Antecedents of Internet of Things Adoption in Oil and Gas Industry

IOP Conf. Series: Journal of Physics: Conf. Series **1196** (2019) 012006 doi:10.1088/1742-6596/1196/1/012006

Antecedents of Internet of Things Adoption in Oil and Gas Industry

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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 18thcentury. 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 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.

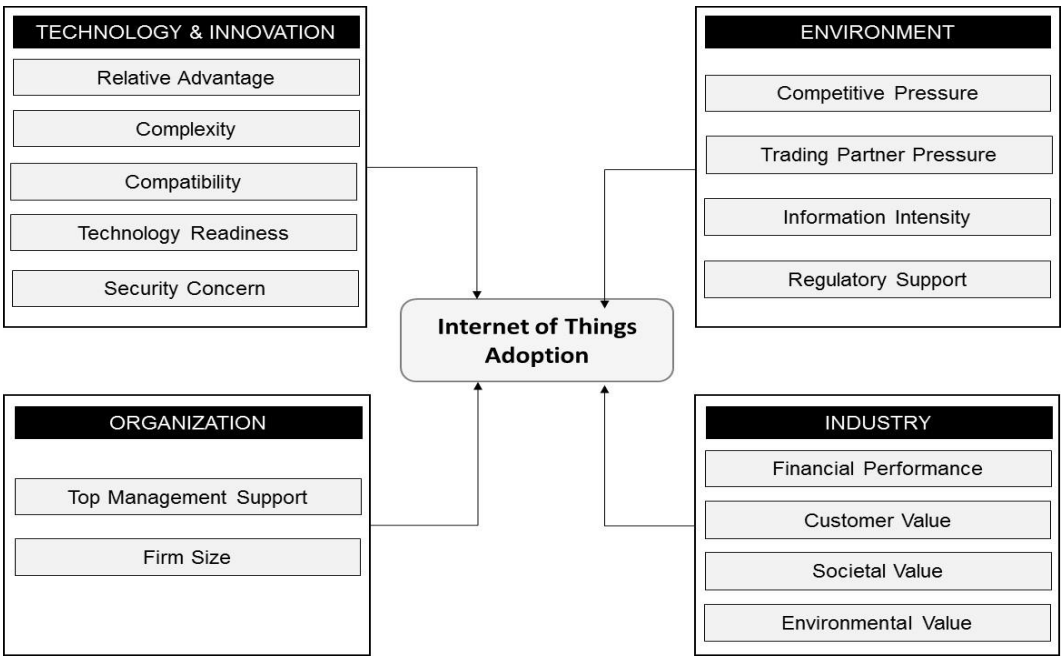

Figure 1. Research Model for IoT Adoption in Oil and Gas Industry

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.

Table 2. Definition of the Antecedents

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 work place.	[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.

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