovation. This provides insights into the GIT literature and addresses a recent research call to understand the nexus of the structural relationships between antecedents and outcomes.

The data has supported five out of seven hypotheses. As gleaned from this research, the antecedents and outcomes of GIT adoption are important to understand green behaviour. As a result, the modified model of GIT adoption is useful for building future studies in GIT practices. This model could be adopted by future researchers, green IT managers, and oil industry practitioners. As shown in this study, the top management should pay more attention to green practices via allocating more resources to support green strategy. Therefore, the level of employees' green IT behaviour in the big oil companies in Sudan needs to be improved. This could be achieved by assigning employees to green training packages across all levels of management. As confirmed by previous studies, GIT adoption creates new opportunities for developing countries, and thinking strategically will be a useful tool for their context to improve performance, competitive advantage, and process innovation.

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