Antecedents of Internet of Things Adoption in Oil and Gas Industry

To cite this article: Shamsul Bahri Abdul Satar et al 2019 J. Phys.: Conf. Ser. 1196 012006

View the article online for updates and enhancements.

You may also like

- Io after Galileo
  Rosaly M C Lopes and David A Williams

- A Model Of Factors Influencing Users' Adoption Of Internet Of Things Services: A Case Study Of Iraqi Educational Institutions
  Hayder Salah Hashim and Zainab Amin Al-Sulami

- The Prospect of Internet of Things and Big Data Analytics in Transportation System
  Waleed Noori Hussein, L.M. Kamarudin, Haider N. Hussain et al.
Antecedents of Internet of Things Adoption in Oil and Gas Industry

Shamsul Bahri Abdul Satar¹, Ab Razak Che Hussin¹, Yusuf Sahabi Ali¹,², Samsuryadi³

¹Universiti Teknologi Malaysia, Department of Information Systems, Malaysia
²Ahmadu Bello University, Department of Computer Science, Zaria, Nigeria
³Universitas Sriwijaya, Department of Informatics Engineering, Indonesia

shamsulbahri@hotmail.com, abrazak@utm.my, sahabiali@yahoo.com, syamsuryadi@unsri.ac.id

Abstract. Internet of Things (IoT) is one of the top digital topics recently emerging within the oil and gas industry. According to several definitions of IoT, everything should be interconnected and linked to each other. For IoT to emerge from the conceptual level and become a reality, organizations must be ready to invest and adopt this new technology. Several studies have showed the potentials that IoT holds for the industrial sector. However, IoT is still not properly adopted across various organizations in various industries, including the oil and gas. We conducted an extensive literature review on several databases to identify the antecedents of IoT adoption in the oil and gas industry. This study aims to identify the antecedents of IoT adoption in oil and gas industry from different literatures and present the research model. This paper will help the organizations in oil and gas industry to understand the antecedents of IoT adoption; and spur the research community to delve into more research on IoT adoption.

1. Introduction

Oil and gas industry have played an important role in producing an energy resource for the world’s population and transforming the world’s economy since the industrial revolution in the 18th century. After the falling prices of crude oil in recent period [1], the oil and gas industry are redefining its boundaries through digitalization and creating the practical solutions to support its operations. Given the huge capital investments, there is a growing concern on IoT adoption in oil and gas industry specially to optimize the overhead and operational costs.

IoT is identified as one of the technologies that developed as a priority in digital topic for the oil and gas industry [2]. It could be defined as a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols, where physical and virtual components have unique identities [3]. It can be conceptually understood as a world where physical objects are integrated into the information network and become active participants in business processes. IoT plays an important role in bridging the gap between the physical world and representations in Information Systems [4]. The economic world is driven by the competitive struggle for knowledge acquisition by organizations. IoT developments show that there will be 16 billion interconnected devices by the year 2020 [5], which will average out to six devices per person on earth, and much more per person in digital societies [3].
According to recent survey results by Gartner, there is global acceptance on the importance of IoT, but less than one-third of organizations are currently using IoT, indicating that IoT is still in the early phase of adoption [6]. The opportunity for the oil and gas industry to leverage the IoT technology becomes more evident with the great potential in providing opportunities for value creation to improve businesses and overall competitiveness [7]. This study is focused on understanding IoT adoption at the organizational level.

2. Methodology

Systematic Literature Review (SLR) approach is used to realize the aim of this study. SLR is referred as a process of identifying, evaluating, and interpreting all available research relevant to research questions, area of study, or rising phenomenon of interest [8]. Analysing previous studies is an important endeavour in all disciplines [9]. A systematic literature study should consider quality literature, provide a basis for any research, indicate the novelty of the research works and propose future studies and benefits [10], [11]. The key activities within SLR including scoping, screening, planning and identifying.

The entire review process was conducted with specific guidelines to reduce the possibility of researcher bias [12]. Development of research questions is important activity in this study with main objective to answer research questions highlighted below:

RQ1. What are the suitable framework and theory to develop research model for IoT adoption in oil and gas industry?
RQ2. What are the antecedents of IoT adoption in oil and gas industry?
RQ3. What is the research model for IoT adoption in oil and gas company?

SLR process dealt with the research questions in the automatic phase by retrieving related published journals and papers from online databases in Information Systems discipline comprises of ACM Digital Library; Computers and Applied Sciences Complete; IEEE Xplore Digital Library; ScienceDirect; SAGE Stats; The Association for Information Systems (AIS); MIS Quarterly; Springer Link and Google Scholar. [16] suggested that researcher should not constrain the search process to certain journals. Backward and forward search method being used in the manual phase to obtain the citations of selected articles [9].

3. Results and Discussions

With a systematic search strategy, initial search result identified 142 articles. Mendeley was used to remove duplicates before deploying the inclusion and exclusion criteria which reduced the result into 98 articles. Total 75 articles were selected as the primary study after applying the quality assessment. During the analysis of primary study, suitable framework and theory have been identified to develop research model for IoT adoption in oil and gas industry. Antecedents of IoT adoption in oil and gas industry were also identified for further discussion. Adoption theories are used to explain the phenomena in adopting Information Technology (IT) and understanding the individuals' and organizations' tendency of adoption and deployment of new technology [14]. Once the new technology is adopted, it will be used by others within a certain time frame [15]. Several popular frameworks and theories in IS research have been identified and that were employed in different studies.

Given that the oil and gas industry is related to organizational level, TOE framework and DOI theory were selected for this study together with Oil and Gas Value (OGV) Framework developed in [33]. Based on the TOE framework, DOI theory and OGV Framework, the antecedents of IoT adoption in oil and gas industry are shown in Table 1 for further discussion.
Table 1. Antecedents for IoT Adoption in Oil and Gas Industry

| Categories | Antecedents               | Authors                                                                 |
|------------|---------------------------|-------------------------------------------------------------------------|
| Technology & Innovation (TOE & DOI) | Relative Advantage | [23], [24], [25], [26], [27], [28], [29], [30] |
|            | Complexity                | [24], [26], [28], [29], [30], [31], [32] |
|            | Compatibility             | [23], [24], [25], [26], [27], [28], [29], [30], [31], [32] |
|            | Technology Readiness      | [25], [30], [31] |
|            | Security Concern          | [25], [31] |
| Organization (TOE & DOI) | Top Management Support    | [24], [26], [28], [30], [31], [32] |
|            | Firm Size                 | [24], [25], [28], [31], [32] |
| Environment (TOE) | Competitive Pressure      | [24], [25], [26], [28], [29], [30], [31] |
|            | Trading Partner Pressure  | [24], [28] |
|            | Information Intensity     | [24], [28] |
|            | Regulatory Support        | [25], [29], [30], [31], [32] |
| Industry (OGV) | Financial Performance     | [33] |
|            | Customer Value            | [33] |
|            | Societal Value            | [33] |
|            | Environmental Value       | [33] |

The research model is proposed after a deep review of relevant literatures in IoT adoption and developed based on TOE framework, DOI theory, and OGV Framework. Fifteen most frequently occurring antecedents were selected to be the driving factors to adopt IoT in the oil and gas industry. Figure 1 presented the model in four different categories – Technology and Innovation, Organization, Environment, and Industry.

![Figure 1. Research Model for IoT Adoption in Oil and Gas Industry](image-url)
Several factors have been selected as antecedents of IoT adoption in oil and gas industry derived from the literature review. The most frequently occurring antecedents with definition explained in Table 2.

| Antecedents               | Definitions                                                                                                                                                                                                 | References |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Relative Advantage        | The degree to which technological factors are perceived in providing greater benefits to the organizations.                                                                                             | [22], [34] |
| Complexity                | The degree to which an innovation is perceived as being relatively difficult to understand and use.                                                                                                         | [22]       |
| Compatibility             | The degree to which an innovation is perceived as consistent with the existing values, experience and needs of firms.                                                                                     | [22]       |
| Technology Readiness      | Technological infrastructure and IT human resources that influences the adoption of new technology.                                                                                                | [34]       |
| Security Concern          | Potential security risks that influence a firm’s decision to adopt the innovation.                                                                                                                         | [31]       |
| Top Management Support    | The degree to which top management intends to adopt new technology and create supportive climate.                                                                                                           | [34]       |
| Firm Size                 | Total workforce employed in the organization.                                                                                                                                                               | [35], [36] |
| Competitive Pressure      | The degree of pressure felt by the firm from the competitors.                                                                                                                                             | [34]       |
| Trading Partner Pressure  | Effectiveness of partners or level of pressure felt by the organization from partners.                                                                                                                        | [34]       |
| Information Intensity     | The degree to which information is present in the product or service of a business                                                                                                                          | [37]       |
| Regulatory Support        | Different types of assistance given by the regulatory agency.                                                                                                                                           | [38]       |
| Financial Performance     | Potential impact on the operating profits generated from digital initiatives.                                                                                                                             | [33]       |
| Customer Value            | Potential gain to customers in cost, time savings and discounts.                                                                                                                                           | [33]       |
| Societal Value            | Impact on productivity, jobs, reduction in injuries and accidents at the workplace.                                                                                                                         | [33]       |
| Environmental Value       | Impact on emissions (CO2e, SO2, NOX and CO), water usage and oil spills                                                                                                                                     | [33]       |
4. Conclusion and Future Work
In summary, this study provides new insight to understanding IoT adoption in the oil and gas industry. With references systematically derived from previous literatures, the study presents fifteen antecedents of IoT adoption in the oil and gas industry. The proposed research model for IoT adoption in the oil and gas industry was developed based on these antecedents. The oil and gas industry needs to understand the benefits and challenges of IoT to decide to adopt IoT technology in its environment. Future works for this study include several steps: content validity, pilot survey, questionnaire distribution and data analysis.

References
[1] Nasdaq Crude Oil Brent: Latest Price & Chart for Crude Oil Brent 2017 http://www.nasdaq.com/markets/crude-oil-brent.aspx
[2] Accenture: The 2016 Upstream Oil and Gas Digital Trends Survey https://www.accenture.com/ch-en/insight-2016-upstream-oil-gas-digital-trends-survey
[3] Vermesan O, Friess P, Guillemin P, Gusmeroli S, Sundmaeker H and Bassi A 2011 Internet of Things Strategic Research Roadmap Internet of Things-Global Technological and Societal Trends I p 9-52
[4] Haller S, Karnouskos S and Schrot C 2008 The Internet of Things in An Enterprise Context in Future Internet Symposium p 14-28
[5] Vision and Challenges for Realizing the Internet of Things 2010 European Union ISBN 9789279150883
[6] Velosa A and Nuttall N 2016 Use the IoT to Optimize Operating Costs and Maximize Asset Utilization whitepaper Gartner
[7] McKinsey Global Institute. The Internet of Things: Mapping the Value Beyond the Hype, http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/the-internet-of-things-the-value-of-digitizing-the-physical-world
[8] Kitchenham B and Charters S 2007 Guidelines for performing Systematic Literature reviews in Software Engineering vol 45
[9] Webster J and Watson R T 2002 Analyzing the Past to Prepare for the Future: Writing a Literature Review MIS vol 26 no 2 pp 13 - 23
[10] Chiasson M, Geromonprez M and Mathiassen L 2008 Pluralist action research: A review of the Information Systems Literature Inf. Syst. J vol 19 no 1 pp 31–54
[11] Dibbern J, Goles T, Hirschheim R and Jayatilaka B 2004 Information Systems Outsourcing: A Survey and Analysis of the Literature SIGMIS Database vol 35, no 4 pp 6–102
[12] Kitchenham B 2004 Procedures for performing systematic reviews vol 33
[13] Bandara W, Miskon S and Fielt E 2011A Systematic, Tool-Supported Method for Conducting Literature Reviews in Information Systems in ECIS 2011: Proceedings of the 19th European Conference on Information Systems pp 1 – 14.
[14] Straub ET 2009 Understanding Technology Adoption: Theory and Future Directions for Informal Learning Review of Educational Research 79(2) 625-649
[15] Tomatzky LG and Fleischer M 1990 The Processes of Technological Innovation Lexington Books Lexington MA
[16] Webster J and Watson R T 2002 Analyzing the Past to Prepare for the Future: Writing a Literature Review MISvol 26 no 2 pp 13 – 23
[17] Davis F 1989 Perceived usefulness, perceived ease of use, and user acceptance of information technology Management Information Systems Quarterly 13(3) 319-340
[18] Venkatesh V, Morris M G, Davis G B and Davis F D 2003 User acceptance of information technology: Toward a unified view Management Information Systems Quarterly 27 425–478
[19] Ajzen I 1991 The Theory of Planned Behavior Organizational Behavior and Human Decision Processes 50(2) 179-211
[20] Fishbein M and Ajzen I 1975. Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research London Addison-Wesley
[21] Tornatzky LG and Fleischer M 1990 The Processes of Technological Innovation Lexington Books Lexington Massachusetts
[22] Rogers E M 2003 Diffusion of Innovations New York NY Free Press
[23] Dedrick J. and West J 2003 Proceedings on the Workshop on Standard Making, a Critical Research Frontier for Information System. Seattle Washington, 236-257
[24] Zhu K, Kraemer K L and Xu S 2006 The Process of Innovation Assimilation by Firms in Different Countries: A Technology Diffusion Perspective on E-Business Management Science, 52(10), 1557, 1576
[25] Leinbach T R 2008 Global E-Commerce: Impacts of National Environment and Policy edited by Kenneth L. Kraemer, Jason Dedrick, Nigel P. Melville and Kevin Zhu. Cambridge: Cambridge University Press the Information Society 24 123-125
[26] Chong A, Ooi K, Lin B and Raman M 2009 Factors affecting the adoption level of e-commerce: an empirical study Journal of Computer Information Systems 50 (2) 124-145
[27] Azadegan A and Teich J 2010 Effective benchmarking of innovation adoptions: A theoretical framework for e-procurement technologies Benchmarking: An International Journal 17 472-490
[28] Wang L, Von Laszewski G, Younge A, He X, Kunze M, Tao J and Fu C 2010 Cloud computing: a perspective study New Generation Computing 28(2) 137-146
[29] Ifinedo P 2011 An empirical analysis of factors influencing Internet/e-business technologies adoption by SMEs in Canada International Journal of Information Technology and Decision Making 10(4) 731-766
[30] Rohani M B 2017 Cloud Based Applications Adoption Model for Universities’ Technology Transfer University Teknologi Malaysia
[31] Oliveira T, Thomas M and Espadanal M 2014 Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors Journal of Information and Management 51 497–510
[32] Lin D, Lee C and Lin K 2016 Research on Effect Factors Evaluation of Internet of Things (IoT) Adoption in Chinese Agricultural Supply Chain Proceedings of the 2016 IEEE IEEM
[33] Digital Transformation Initiative Oil and Gas Industry 2017 World Economic Forum 060117
[34] Low C, Chen Y, Wu M 2011 Understanding the Determinants of Cloud Computing Adoption Industrial Management & Data Systems 111 (7) pp1006-1023
[35] Wagner J 2007 Exports and productivity: A survey of the evidence from firm-level data The World Economy 30(1) 60-82
[36] Lee G and Xia W 2006 Organizational size and IT innovation adoption: A meta-analysis Information & Management 43 (8) 975-985
[37] Thong J 1999 An integrated model of information systems adoption in small businesses Journal of Management Information Systems 15(4) 187-214
[38] Saedi A and Iahad N A 2013 Future Research on Cloud Computing Adoption by Small and Medium-Sized Enterprises: A Critical Analysis of Relevant Theories International Journal of Actor-Network Theory and Technological Innovation 5(2) 1-16