

INTERNET OF THINGS AND SUPPLIER EFFECTIVENESS OF DOWNSTREAM OIL AND GAS COMPANIES IN RIVERS STATE

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Rivers State University Nkpolu-Oroworukwo, Port Harcourt**Abstract**

This study examined the correlation between Internet of Things (IoT) and supplier effectiveness of downstream oil and gas companies in Rivers State. A cross-sectional survey design adopted. The population of the study comprised 30 downstream oil and gas companies in Rivers State. A census was taken, while test units were purposively drawn. 6 management staff were engaged from each of the 30 companies to arrive at 180 respondents. Primary data was collected for the study using questionnaire, and was analyzed using Tables, simple percentages, mean scores and standard deviation. The hypotheses formulated for the study were tested using Pearson Product-Moment Correlation (PPMC). The study found that a significantly positive correlation between IoT and supplier effectiveness of downstream oil and gas companies in Rivers State. Hence, the study concluded that IoT significantly relate to supplier effectiveness of downstream oil and gas companies in Rivers State, and recommends that management of oil and gas companies should implement IoT sensors and tracking devices across their supply chain to monitor product location and environmental conditions.

Keywords: Cost minimization, internet of things, supply effectiveness, waste reduction

Introduction

Organizations operate in an environment characterized by constant change, shorter product lifecycles, and increased demand uncertainty. To adapt and navigate this turbulent business environment, companies must become increasingly dependent on external suppliers for resources and complementary capabilities (Nyaundi & Iravo, 2016). Organizations need a mechanism to track supplier progress towards meeting their goals, and provide feedback to suppliers on their individual performance.

Supplier effectiveness is widely adopted to understand and improve performance of extended enterprises (Gordon, 2010). It is built through effective communication and clearly defined objectives; and includes critical processes that define, measure and analyze supplier performance. Supplier effectiveness is a key enabler for transforming into a mature purchasing organization. The main objective of supplier effectiveness is to improve performance of both suppliers and buying organizations. To improve supplier effectiveness and to sustain competition, organizations need to improve their technology infrastructure, such as Internet of Things IoT.

IoT which has become a critical factor for competitiveness in today's business environment represent an advancement in technological innovation that connect objects and devices through the Internet (Atzori et al., 2010). The network of objects (e.g. devices, vehicles, machines, containers), embedded with sensors and software, has the potential to collect and communicate data over the Internet (Edwards & Hopkins, 2018). IoT platform thus facilitates "things" to be identified, located, sensed and controlled via the global platform (Borgia, 2014). It is viewed as a progression of information and communication technology (ICT) applications that capture and share data in a network of organisations on a real-time basis (Borgia, 2014).

Although there have been a number of studies that investigate IoT integration in improving performance (Li et al., 2009; Qrunfleh & Tarafdar, 2014; Rai et al., 2006; Vanpoucke et al., 2017); there is little or no empirical proof depicting the relationship between IoT and supplier effectiveness among downstream oil and gas firms in Rivers State. This study, therefore, sought to investigate the influence of IoT on supplier effectiveness of downstream oil and gas companies in Rivers State. The conceptual framework of the study is presented in Fig. 1 below.

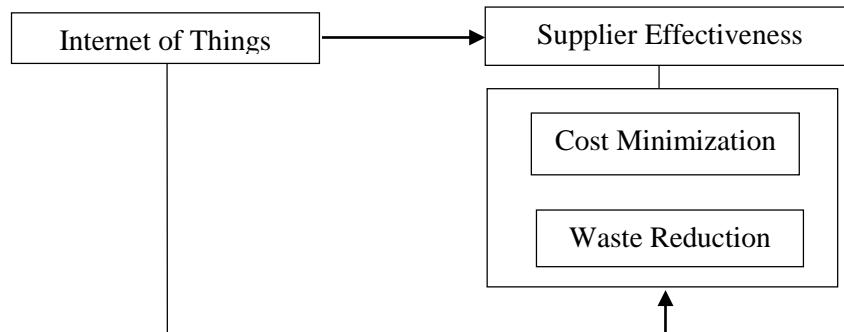


Fig. 1: Conceptual framework of internet of things and supplier effectiveness.

Theoretical Foundation of the Study

This study is predicated upon diffusion of innovation theory (Rogers, 1962) which holds that the cumulative number of adopters of an innovation typically follows an S-shaped curve. Diffusion of innovation refers to the tendency of new products, practices, or ideas to spread among people (Rogers, 1995). Usually, when new products or ideas come about, they are only adopted by a small group of people initially. Later, the innovation spread to other people. The S-curve starts to rise slowly when the first innovators adapt to the innovation. Following that, the cumulative number of adopters rises somewhat faster due to the early adopters.

The criterion for the adopter categorization is innovativeness. Rogers (1995) argues that diffusion is the process by which an innovation is communicated over time among the participants in a social system. Rogers proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. Rogers (1995) emphasizes the importance of reaching a certain 'critical mass' of adopters beyond which the innovation will diffuse without much stimulation. In relating this theory to the study of IoT and supplier effectiveness, we expect that the theory will explain how to increase rate of adoption of digital technology processes to help companies achieve supplier effectiveness.

Concept of Internet of Things

IoT is a new paradigm through which computational objects are connected and communicate with each other. A universal definition of IoT is still not available, as IoT is a term which is broadly used (Wortmann, 2015). However, the term is used to refer to the collective network of connected devices and technology that facilitates communication between devices and the cloud, as well as between the devices themselves. It is a set of interconnected things over the internet, which can measure, communicate, and act all over the world (Díaz et al. (2016). IoT is a foundation stone in industry 4.0 due to its capability and potential to change existing business (Dutton, 2014).

IoT is not just a buzzword in business. It is a developing trend, a proven strategy and an innovative technology with the potential to change the world. It is considered a part of the Internet of the future and will comprise billions of intelligent communicating things (Li et al., 2014). IoT has aroused significant research attention in recent years. However, the exact definition of IoT is still in the process, subject to a variety of perspectives (Hepp et al., 2007; Joshi & Kim, 2008; Pretz, 2013).

IoT is pervasive in the environment, as a variety of things/objects with wireless and wired connections and unique addressing schemes interact with each other and cooperate with other things/objects to create new applications/services and reach common goals (Atzori et al., 2010). Anbazhagan et al. (2022) observe that IoT is a physical object interconnected to the Internet and other networks through different IP addresses, which allow data to be collected and shared via integrated sensors, electronics and software.

IoT is a game-changing technology for improving supplier effectiveness. It enables businesses to navigate the complexities of modern supply chains with greater confidence and precision. It significantly enhances supplier effectiveness by enabling real-time tracking, data-driven decision-making and optimized inventory management that ultimately lead to improved supply chain efficiency. Aich et al. (2019) states that the benefits of implementing IoT in managing supply chains are information continuity and traceability, information accessibility, and a decrease in code of conduct violations and fraud.

Concept of Supplier Effectiveness

Supplier effectiveness is the ability of a supplier to consistently meet or exceed a clients' expectations regarding quality, delivery time, price and other relevant criteria; and effectively contribute to clients' overall business goals (Fowler & Yue, 2012). Essentially, it is a measure of how well a supplier performs in fulfilling its role within a supply chain. Supplier effectiveness is widely adopted as a method to understand and improve the performance of the extended enterprise (Gordon, 2010).

Effective suppliers are those that provide reliable, efficient and cost-effective solutions that meet the needs of client organizations (Handfield et al., 2011). Supplier effectiveness is critical to the success of any organization, as it can impact the quality of products or services, customer satisfaction, and ultimately, the bottom line (Chopra & Meindl, 2019). Supplier effectiveness has significant impact on overall performance of an organization. For example, effective suppliers help buying organizations reduce costs, improve quality and improve customer satisfaction. In contrast, ineffective suppliers result in increased costs, decreased quality, and decreased customer satisfaction. To ensure effective supplier relationships, organizations must develop a clear understanding of their suppliers' capabilities and motivations, as well as their own requirements and expectations (Garvin, 1988). In line with Mesn et al. (2017) and Haile (2017), this study adopts cost minimization and waste reduction as measures of supplier effectiveness.

Cost minimization

Cost minimization is the process of decreasing a company's expenses to maximize profits. It involves identifying and removing expenditures that do not provide added value to customers while also optimizing processes to improve efficiency. Cost minimization typically focuses on generating short-term savings (Figar & Ivanoic, 2015). Companies depend on cost minimization to reduce costs and increase profits. Chartered Institute of Management Accountants (CIMA), defined cost minimization as the achievement of real and permanent reduction in unit cost of goods manufactured or services rendered without damaging the ability of the product to serve the purpose for which it was intended.

According to Gaurav et al. (2013), cost minimization is the way toward searching for, finding and expelling baseless costs from a business to build the benefit without negatively affecting item quality. The concept of continuously searching for new ways and avenue of reducing costs needs to be constantly promoted at all levels of an enterprise, which signifies that the enterprise has a strategic approach to this issue (Figar & Ivanoic, 2015). Cost minimization strategies such as value engineering and value analysis, tight budgetary control (budget discipline), target costing and life cycle costing can be adopted by manufacturing companies to reduce the material cost, labor cost and productivity cost attributed to manufacturing.

Waste reduction

Industrial activities consume resources and generate wastes. Wastes are materials that no longer find usefulness, are residues of industrial activities, have become obsolete or lost their integrity or have been damaged in transit or due to improper handling (Ateke et al., 2025; Zhang et al.,

2022). Waste reduction is the practice of using less material and energy to minimize waste generation and preserve natural resources. It include reusing products such as plastic and glass containers, purchasing more durable products, and using reusable products, such as dishrags instead of paper towels. Donating products, from office equipment to eyeglasses and clothing, reduces the amount of material manufactured overall (Alireza & Mahdi, 2022).

Waste reduction also means economic savings. Fewer materials and less energy is used when waste-reduction practices are applied. Rather than using the traditional cradle-to-grave approach, a cradle-to-cradle system is adopted. In this cradle-to-cradle system, also called industrial ecology, products are not used for a finite length of time. Instead of disposing of materials, or the components of a product after a single use, products are passed on for further uses. This is considered a flow of materials. This can be applied within an organization, or between organizations that may be considered unrelated, on a cooperative basis.

Internet of Things and Supplier Effectiveness

Previous empirical studies provide insight into the role of IoT to enhanced organizational efficiency. Chinedu and Brendan (2023) investigated impact of the IoT in manufacturing management, and found that IoT has significant impact on organizational efficiency, and contributes toward saving cost and time. Relatedly, Zeb-Obipi and Jemima (2022) investigated the relationship between IoT and agility of telecommunication firms in Nigeria. The study found that there is positive relationship between internet of things and organizational agility.

Similarly, Morssi et al. (2020) studied impact of IoT on supply chain performance, with purpose of identifying how IoT impact supply chain performance. The findings showed that IoT has positive impact on supply chain performance. Also, Kitime and Lyimo (2019) assessed the role of IoT in improving organizational efficiency at Arusha Urban Water Supply and Sanitation Authority. The study found that IoT improved revenue collection and increase effectiveness and reduce the managing costs. These empirical studies reviewed suggest that a connection between IoT and supplier effectiveness. However, the following null hypotheses were formulated:

H₀₁: There is no significant relationship between internet of things and cost minimization of downstream oil and gas companies in Rivers State.

H₀₂: There is no significant relationship between internet of things and waste reduction of downstream oil and gas companies in Rivers State.

Methodology

A cross-sectional research design was adopted in this study. The population of the study comprised thirty (30) downstream oil and gas companies in Rivers State. The entire thirty (30) downstream oil and gas companies were studied. The study identified six departments that are relevant in the topical area, which include marketing, production, procurement/purchasing, customer service, quality assurance, and research and development. The study used questionnaire to collect primary data. The instrument was validated by experts in the field of marketing in Rivers State University. The researcher adopted the Cronbach alpha coefficient to measure the reliability of the research instrument, while Pearson Product Moment Correlation was used to test the hypotheses formulated for the study.

Table 1: Cronbach's Alpha of Study Variable

	Study Variables	No. of Items	Reliability Coefficient
2.	Internet of Things	3	.761
4.	Cost Minimizing	3	.883
5.	Waste Reduction	3	.931

Source: SPSS Data Output, 2025

Data Analysis and Result

Table 2: Predictive Statistics on Internet of Things

Items	N	Minimum	Maximum	Mean	Std. Deviation
Our computer network allows sharing of computing resources and information stored on other computers in our organization	142	1.00	5.00	3.29	1.413
We access and use resources provided by devices on the network in our organization	142	1.00	5.00	3.69	1.320
We share files, data, and other information within the organization using network device	142	1.00	5.00	3.36	1.370
Valid N (listwise)	142				

Source: SPSS Output, 2025

Table 2 above shows the frequencies and mean ratings of response to IoT. The result showed that respondents agreed to all the items with their mean ratings greater than 3 when using a 5 Point rating scale. Item 1 “our computer network allows sharing of computing resources and information stored on other computers in our organization” has a mean rating of 3.29. Item 2 “we access and use resources provided by devices on the network in our organization”, has a mean rating of 3.69. Item 3 “we share files, data, and other information within the organization using network device, which enhances customer satisfaction” has a mean rating of 3.36.

Table 3: Descriptive Statistics on Cost Minimization

Items	N	Minimum	Maximum	Mean	Std. Deviation
By minimizing costs, businesses can improve their profit margins.	142	1.00	5.00	3.99	1.182
Firms that manage to keep their costs low can offer lower prices than their competitors.	142	1.00	5.00	3.91	1.193
Reducing costs can help companies weather economic downturns or unexpected financial challenges.	142	1.00	5.00	3.92	1.111
Valid N (listwise)	142				

Source: SPSS Output, 2025

Table 3 shows the frequencies and mean ratings of responses to cost minimization as measure of supplier effectiveness. The result showed that respondents agreed to all the items with their mean ratings greater than 3.00. Item 1 “by minimizing costs, businesses can improve their profit margins” has a mean rating of 3.99. Item 2 “firms that manage to keep their costs low can offer lower prices than their competitors”, has a mean rating of 3.91. Item 3 “reducing costs can help companies weather economic downturns or unexpected financial challenges” has a mean rating of 3.92. This implies that the implementation of digital supply chain systems has helped in reducing cost of operation by oil and gas companies in Rivers State.

Table 4: Descriptive Statistics for Waste Reduction

Items	N	Minimum	Maximum	Mean	Std. Deviation
We use less material and energy to minimize waste generation and preserve natural resources	142	1.00	5.00	3.80	1.331
We often return hazardous materials to the manufacturer	142	1.00	5.00	3.80	1.084
The firm has reduced its solid wastes quantities	142	1.00	5.00	3.80	1.106
Valid N (listwise)	142				

Source: SPSS Output, 2025

Table 4 shows the frequencies and mean ratings of response to waste reduction as measure of supplier effectiveness. The result showed that the respondents agreed to items with their mean ratings greater than 3.00. Item 1 “We use less material and energy to minimize waste generation

and preserve natural resources" has a mean rating of 3.80. Item 2 "We often return hazardous materials to the manufacturer", has a mean rating of 3.80. Item 3 "The firm has reduced its solid wastes quantities" has a mean rating of 3.80. The implication is that waste is reduced through the integration of digital supply chain systems in the organizations under study.

Table 5: Correlations between internet of things and cost minimization

		Internet of Things	Cost Minimization
Internet of Things	Pearson Correlation	1	.615**
	Sig. (2-tailed)		.001
	N	142	142
Cost Minimization	Pearson Correlation	.615**	1
	Sig. (2-tailed)	.001	
	N	142	142

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

Source: SPSS Output, 2025

Table 5 shows a Pearson Product Moment Correlation Coefficient of .615** on the relationship between IoT and cost minimization. This implies a strong, positive and statistically significant correlation between IoT and cost minimization of downstream oil and gas companies in Rivers State. Additionally, the sig-calculated is less than significant level (p-v=0.000, < 0.05). Therefore, the null hypothesis is rejected.

Table 6: Correlations between internet of things and waste reduction

		Internet of Things	Waste Reduction
Internet of Things	Pearson Correlation	1	.889**
	Sig. (2-tailed)		.000
	N	142	142
Waste Reduction	Pearson Correlation	.889**	1
	Sig. (2-tailed)	.000	
	N	142	142

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

Source: SPSS Output, 2025

Table 6 shows a P(r) of .889** on the correlation between IoT and waste reduction. The results showed that a very strong positive and statistically significant correlation between IoT and waste reduction of downstream oil and gas companies in Rivers State. Additionally, sig-calculated is less than significant level (p-v=0.000, < 0.05). Thus, we reject the null hypothesis.

Discussion of Findings

The results of hypotheses showed strong positive correlation between IoT and cost minimization of downstream oil and gas companies in Rivers State; and very strong positive correlation between IoT and waste reduction of downstream oil and gas companies in Rivers State. These findings support the findings of Chinedu and Brendan (2023) whose result showed that IoT has a significant impact on organizational efficiency, and that IoT significantly contributes toward saving cost and time for the organizations.

Furthermore, the currfinding of our study is supported by the findings of Zeb-Obipi and Jemima (2022), which showed that there is a positive relationship between internet of things and organizational agility. Morssi et al. (2020) found that IoT would have a positive impact on supply chain performance metrics of the selected sample, with exception of very few measures that shown as no change. Similarly, Kitime and Lyimo (2019) found that there is a connection between internet of things and supplier effectiveness. Hence, the following hypotheses were formulated

Conclusion and Recommendations

This study investigated the correlation between IoT and supplier effectiveness of downstream oil and gas companies in Rivers State. The study's findings confirmed that IoT has positive and significant correlation with measures cost minimization and waste reduction, which were used to proxy supplier effectiveness. This means that optimal use of IoT is pivotal to supplier effectiveness in terms of cost minimization and waste reduction waste through its capacity to streamline workflows, reduce redundancies, and improve overall supplier performance. The study therefore, concludes that IoT has significant correlation with supplier effectiveness of downstream oil and gas companies in Rivers Stat; and recommends that management of oil and gas companies that seek improved supplier effectiveness should leverage IoT capabilities to sensor and track devices across their supply chain and monitor product location and environmental conditions.

References

Aich, S., Chakraborty, S., Sain, M., Lee, H.I. & Kim, H.C. (2019). A review of benefits of IoT integrated blockchain based supply chain management implementations across different sectors with case study. *In 21st international conference on advanced communication technology (ICACT)* (138-141).

Alireza, A. S., & Mahdi, A. (2012). Target and kaizen costing. *International Journal of Social, Behavioural, Educational, Economic, Business and Industrial engineering*, 6(2), 1-71.

Anbazhagan, A., Guru, K., Gazala, M., Meeta, M., Viney, D., & Mohd, N. (2022). Critically analyzing the concept of internet of things (IoT) and how it impacts employee and organizational performance. *Proceedings of Second International Conference in Mechanical and Energy Technology, Smart Innovation, Systems and Technologies* 290.

Ateke, B. W., Nwulu C. S., & Damian-Okoro, I. R. (2025). Logistics optimization and distribution efficiency of fast-moving consumer goods (FMCG) distributors in Rivers State. *FULafia International Journal of Business and Allied Studies*, 3(2), 1-19.

Atzori, L., Iera, A., & Morabito, G. (2010). The Internet of Things: A survey. *Computer Networks*, 54(15), 2787-2805.

Borgia, E. (2014). The internet of things vision: Key features, applications and open issues. *Computer Communications*, 54, 1-31.

Chinedu, U.N. & Brendan, E. (2023). The impact of internet of things in manufacturing management. *Engineering*, 15, 533-560.

Chopra, S., & Meindl, P. (2019). *Supply Chain Management* (4th edition). Wiley.

Díaz, E., Martín, J., & Puente, J. M. (2004). Evaluation of subjective mental workload: A comparison of SWAT, NASA-TLX, and workload profile methods. *Applied Psychology: An International Review*, 53(1), 61–86.

Dutton, J. E. (2014). Compassion at work. *Annual Review of Organizational Psychology and Organizational Behavior*, 1, 277–304.

Figar, N., & Ivanovic, V. (2015). Cost reduction strategy: Process and effects. *Journal of Current Research*, 12(1), 15-26.

Fowler, A., & Yue, J. (2012). Strategic supplier management. In G. Avlonitis, A. Iavazzo, & B. Roldos (Eds.), *Supply chain management: Principles, practices, and theoretical frameworks*. Springer.

Garvin, D.A. (1988). Quality, productivity, and competitive advantage. *Organizational Dynamics*, 16(4), 30-44.

Gordon, S. (2010). *Supplier Evaluation and Performance Excellence: A Guide to Meaningful Metrics and Successful Results*. Florida: J. Ross Publishing.

Handfield, R., Rogers, D., Morris, R., & Carter, J. (2011). Strategic supply chain management: The five core disciplines for top performance.

Hepp, M., Siorpaes, K., & Bachlechner, D. (2007). Harvesting Wiki consensus: using wikipedia entries as vocabulary for knowledge management. *IEEE Internet Computing*, 11(5), 54–65.

Hsieh, Y.-J., & Wu, Y. J. (2018). Entrepreneurship through the platform strategy in the digital era: Insights and research opportunities. *Computers in Human Behavior*, 5(6), 23-41.

Joshi, G. P., & Kim, S. W. (2008). Survey, nomenclature and comparison of reader anti-collision protocols in RFID. *IETE Technical Review*, 25(5), 234-243.

Kitime, O & Lyimo, B. J. (2019). Role of internet of things in improving organizational efficiency: A case of Arusha Urban Water Supply and Sanitation Authority. *Olwa Academy – School of Researchers*, 2(3), 1-39.

Lee, I., & Lee, K. (2015). The internet of things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons*, 58(4), 431-440.

Li, G., Yang, H., Sun, L., & Sohal, A. S. (2009). The impact of IT implementation on supply chain integration and performance. *International Journal of Production Economics*, 120(1), 125-138.

Morris, M., & Carter, C. R. (2005). Relationship marketing and supplier logistics performance: An extension of the key mediating variables model. *The Journal of Supply Chain Management*, 41, 32–43.

Nyaundi, J. R. & Iravo, M. A. (2016). Effects of supplier effectiveness on organization performance at Kenya Seed Company, Kitale, Kenya. *International Journal of Recent Research in Commerce Economics and Management*, 3(3), 70-84.

Pretz, K. (2013). The next evolution of the internet. Retrieved 2018/3/11 from <http://theinstitute.ieee.org/technology-focus/technology-topic/the-next-evolution-of-the-internet>.

Qrunfleh, S., & Tarafdar, M. (2014). Supply chain information systems strategy: Impacts on supply chain performance and firm performance. *International Journal of Production Economics*, 147(1), 340-350.

Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS quarterly*, 30(2), 225-246.

Rogers, E. M. (1995). *Diffusion of innovations (4th edition)*. The Free Press.

Wortmann, F. (2015). Internet of things-technology and value added. *Business & Information Systems Engineering*, 57, 221-224.

Zeb-Obipi, I., & Jemima, O. R. (2022). Internet of things and organizational agility in telecommunication companies in Nigeria. *Sustainability Accounting, Management and Policy Journal*, 7(2), 115-119