IT governance enablers in relation to IoT implementation: a systematic literature review

Abstract

IT governance it is being used by the organizations to extend and sustain the IT organizations' according to the business objectives. IoT is a new sector of the industry that is performing an impact on how the organizations collect and exchange information, and how they will perceive the customer needs. Some studies predict that several industries may be hugely influenced by IoT technology being an important part to achieve business goals. This research performs a systematic literature review (SLR) aiming to enlighten readers about which are the most suitable IoT enablers and respective usefulness during IoT implementation. A synthesis of the main literature is described and the main list of IoT enablers identified. Future work is also pointed for further investigation.

Keywords:

COBIT5; enablers; governance; IoT; IT governance; systematic literature review.

1. Introduction

Information technology (IT) governance is high on the agenda in many organisations, and high-level IT governance (ITG) models are being raised within the organisations (De Haes and Van Grembergen, 2008). The ITG goals are to encourage desirable behavior in IT use and has capabilities to get the business level aligned with IT, the alignment of IT objectives to the overall business strategy, the measures of IT performance, and the competitive advantages provided by IT for the organisation (Higgins and Sinclair, 2008; Kude *et al.*, 2017). ITG contains the roles and responsibilities to apply in information systems (IS) and related technologies and to manage and support the organisation's functions (Higgins and Sinclair, 2008). Also consists of the leadership and organisational structures and processes that ensure the organisation's IT sustains and extends the organisation's strategy and objectives (De Haes and Van Grembergen, 2008).

ITG can be deployed using a mixture of various structures, processes and relational mechanisms (De Haes and Van Grembergen, 2008) and concentrates on performing and transforming IT to meet present and future demands of the business (De Haes, 2008).

IoT is being emerging as a new computing paradigm where the devices are interconnected with a range of communications solutions, and this can help improve the living standard of the citizens (Yaqoob *et al.*, 2017). IoT it is defined as a global infrastructure, that enables advanced services by connecting the physical devices with the virtual applications (Wortmann and Flüchter, 2015). IoT innovation can bring up new ways to combine the physical and digital components making the appearance of new products and enabling novel business models (Wortmann and Flüchter, 2015).

ITG enablers it is referred in the framework COBIT5 as factors that, individually and collectively influence the governance and management of IT organization (Joshi *et al.*, 2018).

Grounded in the previous paragraphs, SLR methodology was adopted since IoT is a recent concept and its relationship with ITG enablers are unexplored. The authors believe that SLR is then adequate to summarize and synthesize the scientific studies regarding ITG enablers in relation to IoT, checking the best recommendations for an IoT implementation according to each ITG enabler and identify the gaps in order to investigate them in the future work.

An SLR has great importance in research where few or none consensus exist about a specific concept. The SLR is the best approach to synthesize the existing work, find the related work that is not supported by the research questions as well to find the supported research questions information pretended (Tranfield, 2003). The SLR methodology is a systematic, explicit, comprehensive and reproducible method for identifying, evaluating and synthesizing the all information recorded by the authors during the research (Okoli and Schabram, 2010).

To sum up, this research aims to understand each enabler from an IoT perspective and how they can be useful during IoT implementation.

The remaining document is organized as follows: in section 2 (Background), in section 3 (Research Method), in section 4 (Results), in section 5 (Discussion and Insights) and in section 6 (Conclusions).

2. Background

The ITG enablers referred in this research must be assumed as the ones identified by COBIT5, and that can be applied in various practical situations or be used to implement effectiveness and efficiency information governance and information management within an organisation (ISACA, 2013).

COBIT5 enablers are introduced in the 4th principle “Enabling a Holistic Approach” to promote more efficient and effective governance and management of enterprise IT. COBIT5 defines seven categories of enablers to support the implementation of a comprehensive governance and management system for enterprise IT (ISACA, 2013). The ITG enablers are viewed as factors to help the IT- business alignment which is the core of ITG (Ndlovu and Kyobe, 2016). COBIT5 built these insights so-called enablers and they defined them as factors, influencing individually and collectively somethings that will work and in this case is under governance and management over enterprise IT (De Haes, Van Grembergen and Debreceny, 2013). The ITG enablers considered in this research are: principles, policies, and frameworks; processes; organisation structures; culture, ethics and behavior; information; services, infrastructures and applications; people, skills and competencies.

The enablers are factors that, individually and collectively, influence whether something will work in this case, governance and management over organisation IT (ISACA, 2013).

The first definition of IoT came from a “things oriented” perspective and evolved into a concept in which devices are connected to other devices over the internet, where they can communicate to each other using technologies such as Radio Frequency Identification (RFID), Bluetooth by sensors, actuators, etc., to reach common goals (Atzori, Iera and Morabito, 2010). IoT for De Cremer, Nguyen, and Simkin (2017) IoT is considered a network of interconnected devices, systems and services using the existing Internet infrastructure. IoT can also be defined as a global network of interconnected devices based on common standards communication protocols and also allows the interaction and communication with one another with a data exchange environment about the surrounding environment enabling the creation of services without direct human intervention (Gubbi *et al.*, 2013).

This research has meant to contribute conceptually the worlds from ITG and IoT, combining them through a list of recommendations, providing more tools and capacities for the organisations to increase the success rate in their IoT projects.

3. Research Method

This research applied a systematic literature review approach to identify and summarize the knowledge publish about IoT and ITG enablers defined by the COBIT 5 framework. The stages detailed in Figure 1 were constituted using as reference the article (Qumer Gill *et al.*, 2018).

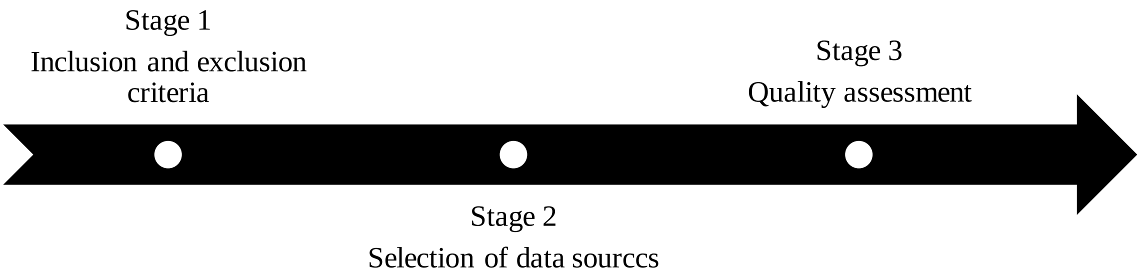

Figure 1 - Research Stages

Stage 1. Inclusion and exclusion criteria

The inclusion and exclusion criteria for this review guides the following research questions:
RQ1: The article was published in a journal with a classification of Q1, Q2?
RQ2: The article selected for the review is from a conference proceeding with an ERA classification of A or B, or Qualis classification of A1, A2 or B1?

Stage 2. Selection of data sources and search strategies

The search for this review was performed using the Google Scholar database to retrieve the articles and the proceedings included in the review.

The selected data sources provided sufficient literature coverage in relation to the subject of the review. The search for this review began on October 10th, 2018 and finished on December 15th, 2018. The data sources were systematically searched using carefully selected search terms or keywords (see Table 1). For instance, we include the term IoT along with enablers. We separate the search by categories (“IoT”, “IoT Enablers”). Inside of these categories we selected several keywords which were combined using Boolean “AND”, e.g., between IoT “AND” principles. It was also used some other keywords to enforce the search in several enablers.

Table 1. Search Terms	
Search Category	**Keywords**
IoT	IoT definition, IoT adoption
IoT Enablers	IoT principles, IoT adoption principles, IoT frameworks, IoT frameworks standards, IoT policies, IoT processes, IoT processes governance, IoT processes cobit, IoT organisational structures, IoT structures, IoT culture, IoT ethics, IoT behavior, IoT information, IoT services, IoT infrastructures, IoT applications governance, IoT people, IoT people roles, IoT people responsibilities, IoT skills, IoT competencies

For the research process, a filtration process was used that brought us to the number of 38 articles selected for the literature review. In Table 2 below is the description of each filtration iteration to help select the relevant articles.

In the first filtration iteration, was used to filter the search terms described in Table 10 using "". In the second filtration iteration, it was used to filter the condition title keywords "-title" to retrieve the results only with the keywords in the title. In the third filtration iteration, the "-abstract" condition was used to check if the keywords were within the abstract of the article. For the final filtration iteration, the relevant articles were chosen for the literature review, checking the articles that matched to the research questions mentioned before.

Table 2. Filtration Iterations			
Filtration Iterations	**Description**	**Assessment criteria**	**Count**
1st filtration	Identification of relevant studies from the selected database.	Search Category and keywords using the filter ""	*12315*
2nd filtration	Exclude studies based on titles	Title = Search terms	*9965*
3rd filtration	Exclude studies based on abstracts	Keywords inside the abstract.	*2347*
Final filtration	Obtain selected relevant articles	Address the research questions.	*38*

Stage 3. Quality Assessment

In the quality assessment, some questions to guarantee the relevance and quality of the selected articles. The assessment criteria were developed (Table 4) and applied to ensure the quality, relevance, and credibility of the articles included in this review. Table 5 details which articles are aligned to the quality criteria questions applied to this literature review. It verifies selected articles to provide more information on compiling points to consider in each ITG enabler with IoT.

Table 3 describes the filtration iterations for each term used to search the relevant articles selected for the literature review.

Table 3. Filtration iterations for each term

Search Terms	**1st filtration**	**2nd filtration**	**3rd filtration**	**Final filtration**
IoT principles	176	149	29	3
IoT applications governance	207	178	32	2
IoT adoption	393	318	43	1
IoT definition	374	292	52	2
IoT frameworks	510	463	45	2
IoT frameworks standards	293	252	28	1
IoT policies	81	63	9	2
IoT processes	111	88	17	2
IoT processes governance	20	17	4	2
IoT organisational structures	3	3	3	1
IoT structures	70	72	4	0
IoT culture	29	24	3	2
IoT ethics	22	19	3	3
IoT behavior	50	44	8	1
IoT information	1900	1280	186	3
IoT services	6890	5670	713	3
IoT infrastructures	1070	958	1010	3
IoT people	188	157	161	1
IoT people roles	50	37	10	1
IoT people responsibilities	30	11	6	1
IoT skills	51	44	12	1
IoT competencies	4	4	1	1
Total	12315	9965	2347	38

The analysis performed in Table 3 makes the conclusions that several enablers have very few relations with IoT. As you can see the enabler organizational structures only had 1 article with the necessary information regarding the relation between IoT. Also for the enabler people, skills, and competencies very few options appeared in the literature to guides constructing a relation between

IoT. In Table 4 there is the quality criteria questions that were used to filter the selection of articles during the search process, making more consistent the selection itself.

Table 4. Quality Criteria
Quality Criteria
QC1. The article context is related to ITG?
QC2. The article context is related to IoT?
QC3. The description of the article is related to the research context?
QC4. The findings found in the articles bring value to the creation of the concepts?

In Table 5 there is a separation of the articles selected that answered to the quality criteria questions mentioned in Table 4.

Table 5. References according to the quality criteria	
Questions	**References**
QC 1	(Abobakr and A. Azer, 2017)(Almeida, Doneda and Monteiro, 2015)(Almeida, Goh and Doneda, 2017)(Baldini *et al.*, 2015)(Buyya and Vahid Dastjerdi, 2016)(Cao *et al.*, 2016)(Cervantes-Solis and Baber, 2017)(Chatfield and Reddick, 2018)(De Cremer, Nguyen and Simkin, 2017)(Derhamy *et al.*, 2015)(Ding, Chen, & Yang, 2013) (Jayashankar *et al.*, 2018)(Bowen *et al.*, 2017)(Lainhart and J. Oliver, 2012)(Neisse et al., 2015)(Pereira, Benessia and Curvelo, 2013)(Piccialli & Chianese, 2017)(Shen et al., 2018)(Shin, 2014)(Shin and Jin Park, 2017)(Van Deursen & Mossberger, 2018)(Weber, 2009)(Weber, 2013)(Wirtz, Weyerer, & Schichtel, 2018)(Wortmann & Flüchter, 2015)
QC 2	(Abobakr & A. Azer, 2017)(Almeida, Doneda, & Monteiro, 2015) (Almeida, Goh, & Doneda, 2017)(Baldini et al., 2015)(Buyya & Vahid Dastjerdi, 2016)(Cao et al., 2016)(Carretero & García, 2014)(Cervantes-Solis & Baber, 2017)(Chatfield & Reddick, 2018)(Dautov et al., 2018)(De Cremer, Nguyen, & Simkin, 2017) (Derhamy et al., 2015)(Gubbi *et al.*, 2013)(Jayashankar *et al.*, 2018)(Keoh, Kumar and Tschofenig, 2014))(Lainhart, Oliver, & Andrews, 2012)(Neisse et al., 2015)(Pereira, Benessia, & Curvelo, 2013)(Piccialli & Chianese, 2017)(Roman, Zhou, & Lopez, 2013)(Ruggieri *et al.*, 2013)(Shen et al., 2018)(Shin, 2014)(Shin and Jin Park, 2017)(Soro et al., 2017)(Suo *et al.*, 2012)(Truong et al., 2015)(Van Deursen & Mossberger, 2018)(Weber, 2009)(Weber, 2013) (Wen et al., 2017) (Wirtz, Weyerer and Schichtel, 2018)(Wortmann & Flüchter, 2015)
QC 3	(Abobakr & A. Azer, 2017)(Almeida, Doneda and Moreira Da Costa, 2018)(Almeida, Doneda, & Monteiro, 2015) (Almeida, Goh, & Doneda, 2017)(Baldini et al., 2015)(Bowen *et al.*, 2017)(Bowen, Cheung and Rohde, 2007)(Cervantes-Solis & Baber, 2017)(Chatfield & Reddick, 2018)(Dautov et al., 2018)(De Cremer, Nguyen, & Simkin, 2017)(Derhamy et al., 2015)(Keoh, Kumar, & Tschofenig, 2014)(Jayashankar et al., 2018)(Lainhart, Oliver, & Andrews, 2012)(Neisse et al., 2015)(Pereira, Benessia, & Curvelo, 2013) (Piccialli & Chianese, 2017)(Shen et al., 2018)(Shin, 2014)(Shin and Jin Park, 2017)(Soro et al., 2017)(Van Deursen & Mossberger, 2018)(Vlahogianni et al., 2016)(Yao, Sheng, & Dustdar, 2015) (Weber, 2009)(Weber, 2013)(Wen et al., 2017)(Wirtz, Weyerer, & Schichtel, 2018)(Wortmann & Flüchter, 2015)
QC 4	(Abobakr & A. Azer, 2017)(Almeida, Doneda, & Monteiro, 2015)(Almeida, Doneda, & Moreira Da Costa, 2018)(Almeida, Goh, & Doneda, 2017)(Baldini et al., 2015)(Bowen et al., 2017)(Buyya & Vahid Dastjerdi, 2016)(Cao et al., 2016)(Carretero & García, 2014)(Cervantes-Solis & Baber, 2017)(Chatfield & Reddick, 2018)(Dautov et al., 2018)(Derhamy et al., 2015)(De Cremer, Nguyen, & Simkin, 2017)(Ding, Chen, & Yang, 2013)(Gubbi et al., 2013)(Jayashankar et al., 2018)(Keoh, Kumar, & Tschofenig, 2014)(Neisse et al., 2015)(Piccialli & Chianese, 2017)(Roman, Zhou, & Lopez, 2013)(Shen et al., 2018)(Shin, 2014)(Shin and Jin Park, 2017)(Soro et al., 2017)(Suo et al., 2012)(Truong et al., 2015)(Van Deursen & Mossberger, 2018)(Vlahogianni *et al.*, 2016)(Yao, Sheng, & Dustdar, 2015)(Weber, 2009)(Weber, 2013)(Wen et al., 2017)(Wirtz, Weyerer, & Schichtel, 2018)(Wortmann & Flüchter, 2015)

4. Results

Table 6 presents the journals and conferences of each article selected and what the classification consists of. The classification of the journals selected for this review is between Q1 and Q2 classification, and for the conferences, the classification is between A, B, A1, A2, and B1, according to the inclusion criteria mentioned above.

Table 6. Journals & Conferences Selection

Journal & Conference	References	Classification
IEEE Internet of Things Journal	(Keoh, Kumar, & Tschofenig, 2014)(Shen et al., 2018)	Q1
Computer Networks	(Roman, Zhou and Lopez, 2013)	Q2
Conference on Emerging Technologies and Factory Automation	(Derhamy et al., 2015)	B1
IEEE 2nd World Forum on Internet of Things	(Neisse et al., 2015)	B
Conference on Computer Science and Electronics Engineering	(Suo et al., 2012)	A
Journal of Business & Industrial Marketing	(Jayashankar et al., 2018)	Q1
Computer Law & Security Review	(Weber, 2013)(Weber, 2009)	Q2
Government Information Quarterly	(Chatfield & Reddick, 2018)(Wirtz, Weyerer, & Schichtel, 2018)	Q1
IEEE International Conference on Mobile Data Management	(Truong et al., 2015)	A2
Personal and Ubiquitous Computing	(Carretero & García, 2014)	Q2
Journal of Marketing Management	(De Cremer, Nguyen, & Simkin, 2017)	Q1
Future Generation Computer Systems	(Gubbi et al., 2013)	Q1
International Conference on Computer Engineering and Systems	(Abobakr & A. Azer, 2017)	B
Computer Society Conference on Human-Computer Interaction	(Bowen et al., 2017) (Cervantes-Solis & Baber, 2017)	A

In Table 7 there is a separation of the references by classification, was check how many citations each classification has and in the end there is a count to check which classification has more articles and which rank has more citations.

Table 7. References Classification & Citations			
References	**Citations**	**Classification**	**Count**
(Keoh, Kumar, & Tschofenig, 2014)(Jayashankar et al., 2018)(Chatfield & Reddick, 2018)(Wirtz, Weyerer, & Schichtel, 2018)(De Cremer, Nguyen, & Simkin, 2017)(Shen et al., 2018)(Gubbi et al., 2013)(Vlahogianni et al., 2016)(Van Deursen & Mossberger, 2018)	*5683*	Q1	*9*
(Weber, 2013)(Carretero & García, 2014)(Weber, 2009) (Yao, Sheng, & Dustdar, 2015)(Ding, Chen, & Yang, 2013)(Almeida, Goh, & Doneda, 2017)(Almeida, Doneda, & Moreira Da Costa, 2018)(Almeida, Doneda, & Monteiro, 2015)(Wen et al., 2017)(Cao et al., 2016)(Dautov et al., 2018)(Wortmann & Flüchter, 2015)(Piccialli & Chianese, 2017)(Shin, 2014) (Shin and Jin Park, 2017)	*432*	Q2	*15*
(Suo et al., 2012)(Bowen et al., 2017) (Cervantes-Solis & Baber, 2017)(Soro et al., 2017)	*364*	A	*4*
(Neisse et al., 2015)(Abobakr & A. Azer, 2017)	*10*	B	*2*
None	*0*	A1	*0*
(Truong et al., 2015)	*3*	A2	*1*
(Derhamy et al., 2015)	*83*	B1	*1*

5. Discussion and Insights

The Table 8 shows the articles selected for the literature review by each ITG enabler related with IoT.

Below is a description of each term of the ITG enabler with IoT, for example: “IoT AND IT governance principles”, which has been decided to define as “IoT principles”. Information was collected from the various articles selected for this literature review:

Principles, Policies, and Frameworks: In IoT, according to (Roman, Zhou, & Lopez, 2013) it is considered principle the collaboration between several organisations to achieve common goals. In IoT, according to (Buyya & Vahid Dastjerdi, 2016) should exists transparency despite the heterogeneous environment of the IoT system. Ability to have mechanisms for policy generation and enforcement of the governance in the IoT (Buyya & Vahid Dastjerdi, 2016). For (Weber, 2009) the principles in IoT are related to architecture with decentralized management.

Table 8. References selected for each IT governance enabler		
IT governance enablers	**References**	**Total**
Principles, Policies, and Frameworks	(Roman, Zhou, & Lopez, 2013)(Buyya & Vahid Dastjerdi, 2016)(Jayashankar et al., 2018)(Suo et al., 2012)(Neisse et al., 2015)(Chatfield & Reddick, 2018)(Weber, 2013)(Derhamy et al., 2015)(Wirtz, Weyerer, & Schichtel, 2018)(De Cremer, Nguyen, & Simkin, 2017)(Ruggieri et al., 2013)(Weber, 2009)(Almeida, Goh, & Doneda, 2017)	*13*
Services, Infrastructure, and Applications	(Gubbi et al., 2013)(Almeida, Doneda, & Monteiro, 2015)(Wen et al., 2017)(Cao et al., 2016)(Dautov et al., 2018)(Wortmann & Flüchter, 2015)(Piccialli & Chianese, 2017)(Shin, 2014)	*8*
Culture, Ethics, and Behavior	(Abobakr & A. Azer, 2017)(Bowen et al., 2017) (Pereira, Benessia, & Curvelo, 2013)(Baldini et al., 2015)(Cervantes-Solis & Baber, 2017)(Almeida, Doneda, & Monteiro, 2015)(Shin, 2014)	*7*
People, Skills, and Competencies	(De Cremer, Nguyen, & Simkin, 2017)(Shin, 2014)(Soro et al., 2017)(Shin and Jin Park, 2017)(Van Deursen & Mossberger, 2018)	*5*
Processes	(Truong et al., 2015)(Carretero & García, 2014)(De Cremer, Nguyen, & Simkin, 2017)(Ruggieri et al., 2013)	*4*
Information	(Yao, Z. Sheng and Dustdar, 2015)(Vlahogianni et al., 2016)(Almeida et al., 2018)	*3*
Organisational Structures	(Shen et al., 2018)	*1*

Proportionality in IoT should be included by governance to help make decisions, and such decisions must maximize the overall state of the IoT system (Buyya & Vahid Dastjerdi, 2016). The outcomes of the principles should reflect stakeholder values (Weber, 2009). Accountability would be necessary to keep a record of decisions and factors to contribute to the decisions of the past (Buyya & Vahid Dastjerdi, 2016). The principles need to contribute to contextualize IoT as part of global resources (Almeida, Goh and Doneda, 2017). The (Ruggieri et al., 2013) says that should be considered as a principle the perceived risk associated with IoT technology when we are making an IoT adoption within an organisation (Jayashankar et al., 2018).

The relationship between perceived risk, technology adoption, purchasing decisions and behaviors should be verified (Jayashankar et al., 2018). It is recommended by (Weber, 2013) to create principles and operational procedures in IoT. The (Suo et al., 2012) says countries should implement new IoT-specific legislation to promote the development of IoT. IoT policies are associated with privacy mechanisms to guarantee safe authentication (Neisse et al., 2015). According to (Almeida, Goh, & Doneda, 2017) the principles in IoT must bring together different interests in an environment that must be effective and a legitimate governance framework. The IoT devices in an IoT system must manage and deploy privacy policies to control the flow of data to service providers (Neisse et al., 2015). According to (Chatfield and Reddick, 2018) at IoT, public policies consist of cybersecurity policies and digital technology policies and should behave as complements to each other (Chatfield & Reddick, 2018).

For industry 4.0 industries such as smart manufacturing, operations require the development of guidelines, strategic policies to enhance the adoption (Chatfield & Reddick, 2018). For (Weber, 2013) IoT should consider the requirements of cooperation, policy, coordination, standards, and laws to create rules to extend governance among the IoT's structural issues. In IoT business, it is necessary to have harmonized standards, for example in Europe there are organisations that join forces to create such harmonization of standards (Weber, 2013). A framework in IoT is a set of principles, protocols, and standards where enables the implementation of IoT in an organisation (Derhamy et al., 2015).

The frameworks in IoT have the possibility to accelerate the implementation, interoperability, maintainability, and security of the system (Derhamy et al., 2015). For (Wirtz, Weyerer and Schichtel, 2018) an IoT framework provides an overview of the elemental and central aspects of the IoT concept, where it contributes to a better understanding and helps to organize and structure the system. A framework in IoT must materialize governance structures and needs to be driven by stakeholder requirements (Wirtz, Weyerer, & Schichtel, 2018). An IoT framework in terms of governance should equal opportunities for all stakeholders towards progress in governance procedures and these frameworks need to be agile to change requirements (Wirtz, Weyerer, & Schichtel, 2018). The (De Cremer, Nguyen and Simkin, 2017) defends that a framework should be holistic, and process-oriented to provide a useful checklist for managers through the iterations of the IoT implementation (De Cremer, Nguyen and Simkin, 2017). A framework in IoT should help the organisations develop and expand IoT-related policies and procedures and ensure openness and transparency (Almeida, Goh, & Doneda, 2017).

Processes: The governance processes in an IoT system can bring elasticity strategies needed to provide more coordination throughout the system (Truong *et al.*, 2015). The processes in IoT enable the capabilities of the IoT entities and the implementation of software in these entities (Truong et al., 2015). The data obtained by the IoT system, if managed locally by the IoT nodes, will make the processes more feasible to be managed by the users (Carretero and García, 2014). According to (De

Cremer, Nguyen and Simkin, 2017)(De Cremer, Nguyen and Simkin, 2017), it is critical to identify the main strategic processes in IoT in the organisation.

The processes in IoT when they have a holistic approach can help guide organisations to a more enlightened practice (De Cremer, Nguyen, & Simkin, 2017). The processes in IoT must take into count the business processes models that exist in the organisation (Ruggieri et al., 2013). According to (Ruggieri et al., 2013) governance decomposes and decentralize the existing business processes, increase scalability and performance allowing better decision making to create more business value (Ruggieri et al., 2013).

Organisational Structures: The organisational structures can provide a framework for activities and interactions, defining roles, tasks, groups, standards, and relationships within the IoT system (Shen *et al.*, 2018). As the search demonstrated there was only one article according to our criteria that provided information regarding the enabler organizational structures, which only has one reference.

Culture, Ethics, and Behavior: An organisation should have a level of micro management of activities to spread social culture during the implementation of IoT (Shin, 2014). IoT culture and complexities are related parts in terms of diversity characteristics, with the aim of increasing people's adoption to new services (Shin, 2014).

Ethics in IoT refers to enforce the social behavior standards, information privacy, access to information, information integrity and property rights (Abobakr and A. Azer, 2017). According (Bowen *et al.*, 2017) ethics should focus on how organisations will use personal data and how they will access it. In terms of ethics, must pay attention during IoT implementation to the policies used, to the diffusion and access to IoT technology (Pereira, Benessia and Curvelo, 2013). IoT ethics should separate privacy from ethical issues because privacy is widely regulated by law (Baldini *et al.*, 2015). Ethics in IoT need to focus on identity, autonomy, trust as specific concerns and treated separately (Baldini et al., 2015).

The IoT system needs to enhance IoT's "smart" behaviours to provide better interfaces and interaction experiences (Cervantes-Solis and Baber, 2017). IoT ethics must be following human rights to ensure privacy safety (Almeida, Doneda and Monteiro, 2015). On behavior is important the IoT system have human behavior recognition, modeling, and representation (Shin, 2014).

Information: IoT system is a way of accessing, exchanging and manipulating information between digital and physical items and, to process this amount of information the data must flow synchronously (Yao, Z. Sheng and Dustdar, 2015). IoT networks delivered real-time information to improve and support the organisation's operations (Vlahogianni *et al.*, 2016). According to (Almeida, Doneda and Moreira Da Costa, 2018) it is crucial to have good information retrieval and search techniques in an IoT system to deal with a large amount of data exchanged. For (Almeida, Doneda, & Moreira Da Costa, 2018) the information processed at IoT will help organisations make better and transparent decisions if all stakeholders are involved in the decision-making processes.

Services, Infrastructures, and Applications: IoT services are composed of sensors, devices, compute resources and aim to improve the quality of life by improving the efficiency of services to meet business needs (Wen *et al.*, 2017). According to (Wen et al., 2017) IoT services should be built on robust standards and protocols to reach a global ecosystem of interconnected devices. The (Wen et al., 2017) argues that IoT services need to be able to evolve and dynamically change the workflow composition. For (Cao *et al.*, 2016) IoT services are smart services that enhancing the IoT sensing data to present better results from the data collected by the services. The IoT services play a major role in developing a sustainable society and improving people's living conditions (Cao et al., 2016).

In an IoT system, infrastructures must include data management, processing, and analytics to deploy large-scale independent platforms (Gubbi *et al.*, 2013). An IoT infrastructure should be thought of as an interoperable ecosystem where is capable of interacting with other infrastructures regardless of the underlying hardware and software (Dautov et al., 2018). According to (Gubbi et al., 2013) the infrastructures in IoT should be centralized to support storage and analysis requirements. According to (Shin, 2014) it is recommended continuity of investment in the core of IT infrastructure. IoT applications should explore various possibilities to provide meaningful information about the data collected from the system (Almeida, Doneda and Monteiro, 2015).

IoT application can be a platform that allows the development and execution of new IoT applications, helps to define, execute and monitor all the data exchanged by the IoT devices and is software that guides the interaction between people, systems and devices in the context of the IoT system (Wortmann and Flüchter, 2015). For IoT applications, it is very important, according to (Wortmann & Flüchter, 2015) to have a set of application-independent functionalities to be used to build the IoT applications. The (Almeida, Goh, & Doneda, 2017) says that IoT applications increase vulnerabilities in software and hardware, so he defends that IoT applications should draw attention to security and privacy protection. For (Piccialli and Chianese, 2017) the applications aim to provide useful and contextualized information on the business needs.

People, Skills and Competencies: People in IoT are not only end-users but, also an integral part of the system, so it is important to pay attention to improving human interaction in the IoT system (Shin, 2014). It will be important in an IoT system that is carefully implemented in relation to the acceptance of the system by the people who will benefit (Shin, 2014). According to (Soro et al., 2017) during the IoT conceptualization, there is a lack of human-oriented vision. People's attitude and motivation toward IoT are important to successful implementation, where there must be incentives for socio-technical literacy (Shin and Jin Park, 2017).

According to (Van Deursen and Mossberger, 2018) on skills it is necessary to have strategic skills to decide what kind of data is applied and shared, also it is necessary information skills to visualize the data collected by the IoT system and communication skills are needed to share the data for the purpose of creating knowledge. Organisations should develop managerial skills to improve the IoT implementation focusing on strategic orientation (De Cremer, Nguyen, & Simkin, 2017).

After gathering the information related to IoT and the enablers of the ITG, a list of recommendations to be considered during the adoption of IoT in each enabler was elaborated, as shown in Table 9.

Table 9. Initial list of recommendations between ITG enablers and IoT.		
Enablers	**Recommendations**	**References from literature**
Principles, Policies, and Frameworks	Promote interoperability via decentralization.	(Buyya & Vahid Dastjerdi, 2016)
	Promote collaboration between organisations.	(Roman, Zhou and Lopez, 2013)
	Implementation of trust.	(Derhamy *et al.*, 2015)
	Implementation of transparency.	(Derhamy *et al.*, 2015)(Jayashankar et al., 2018)
	Implementation of data privacy and data protection.	(Derhamy *et al.*, 2015)
	Implementation of accountability.	(Derhamy *et al.*, 2015)
	Interiorization of risk management.	(Jayashankar *et al.*, 2018)
	Adoption of frameworks	(Wirtz, Weyerer and Schichtel, 2018)
	Cooperation in building policies.	(Weber, 2013)
	Strategic policies.	(Weber, 2013)
	Governance framework application.	(Almeida, Goh, & Doneda, 2017).(Derhamy et al., 2015)
	Include users' privacy issues in IoT policies.	(Neisse et al., 2015)
	Operational principles are aligned with IoT procedures.	(Weber, 2013)
	Include cybersecurity and digital policies in IoT policies.	(Chatfield & Reddick, 2018)
	Governance framework guides management team in IoT implementation.	(Derhamy *et al.*, 2015)
Processes	Strategy processes to coordinate IoT processes.	(De Cremer, Nguyen and Simkin, 2017)
	Business processes to align IoT process with business models.	(Ruggieri *et al.*, 2013)
	Governance processes to decompose and decentralize the business processes.	(Ruggieri *et al.*, 2013)
	Information processing	(Yao, Z. Sheng and Dustdar, 2015)
	Data management	(Gubbi *et al.*, 2013)

	Data analytics	(Gubbi *et al.*, 2013)
	Application management.	(Almeida, Doneda and Monteiro, 2015)
	Application monitoring.	(Wortmann and Flüchter, 2015)
	Application security management.	(Almeida, Goh and Doneda, 2017)
Organisational Structures	Attribution of roles, responsibilities and tasks in IoT.	(Shen *et al.*, 2018)
Culture, Ethics, and Behavior	Spread social culture in IoT implementation.	(Shin, 2014)
	Organisation's culture aligns with identity, autonomy and trust protection of IoT users.	(Almeida, Doneda and Monteiro, 2015)
	Organisation's implements his culture and values in IoT acceptance.	(Shin, 2014)
	Ethics integrates social behaviors, privacy and integrity in IoT implementation.	(Abobakr and A. Azer, 2017)
	Implementation of awareness in people's attitude and motivation.	(Shin and Jin Park, 2017)
Information	Information research techniques for IoT support.	(Vlahogianni *et al.*, 2016)
Services, Infrastructures, and Applications	IoT services promotes sustainability.	(Cao *et al.*, 2016)
	IoT services are built on top of strong standards and protocols.	(Wen et al., 2017)
	IoT infrastructures it is aligned with continuity of investment.	(D. Shin, 2014)
	Ensure IoT services improve organisation's efficiency by being aligned with business needs.	(Wen *et al.*, 2017)
People, Skills, and Competencies	Integration of people in IoT.	(D. Shin, 2014)
	Socio-technical skills.	(Shin and Jin Park, 2017)
	Strategic skills.	(Van Deursen and Mossberger, 2018)
	Information skills.	(Van Deursen & Mossberger, 2018)
	Organisation skills.	(Van Deursen & Mossberger, 2018)
	People are an important role in the acceptance of IoT.	(D. Shin, 2014)

6. Conclusion

This research proposes to investigate which are the suitable IoT enablers to help organization in future IoT implementations. From 38 articles selected in Google Scholar database several findings were withdrawn. A list of IoT enablers were elicited (Table 9) which may help organization in future IoT implementations.

Our attention was drawn to the fact that the information regarding IoT enablers among the literature is in an early stage. The information is scarce despite their relevance to the field. IoT is a recent field of study which may in part justify the scarcity of information in literature. For instance, little or none information exist about organisational structures, culture, behavior, and competencies enablers.

Plus, literature demonstrate that most of the studies regarding IoT are focused on technology approach instead business and strategy perspectives. Technology may not exist without a business meaning so this is a clear statement for future research.

Future researchers should lay their efforts investigating the implications of IoT technology and respective application on the business. Moreover, enablers with less information must be further investigated to increase awareness and knowledge about the topic. The authors will continue this research by using the elicited list of ITG enablers for IoT implementation as a baseline for a delphi study with several IoT experts to increase the list also with expert’s knowledge.

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