

**BUSINESS INTELLIGENCE MATURITY MODELS: OPPORTUNITIES AND
RECOMMENDATIONS FOR FUTURE INVESTIGATION - A SYSTEMATIC
LITERATURE REVIEW – PART 1**

**MODELOS DE MADUREZ DE INTELIGENCIA DE NEGOCIOS: OPORTUNIDADES Y
RECOMENDACIONES PARA FUTURAS INVESTIGACIONES – UNA REVISIÓN
SISTEMÁTICA DE LITERATURA – PARTE 1**

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ABSTRACT

The economy globalization represents significant challenges. One of them is information exploitation and company knowledge. Converting data into information and information into knowledge is called Business Intelligence – BI. Several BI tools have been established to support the decision-making process. Maturity Models is one of these tools. This research aims to show in two parts, breaches and to propose prospects for the progression of this field. In general, the prevalence of generic and descriptive features was revealed. Some gaps related to models that can be modified to specific industrial sectors were detected. This field offers great promises for new investigations and maturity models.

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RESUMEN

La globalización de la economía representa grandes desafíos. Uno de ellos es la explotación de la información y el conocimiento de la empresa. Convertir datos en información y la información en conocimiento se denomina inteligencia de negocios- BI. Se han desarrollado varias herramientas de BI para apoyar el proceso de toma de decisiones. Los modelos de madurez son una de estas herramientas. Esta investigación tiene como objetivo mostrar en dos partes, lagunas y proponer oportunidades para el avance en este campo. En general, se reveló un predominio de características genéricas y descriptivas. Se detectaron algunas lagunas relacionadas con modelos que pueden adaptarse a segmentos industriales específicos. Este campo todavía ofrece amplias posibilidades para nuevos modelos de investigación y madurez.

Palabras clave: Modelos de madurez, revisión sistemática, pequeñas empresas, inteligencia de negocios.

Introduction

The economy globalization through the implementation of free trade agreements with different countries represents for micro, small, and medium-sized enterprises - SMEs considerable challenges (Canabal Guzmán & Franco Campos, 2014). For these authors (Canabal Guzmán & Franco Campos, 2014), this globalization brings with it a series of commitments by employers, managers, and executives of SMEs. Among them is the renovation and upgrading of their administrations to adjust to the new global business environment. One of the most critical challenges today is the use and exploitation of information and company knowledge since it becomes the intangible capital of the Organization (Fedouaki, Okar, & El Alami, 2013). Through this intangible capital, companies seek to improve their competitive position (González Díaz & Becerra, 2015; Martínez, Castillo Osorio, & Díaz Pertúz, 2015). They are always trying to effectively facilitate the acquisition, processing and analysis of a vast amount of data that can come from diverse bases, and that would aid as the basis for the discovery of new knowledge (Olszak & Ziemia, 2007).

The process of converting the data into information and information into knowledge is called business intelligence - BI (W. W. Eckerson, 2002; Kurtyka, 2003; M. Santos & Correia, 2010). Companies take this knowledge as a basis for decision-making. Most of the data enterprises are supported in the use of information systems - IS, several more elaborate than others, such as enterprise resource planners - ERP, customer relations managers - CRM, Supply chain managers - SCM among others (Fedouaki et al., 2013; Wu, 2010). To Wu (2010), abundant BI tools have been developed to sustainance the decision-making process (Liyang, Zhiwei, Zhangjun, & Li, 2011). Business intelligence maturity models can be found within the tools.

These maturity models provide a methodical process to understand current BI maturity models. It includes a review of important business and technical processes, taking into consideration the critical success factors for BI within an organization (Brooks, El-Gayar, & Sarnikar, 2015). Maturity models - MMs also help administrations to understand where they are and how they can improve (Hribar Rajterič, 2010). In literature, we can obtain many business intelligence maturity models (Burton, 2009; M.-H. Chuah, 2010; M.-H. Chuah & Wong, 2011a; M. H. Chuah & Wong, 2014; Deng, 2007; Wayne Eckerson, 2004; W Eckerson, 2007; Fisher, 2005; Hagerty, 2006; Hostmann & Hagerty, 2010; Raber, Winter, & Wortmann, 2012; Rayner & Schlegel, 2008; Watson, Ariyachandra, & Matyska, 2001; Williams & Williams, 2004, 2007a, 2007b, 2010). These maturity models are accessible for big companies to advance their decision making and strategic thinking. (Fedouaki et al., 2013). However, according to the same author, no one of these maturity models report the project of scheming and employing BI Systems in SMEs specifically.

In that sense, literature reviews – LR - have been directed to map and to classify current models, approaches and methods in diverse fields of knowledge about these topics. Hribar Rajterič (2010) in his research, described and analyzed six diverse maturity models used for the maturity of BI systems assessment. According to his analysis, most of the models do not cover the complete area of BI, but they slightly emphasis on a specific point of view and area of the problem domain. His results express that using maturity models, only, a short period is needed for one to determine the areas within the company or institution that need unique, more intensive attention and work.

M.-H. Chuah and Wong (2011b) explored the abundant of BI maturity models through a complete review of academic as well as practitioner's literature. Among their findings, in some aspects agree with (Hribar Rajterič, 2010) about most of them do not contemplate all factors that

affect BI in their results. Also, some of BI maturity models do emphasis on the technical aspects and several of them focus on a business point of view. According to the author, the main goal of the research was to link this absent gap between academia and industry, over a detailed formal study of the maturity model pertaining to BI.

Prieto Morales, Meneses Villegas, and Vega Zepeda (2015) made a comparative study using the method of study of similarities and standards (MESME) and the technique of data envelopment analysis (DEA). They characterized and compared a set of maturity models in selected BI applies. Using MESME, they identified and compared the likenesses between the different BI maturity models. Using the DEA technique, a quantitative description of the capacity of diverse models in each stage was obtained to convert inputs into outputs, at different levels of maturity for a set of analyzed models.

Despite the existence of several reviews and analyses of different maturity models in diverse areas, it wasn't identified any study that maps state of the art on "Enterprise Business intelligence maturity models".

For filling this breach in the literature, this research aimed to show gaps and propose prospects for the progress of the Business Intelligence maturity models. In this case, directions concerning possible study areas, insides, and predominant features for new Enterprise Business intelligence maturity models will be shown.

Through the classification and severe analysis of the found models, this study will present tendencies, endorsements and topics for more studies. Therefore, the main objective of this research was to identify, evaluate and analyze the primary source of information to respond to a specific research question. This method provides information on existing lines of research and identifies potential research gaps for future works (Kitchenham, 2004, 2007; Kitchenham et al., 2009). The proposed research question - **RQ** was: What research gaps presently exist and what research guidelines may be capable in the field of Enterprise Business intelligence maturity models? To answer this question above, and following the methodology used by Xavier, Naveiro, Aoussat, and Reyes (2017), the research team proposed secondary questions as follows:

- ✓ **Q1:** Which research methods have been used for developing Enterprise Business intelligence maturity models?
- ✓ **Q2:** What are the growth and detailed level of the available Enterprise Business intelligence maturity models?

- ✓ **Q3:** Which research fields, sectors, or market sections have been studied and used as an application unit of Enterprise Business intelligence maturity models?
- ✓ **Q4:** What is the difference in content and predominant characteristics of these Enterprise Business intelligence maturity models?

According to the authors above, this investigation could be characterized as theoretic and conceptual, and would comprise two main contributions:

1) to offer a literature review grounded on published researches between 2010 up to 2017 in most essential databases, counting a mapping and a classification of selected works that developed Enterprise Business intelligence, maturity models;

2) to offer a qualitative analysis of models, containing gaps' identification and proposals for future studies in this knowledge field. The results summarize the main research areas and application sectors of Enterprise Business intelligence maturity models. This paper describes input facts for new investigators, making proposals founded on the results of the models' classification about the method and research technique. Also, make a description of the models; the level of advance, feature and generality; content, and main characteristics.

The remainder of this paper is organized as follows. Section 2 discusses the background theory. Section 3 discusses the research method used in this paper. Section 4 discusses the research findings and discussion of the state of art. Section 5 provides the final conclusions of this paper and proposals for future studies, and finally, the references are shown.

Background theory

This apart will be discussing the perceptions and requests of Enterprise Business intelligence maturity models, the interrelations with other concepts, highlighting the research fundamental areas that will be lectured in the SLR.

Enterprise Architecture - EA

According to Zachman (1997), EA is a set of descriptive, relevant illustrations for describing an enterprise so that it can realize management requirements and be maintained throughout its useful life. EA pacts with the construction of an enterprise, relations, and connections of its units (Goel, Schmidt, & Gilbert, 2009).

For Balcicek, Gundebahar, and Cekerekli (2013), EA is a concept that creates the corporates integrated business procedures and information technologies to achieve a corporates' mission over the optimal performance of its core business processes within an efficient information technology (IT) environment.

Lankhorst (2005), defines EA as a coherent whole of values, approaches, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure. This author also considered EA as a holistic expression of the enterprise in terms of crucial strategies.

According to Armour, Kaisler, and Liu (1999), EA offers a knowledge base and support for decision making within the enterprise and it serves as the blueprint of the current situation and strategy for future directions of the enterprise.

The Federal CIO-Council (2013), states that EA supports preparation and decision-making through certification and evidence that provides an abstracted view of an organization at various levels of scope and detail.

Rouhani, Mahrin, Nikpay, and Nikfard (2013) define EA as a structure for alignment business and IT within an enterprise.

As a conclusion, all the authors agree that EA is a complete and integrated model or illustration of an organization; It can be considered as a master plan which 'acts as a collaboration force' between features of business scheduling such as goals, visions, strategies and governance principles; Other aspects of business processes such as corporate terms, group structures, procedures and data; automation' features such as information systems and databases; and the qualifying technological infrastructure of the business such as computers, operating systems and networks (Federal CIO-Council, 2013; Schekkerman, 2005).

Business Intelligence - BI

BI is not a new concept; it dates from the decade of the 90. Several authors have been defined as the concept. Some of them are the following:

W. W. Eckerson (2002) defines BI as "The processes, technologies, and tools needed to turn data into information, information into knowledge, and knowledge into plans that drive profitable business action. Business intelligence encompasses data warehousing, business analytic tools, and content/knowledge management".

Christophe, Manon, Eric, and Claude (2015) emphasize that BI is the procedure for collecting, analyzing, and applying information about products, clients, and opponents to meet the organization's long-term and short-term planning requirements.

Pellissier and Nenzhelele (2013) proposed a Business Intelligence process model composed of six phases: Planning and Direction, Data or information Collection, information sorting, capturing and storing; information analysis; intelligence dissemination.

Maturity models: concepts and applications

A maturity model signifies a path to progressively planned and systematic way of doing business in enterprises (Proença, 2016). BI maturity models (BIMM) are used for describing, explaining and evaluating the growth cycles of life in BI initiatives (Prieto Morales et al., 2015). According to Brooks, El-Gayar, and Sarnikar (2013), BIMM delivers methodical maturity guidelines and readiness valuation for using technology and data to transform it into information for developing insight and make knowledgeable decisions.

To Hribar Rajterič (2010), the maturity model helps assess the business intelligence maturity of an organization; meanwhile, it can be used to regulate which areas need special consideration. The model reveals areas, which would otherwise be simply ignored.

Generally, a maturity model comprises a model and survey, which is used to measure the level of maturity of the progress environment (Pivka, Rozman, & Mohorič, 1996).

Maturity Models Characteristics

Significant characteristics of MMs are the maturity concept, the dimensions, the levels, the maturity principle, and the assessment approach (Lahrman & Marx, 2010; Raber et al., 2012).

Table 1 shows an overview of the main characteristics of a maturity model.

Table 1. Main Features of a maturity model.

| Characteristic | Description |
|---|--|
| Object of maturity assessment (Key process areas) | MMs permit for the maturity assessment of a variety of diverse objects or key process areas. Most commonly measured objects are technologies (M.-H. Chuah, 2010; M.-H. Chuah & Wong, 2011a; M. H. Chuah & Wong, 2014; Fisher, 2005; Gericke, Rohner, & Winter, 2006; Hagerty, 2006; Raber et al., 2012; Rayner & Schlegel, 2008), processes (Burton, 2009; Fisher, 2005; Hagerty, 2006), people / workforce (Curtis, Hefley, & Miller, 2010; M.-H. Chuah, 2010; M.-H. Chuah & Wong, 2011a; M. H. Chuah & Wong, 2014; Fisher, 2005; Hagerty, 2006; Watson |

| | |
|---------------------|---|
| | et al., 2001) and management capabilities like project or knowledge management (M.-H. Chuah, 2010; M.-H. Chuah & Wong, 2011a; M. H. Chuah & Wong, 2014; Deng, 2007). |
| Dimensions | Dimensions are capability areas structuring the interest field (De Bruin, Freeze, Kaulkarni, & Rosemann, 2005). Each dimension is added specified by a number of elements, practices, activities, or measures (sub-processes) at each level (De Bruin et al., 2005; Fraser, Moultrie, & Gregory, 2002). |
| Levels | MMs contains of numerous levels (also called phases) of maturity and several arranging dimensions. Each level takes an individual descriptor, evidently providing the intent of the level and a comprehensive report of its features (Lahrmann & Marx, 2010). Classically, the number of levels on MMs are between 3 and 6 levels. At the same time, a descriptor for each level and a generic description or summary of the characteristics of each level as a whole must be presented (Fraser et al., 2002). |
| Maturity principle | MMs could be continuous or staged (Brooks et al., 2013; M.-H. Chuah & Wong, 2011a). Continuous models permit counting of features at diverse levels; meanwhile, staged models need that all elements of one different level are completed (Fraser et al., 2002). Hereafter, in the first category of MMs a maturity rank may be determined as either the (weighted) sum of the distinct scores or the individual stages in diverse dimensions. On the contrary, staged MMs specify a set of goals and key performs that need to be applied to reach a certain level (Lahrmann, Marx, Winter, & Wortmann, 2011; Raber et al., 2012). |
| Assessment approach | To pursue a maturity assessment either qualitative (e.g. interviews - (M.-H. Chuah & Wong, 2013; Dinter, 2012; Olszak, 2013, 2016; Raber, Epple, Winter, & Rothenberger, 2016; Spruit & Sacu, 2015; Trieu, 2013)) or quantitative approaches (e.g. questionnaires with Likert scales or not - (Burton, 2009; M.-H. Chuah & Wong, 2011a; M. H. Chuah & Wong, 2014; Dinter, 2012; Wayne Eckerson, 2004; W Eckerson, 2007; Lahrmann et al., 2011; Lih & Hwa, 2013; Najmi, Sepehri, & Hashemi, 2010; Ong, Siew, & Wong, 2011; Prieto-Morales, Meneses-Villegas, & Vega-Zepeda, 2015; Rayner & Schlegel, 2008; Vukšić, Bach, Grublješić, Jaklić, & Stjepić, 2017; Williams & Williams, 2007a, 2007b, 2010)) may be used (Fraser et al., 2002; Raber et al., 2012). |

Source: adapted from (Lahrmann et al., 2011; Raber et al., 2012).

In addition to these features, maturity models must have the following:

1. **Maturity models Updates:** Maturity models are subject to modification and growing, comparable to any other theoretical models. They need to be complemented and adjusted to discoveries so that they preserve accurate value and to produce consistent and similar outcomes (Hribar Rajterič, 2010).
2. **Easy to Understand:** Two of the most critical recompenses of a maturity model are in the acceptance of considerate and in providing an instrument for linking different organizations and parts of a company among each other (Hribar Rajterič, 2010).

3. **Maturity model documentation:** All maturity models should document with an explanation of each maturity level, likewise show a method report, on which the model is based, an explanation of the business intelligence technical structure hitting business intelligence into a wider image, and an explanation of common errors and hazards when presenting and applying business intelligence initiatives (Hribar Rajterič, 2010).
4. **Avoid incompleteness or poorly description:** The maturity models at least should describe the main characteristics proposed in Table 1 (Hribar Rajterič, 2010).

Research method

To develop the present work, the researchers used a descriptive methodology. The method used was exploratory. The research method used to develop this work was the systematic literature review. The main aim in this kind of work is to find the breaches in literature, later, provides suggestion of future fields of investigation (Booth, Sutton, & Papaioannou, 2016; Kitchenham, 2004, 2007) through localizing existing studies, selecting and evaluating the current contributions, analyzing and synthesizing data, and reporting the indication in such a way that permits rationally reliable inferences to be reached about what is and is not known (Denyer & Tranfield, 2009).

There exist several systematic literature review methodologies (Booth et al., 2016; Denyer & Tranfield, 2009; Forrester, Slater, Jomar, Mitzman, & Taylor, 2017; Kitchenham, 2004, 2007; Kitchenham et al., 2009; Moher et al., 2015). In our case, the methodology published by Booth et al. (2016) was used. The principal methodology consists of seven (7) steps or phases:

1. *Planning,*
2. *Define Scope,*
3. *Searching,*
4. *Assessing,*
5. *Synthesizing,*
6. *Analyzing,*
7. *Writing.*

Step 1: Planning

According to the author, the main goal of this step is to define: the period of the project, detecting the databases that will be used and choosing the software for managing the references.

For our work, the databases utilized for the SLR were selected based on (Kitchenham et al., 2009) and (Palmarini, Erkoyuncu, Roy, & Torabmostaedi, 2018) and were combined with the incomes obtainable for the project:

- IEEE Xplore (<http://ieeexplore.ieee.org/Xplore/home.jsp>)
- Web of Science (<https://webofknowledge.com>)
- Science Direct (www.sciencedirect.com)
- Scopus (www.scopus.com)

In concordance with Palmarini et al. (2018), the research team considers that owing to the rapidly evolving nature of the main topic (Enterprise Business intelligence maturity models) a manual of Grey Papers search was done. According to Booth et al. (2016) this included papers obtainable on the Internet and available by non-academic institutions such as industries, governments and societies.

The reference manager software utilized in this work was EndNote X7 due to its facility to integrate PDF viewer and the programmed quotation add-in for Microsoft Word.

The statistical analysis was made using the qualitative data analysis software package ATLAS.ti® version 7.5.4. This powerful tool is very effective for content analysis (Walter & Bach, 2015). It is a qualitative data analysis software (Computer Assisted Qualitative Data Analysis Software - CAQDAS). With the aim to avoid differences in the codification process, all process by only one researcher was made.

Step 2: defining the scope

The main aim of this step is to define the scope through properly formulate answerable research questions. According to Palmarini et al. (2018) this process can be defined through an iterative process among (i) initial brainstorming, (ii) literature search and (iii) the Population, Intervention, Comparison, Outcomes, and Context – PICOC (Petticrew & Roberts, 2008) framework application. As a result of the application of (i) and (ii), different review and key papers on Enterprise Business intelligence maturity models have been

identified (M.-H. Chuah & Wong, 2011b; Prieto Morales et al., 2015; Proença, 2016). To Booth et al. (2016) the PICOC framework can be utilized to define the research key concepts. The elements of PICOC on this study were: *Population* consists of the Small enterprises. The *Intervention* considered is the Enterprise Business intelligence maturity models.

The *Comparison* can be done with enterprises with no enterprise architecture or traditional enterprises or other Systematics Literature Reviews. The *Outcomes* of the application of these different methods could be measured in terms of Key Performance Indicators related to the specific Enterprise Business intelligence maturity models. Moreover, finally, the *context* includes Enterprise business intelligence in Small Enterprises.

At last, the research questions. These were exposed in Section 1 (Introduction) of this work.

Step 3: Searching

This step involves looking for separately the catalogs identified at step 1 and registered in Section 3.1 utilizing the strings: “Maturity models,” “Systematic review”, “Enterprise Architecture”, “Small Enterprises - SME”, “Business Intelligence”. It has been carefully chosen based on the investigation questions and critical concepts stated in Section 3.2. Boolean operators “AND” and “OR” were used for providing a more comprehensive first screening joining keywords with their substitutes for covering the most significant quantity of studies for a study.

The outcomes of this searching step updated on Wednesday, September 14th, 2017 is the collection of Systematic literature review of Enterprise Architecture - Business Intelligence maturity models for Small Enterprises: Opportunities and recommendations for future research documents. (Table 2).

Table 2. Searching phase outcomes for the Enterprise Business intelligence maturity models.

| Database name | Search fields | Documents returned |
|----------------|---------------|--------------------|
| IEEE Xplore | Metadata only | 65 |
| Web of Science | Topic | 22 |
| Science Direct | Title-Abs-Key | 4044 |
| Scopus | Title-Abs-Key | 146 |
| | Sum | 4277 |

Source: own elaboration.

Subsequently, this stage has been carried out for each database distinctly, the final quantity of Systematic literature review of Enterprise Architecture - Business Intelligence maturity models for Small Enterprises: Opportunities and recommendations for future research documents include duplicates. More details are shown in Table 3. According to Palmarini et al. (2018) it is value to indicate that this stage does not necessarily involve understanding the titles or the abstracts of the found papers.

Step 4: Assessing

To Palmarini et al. (2018), this stage aims to slight down the hundreds of papers found in the previous phase to a final amount of papers that are pertinent for answering the research questions. For that reason, Inclusion and Exclusion Criteria (IC & EC, respectively) were used for making the first screening of the papers. The selection of IC and EC in this study were chosen according to the author's experiences and through that the election of the methodology proposed by Palmarini et al. (2018) and other examples of another methodologies (Booth et al., 2016; Denyer & Tranfield, 2009; Forrester et al., 2017; Kitchenham, 2004, 2007; Kitchenham et al., 2009; Moher et al., 2015):

Inclusion Criteria:

IC1) Primary studies that represent the use of Enterprise Business intelligence maturity models.

IC2) Primary studies that represent the Enterprise Business intelligence maturity models state of the art.

Exclusion Criteria:

EC1) Primary studies that haven't been published in different to the English, Spanish or Portuguese languages.

EC2) Range Out of period (2010 up to 2017).

EC3) Primary studies that do not belong to the Computer Science, Engineering and Economics, management, and accounting knowledge field.

EC4) Primary studies no related to Small enterprises.

All these criteria have been applied to the documents found in the four (4) databases listed in Section 3.1 distinctly and in three different stages: firstly, over the searching tools

providing by each database selected have been used (filters and data mining tools); secondly, over studying the title and the abstract and finally studying introduction and conclusion of the remaining papers. In the third phase, the documents resulting from the four (4) different databases have been collated.

The final results of the application process of the IC and EC are shown in Table 3.

Table 3. The primary studies selection process in all databases.

| Searching Strings: | Documents Returned | |
|--|---------------------------|-----------------|
| “Maturity models” | 4277 | |
| “Business Intelligence” | | |
| | Included | Excluded |
| Phase I. | | |
| IC & EC through database searching tools: | | |
| 1) Years: from 2010 up to 2017. | 1) 2137 | 1) 2140 |
| 2) Documents type: Article, conference proceedings, or review article. | 2) 1478 | 2) 659 |
| 3) Publication field of knowledge: Computer Science, Engineering and Economics, management and accounting. | 3) 265 | 3) 1213 |
| Phase II. | | |
| IC & EC applied to title and abstract. | 58 | 207 |
| Phase III. | | |
| IC & EC applied to introduction and conclusions. | 48 | 10 |
| Phase IV. | | |
| Duplicates studies | 30 | 18 |

Source: own elaboration.

Table 4. Quality criteria assessment applied to the 30 selected articles in this SLR.

| Study ref. | QC1 | QC2 | QC3 | QC4 | QC5 | Sum |
|------------------------------|------------|------------|------------|------------|------------|------------|
| Brooks et al. (2015) | 1 | 1 | 1 | 1 | 1 | 5 |
| Tan, Sim, and Yeoh (2011) | 1 | 1 | 1 | 1 | 1 | 5 |
| M.-H. Chuah and Wong (2011b) | 1 | 1 | 1 | 1 | 1 | 5 |
| M.-H. Chuah (2010) | 1 | 1 | 1 | 1 | 1 | 5 |
| M.-H. Chuah and Wong (2013) | 1 | 1 | 1 | 1 | 0.5 | 4.5 |
| Ong et al. (2011) | 0.5 | 1 | 1 | 1 | 1 | 4.5 |

| | | | | | | |
|--|-----|-----|-----|-----|-----|-----|
| Tavallaei, Shokohyar, Moosavi, and Sarfi (2015) | 1 | 1 | 0.5 | 1 | 1 | 4.5 |
| Olszak (2013) | 1 | 1 | 0.5 | 1 | 1 | 4.5 |
| Côrte-Real, Neto, and Neves (2012) | 1 | 1 | 0.5 | 1 | 1 | 4.5 |
| Lahrman et al. (2011) | 1 | 1 | 1 | 1 | 0.5 | 4.5 |
| Lukman, Hackney, Popovič, Jaklič, and Irani (2011) | 1 | 0.5 | 0.5 | 1 | 0.5 | 3.5 |
| Raber et al. (2016) | 1 | 0.5 | 1 | 1 | 0 | 3.5 |
| Prieto Morales et al. (2015) | 1 | 0.5 | 1 | 1 | 0 | 3.5 |
| M.-H. Chuah and Wong (2011a) | 0.5 | 0.5 | 1 | 1 | 0.5 | 3.5 |
| Spruit and Sacu (2015) | 1 | 0.5 | 0 | 1 | 1 | 3.5 |
| Trieu (2013) | 1 | 1 | 0 | 1 | 0.5 | 3.5 |
| Prieto-Morales et al. (2015) | 0.5 | 0.5 | 0 | 1 | 1 | 3 |
| Shen, Chang, Hsu, and Chang (2017) | 1 | 1 | 0 | 0.5 | 0.5 | 3 |
| Russell, Haddad, Bruni, and Granger (2010) | 1 | 0.5 | 0 | 1 | 0.5 | 3 |
| Hribar Rajterič (2010) | 1 | 0.5 | 0 | 0.5 | 1 | 3 |
| Raber, Wortmann, and Winter (2013) | 1 | 0.5 | 0.5 | 1 | 0 | 3 |
| Najmi et al. (2010) | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 3 |
| Bonner and Chae (2016) | 0.5 | 0.5 | 0 | 1 | 0.5 | 2.5 |
| Lih and Hwa (2013) | 1 | 0.5 | 0 | 1 | 0 | 2.5 |
| Dinter (2012) | 1 | 0.5 | 0 | 1 | 0 | 2.5 |
| Vukšić et al. (2017) | 1 | 0.5 | 0 | 0.5 | 0 | 2 |
| Olszak (2016) | 1 | 1 | 0 | 0 | 0 | 2 |
| Brooks et al. (2013) | 1 | 0.5 | 0 | 0 | 0 | 1.5 |
| Raber et al. (2012) | 1 | 0 | 0.5 | 0 | 0 | 1.5 |
| M. H. Chuah and Wong (2014) | 0.5 | 0.5 | 0 | 0.5 | 0 | 1.5 |

Source: own elaboration adopted from (Palmarini et al., 2018)

Once selected or collated the articles, the next step in the respective methodology is to categorize quality criteria to strengthen the abstraction of quantitative and qualitative data for the amalgamation and outcomes analysis (Table 4). One example of the quality criteria can be found on A. C. C. d. Santos, Delamaro, and Nunes (2013). The quality criteria exposed by the authors are listed in Table 5. For each one of the 30 selected documents, a score from 0 to 5 has been calculated summing up the scores assigned for each QC. One point has been assigned for the full compliance with the QC; 0.5 points for the partial compliance and 0 for none compliance. Table 4 reports the results of the application of the QC. This table offers to the reader a tool for assessing the quality of the qualitative results mentioned in section 4 (results and discussion).

Table 5. Quality criteria for this SLR.

| Quality Criteria | Description |
|------------------|---|
| QC1 | The document is clear. |
| QC2 | The methodology of the primary work is well exposed and detailed. |
| QC3 | The proposal and case studies (if available) are not obsolete. |
| QC4 | The study results are applicable to Small enterprises. |

QC5 Analytical results are provided.

Source: (A. C. C. d. Santos et al., 2013), adapted by (Palmarini et al., 2018).

According to Palmarini et al. (2018), it is owing to the bias on the submission of the quality criteria proposed by A. C. C. d. Santos et al. (2013), these grades are not used to reject any study from this SLR. All the 30 identified papers offer a valuable influence on this study.

Step 5: Synthetizing and analyzing.

According to Xavier et al. (2017), this analysis aims to break down individual studies into constituent parts and describe how each relates to the other, and synthesis aims to make associations among the parts identified in individual studies.

In this step, the primary purpose is to analyze and synthesize the collated or selected articles (30) through the implementation of the previously mentioned steps (Booth et al., 2016). For doing this, it was necessary to build a table, which could correlate the documents to find trends and standard features of the different studies (Palmarini et al., 2018). Table 6 shows as columns, the main characteristic of a business intelligence maturity model (Key process areas, dimensions and levels), and the rows represent the studied business intelligence maturity model. These main features have been designated founded on the papers and the authors' skill in the field.

Table 6. Example of data extraction from the selected articles (30) for the SLR.

| Bi maturity model | Key process area | Dimension | Levels |
|--|---------------------------|------------------|--|
| Business intelligence Maturity Model - biMM - (Dinter, 2012) | • Scope. | • Functionality. | Level 1: Individual information. Level 2: Information islands. Level 3: Information integration. Level 4: information intelligence. Level 5: Enterprise Information management. |
| | • Data architecture. | | |
| | • Penetration level. | | |
| | • Technical architecture. | • Technology. | |
| | • Data management. | | |
| | • Information design. | | |
| | • Organization structure. | | |
| | • Processes. | • Organization. | |
| | • Profitability. | | |
| | • Strategy. | | |

Source: Own elaboration.

Finding and Discussion

Classification and analysis

Table 7. Number of employees on the case studies

| Authors: | (Lukman et al., 2011) | (Ong et al., 2011) | (Prieto-Morales et al., 2015) | (Raber et al., 2013) | (Lih & Hwa, 2013) | (Raber et al., 2012) |
|----------------------------|------------------------------|---------------------------|--------------------------------------|-----------------------------|------------------------------|-----------------------------|
| | 1-50 | 501 - 1000 | 500 | 1-50 | 1-1000 | 0-500 |
| | 50-249 | 1001 - 5000 | 800 | 50-500 | 1001-5000 | 500-5000 |
| | 250-499 | 10000 above | 1000 | 500-1000 | 5000 above | 5000-10000 |
| Number of employees | 500-999 | | | 1000-5000 | | 10000 above |
| | 1000 above | | | 5000-10000 | | |
| | | | | 10000-50000 | | |
| | | | | 50000 above | | |

In this section, the outcomes of the SLR and the amalgamation of the analyzed papers will be reported.

Classification of the selected studies

27 Business Intelligence models were identified. These models have been applied or tested in diverse segments and sectors of the economy. Many of them have been applied in telecommunications and Banking (7), followed by Insurance (6), Financial and Manufacturing has the same number of case studies (5), the other sectors have less than five cases (Fig. 1) but they were not restricted to a specific sector. The reason for this is that the method used in such cases was the multiple case studies (Prieto-Morales et al., 2015; Spruit & Sacu, 2015), including a group of enterprises of different sectors in a specific district. Likewise, it was the demarcation of specific research not an industry segment, but to the Small, Medium and Large-sized Enterprises (SMLEs) sector (Table 7) **Table 7.** Number of employees on the case studies.

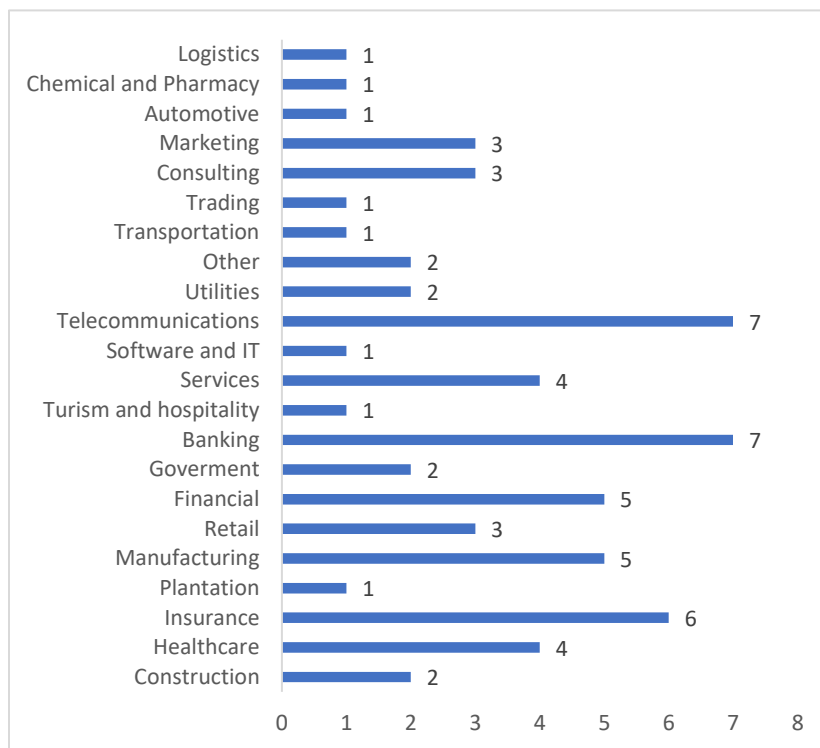


Fig. 1. Distribution by research area.

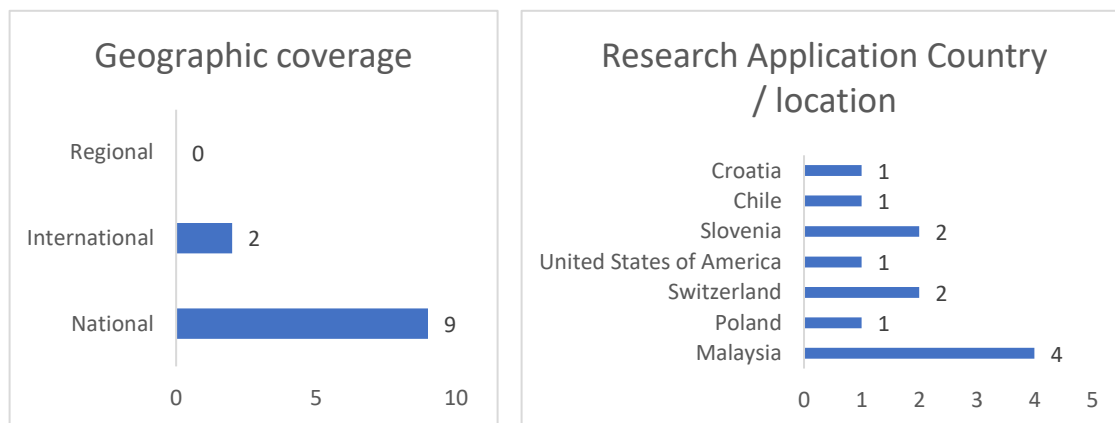


Fig. 2. Distribution by geographic coverage

Respecting to applied researches, around 82% had national reporting, that is, they were applied in organizations of a country or group. The international coverage delivery was 18%. The country where there has been the maximum occurrence of applied researches was Malaysia (4), followed by Switzerland and Slovenia (2). The other countries only have one

research application, respectively. It is worth noticing that the attention of applied researches was in Europe (4), America (2), and Asia (4). The territorial distribution is portrayed in Fig. 2.

Among the databases that were used, IEEE Xplore digital library showed the highest number of papers with Business Intelligence Maturity models, representing 50%; Scopus seems afterward, in charge of 37% of the researches. Followed by Web of Science with 13% of them. It is important to highlight that the Science Direct database represented 0% in the final selected papers, despite, to have the highest number of initial returned documents (Table 1) (Fig. 3). Regarding the kind of the available paper, it was possible to observe that 40% of the documents are journaling papers, the rest of the documents, were conference proceedings (60%).

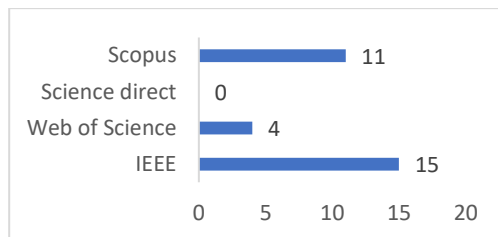


Fig. 3. Documents' distribution by Database.

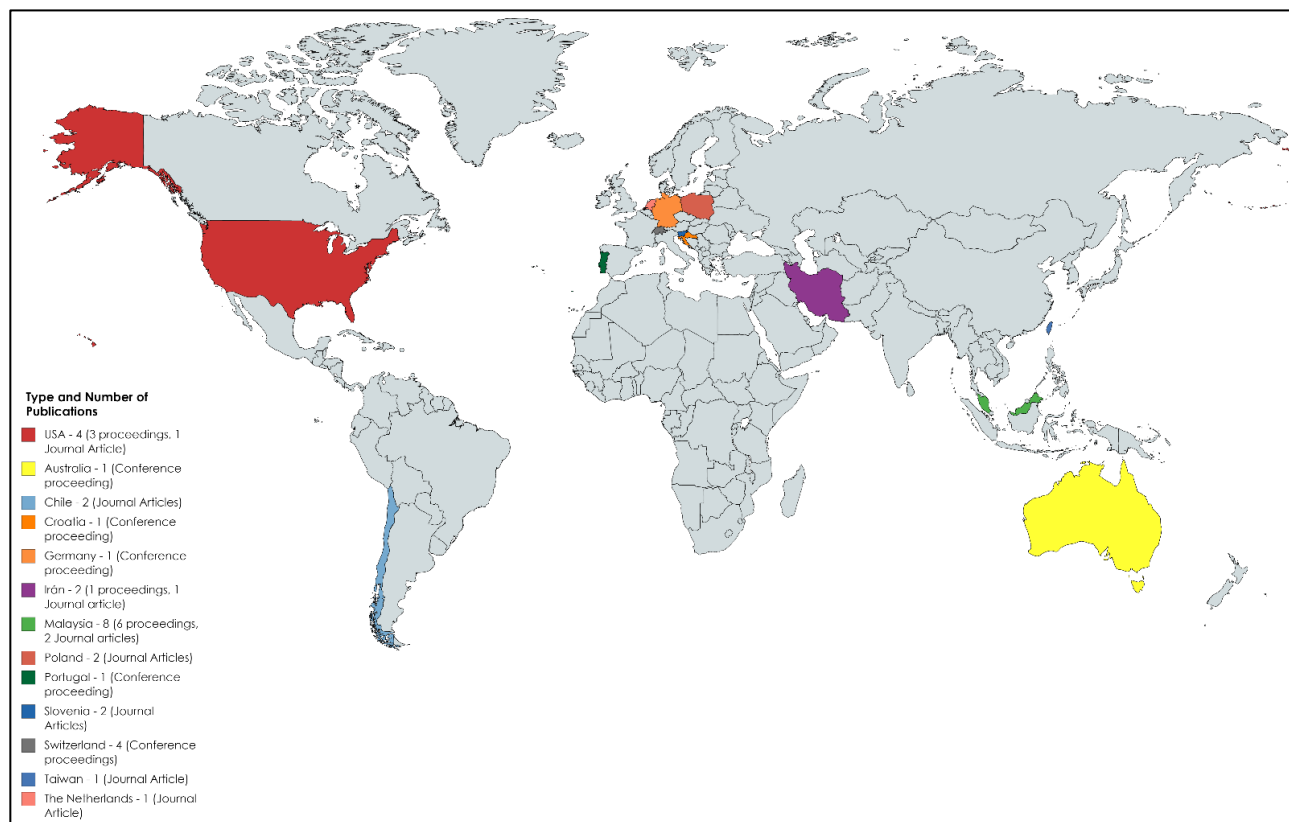


Fig. 4. Type and number of publications.

Of the 30 selected articles, 12 of them, journal articles (40%), and 18 were conference proceedings (60%). The countries with the most significant publications were: Malaysia, with eight publications (37%), Switzerland, and the United States of America with four publications each one (13%, respectively). Iran, Poland, Chile and Slovenia with two publications (7%, respectively), and the other countries with one publication (3%, respectively). Fig. 4 shows the geographical distribution of the publications' sources.

Partial Conclusions

The main objective of this work was to identify, evaluate, and analyze the primary source of information, to respond to a specific research question about the field of Business Intelligence maturity models. In this case, the main research question was: *What research gaps currently exist and what research directions may be promising in the field of Enterprise Business intelligence maturity models?* For answering this question, a systematic literature review was carried out according to the methodology proposed by Booth et al. (2016). Using this methodology, 30 documents containing business intelligence maturity models were selected. These models were analyzed according to some factors established by Xavier et al. (2017). Therefore, it was conceivable to highlight as gaps and capable opportunities for future investigation in the field of BI maturity models. In the second part of this research article, we are going to show more specific conclusions about the research questions presented in the introduction section.

Bibliographical references

- Armour, F. J., Kaisler, S. H., & Liu, S. Y. (1999). A big-picture look at enterprise architectures. *IT professional*, 1(1), 35-42. doi: <https://doi.org/10.1109/6294.774792>
- Balcicek, O. E., Gundebahar, M., & Cekerekli, S. (2013). *An agile approach for converting enterprise architectures*. Paper presented at the The International Conference on Technological Advances in Electrical, Electronics and Computer Engineering, TAEECE, Konya, Turkey.
- Bonner, D. M., & Chae, H. C. (2016). *The impact of ERP assimilation, process agility and business intelligence maturity on innovation performance*. Paper presented at the AMCIS 2016: Surfing the IT Innovation Wave - 22nd Americas Conference on Information Systems.

- Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic approaches to a successful literature review* (first ed.). London, UK: Sage publications Ltd.
- Brooks, P., El-Gayar, O., & Sarnikar, S. (2013). *Towards a business intelligence maturity model for healthcare*. Paper presented at the System Sciences (HICSS), 2013 46th Hawaii International Conference on.
- Brooks, P., El-Gayar, O., & Sarnikar, S. (2015). A framework for developing a domain specific business intelligence maturity model: Application to healthcare. *International Journal of Information Management*, 35(3), 337-345. doi: <https://doi.org/10.1016/j.ijinfomgt.2015.01.011>
- Burton, B. (2009). Toolkit: Maturity Checklist for Business Intelligence and Performance Management. *Gartner Research*.
- Canabal Guzmán, J. D., & Franco Campos, D. P. (2014). *Análisis estructural a los modelos de gestión financiera en la pequeña y mediana industria en la ciudad de Montería* (first ed. Vol. 1). Montería, Córdoba: Publicaciones Unisinú.
- Côrte-Real, N., Neto, M., & Neves, F. (2012). *Business intelligence maturity assessment model for organizations*. Paper presented at the Information Systems and Technologies (CISTI), 2012 7th Iberian Conference on.
- Curtis, B., Hefley, W., & Miller, S. (2010). *The People Capability Maturity Model: Guidelines For Improving The Workforce* (Vol. 2): Pearson Education.
- Christophe, O.-G., Manon, G. G., Eric, F., & Claude, C. (2015). When Competitive Intelligence Meets Geospatial Intelligence. *International Journal of Business Intelligence Research (IJBIR)*, 6(2), 33-54. doi: <https://doi.org/10.4018/IJBIR.2015070103>
- Chuah, M.-H. (2010). *An enterprise business intelligence maturity model (EBIMM): Conceptual framework*. Paper presented at the Digital Information Management (ICDIM), 2010 Fifth International Conference on, Thunder Bay, ON, Canada.
- Chuah, M.-H., & Wong, K.-L. (2011a). *Notice of Retraction Constructing an enterprise business intelligence maturity model (EBI2M): Applying Delphi method for consensus (prelimary result)*. Paper presented at the Emergency Management and Management Sciences (ICEMMS), 2011 2nd IEEE International Conference on, Beijing, China.
- Chuah, M.-H., & Wong, K.-L. (2011b). A review of business intelligence and its maturity models. *African journal of business management*, 5(9), 3424-3428. doi: <https://doi.org/10.5897/AJBM10.1564>
- Chuah, M.-H., & Wong, K.-L. (2013). *An Enterprise Business Intelligence Maturity Model: Case Study Approach*. Paper presented at the IT Convergence and Security (ICITCS), 2013 International Conference on.
- Chuah, M. H., & Wong, K.-L. (2014). *Web Based Enterprise Business Intelligence Maturity (EBI2M) Assessment Tool*. Paper presented at the IT Convergence and Security (ICITCS), 2014 International Conference on, Beijing, China.
- De Bruin, T., Freeze, R., Kaulkarni, U., & Rosemann, M. (2005). Understanding the main phases of developing a maturity assessment model. *ACIS 2005 Proceedings*, 11. doi: <http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1220&context=acis2005>
- Deng, R. (2007). Business intelligence maturity hierarchy: a new perspective from knowledge management. *Information management*, 1079089-1079081.
- Denyer, D., & Tranfield, D. (2009). Producing a systematic review.
- Dinter, B. (2012). *The maturing of a business intelligence maturity model*. Paper presented at the 18th Americas Conference on Information Systems 2012, AMCIS 2012.

- Eckerson, W. (2004). Gauge your data warehouse maturity. *Information management*, 14(11), 34. doi: <http://www.jamesserra.com/archive/2013/10/data-warehouse-maturity-model/>
- Eckerson, W. (2007). TDWI Benchmark Guide: Interpreting Benchmark Scores Using TDWI's Maturity Model. *TDWI Research*, 3-14.
- Eckerson, W. W. (2002). The Rise of Analytic Applications: Build or Buy? *TDWI Report Series* (pp. 1-37): The DataWarehouse Institute - TDWI.
- Federal CIO-Council. (2013). *Federal enterprise architecture framework version 2.0*. Washington, DC: Federal CIO.
- Fedouaki, F., Okar, C., & El Alami, S. (2013). A maturity model for Business Intelligence System project in Small and Medium-sized Enterprises: An empirical investigation. *IJCSI International Journal of Computer Science Issues*, 10(6), 61-69. doi: <https://www.ijcsi.org/papers/IJCSI-10-6-1-61-69.pdf>
- Fisher, T. (2005). How mature is your data management environment? *Business Intelligence Journal*, 10(3), 20. doi: <http://www.bi-bestpractices.com/view-articles/5831>
- Forrester, R. L., Slater, H., Jomar, K., Mitzman, S., & Taylor, P. J. (2017). Self-esteem and non-suicidal self-injury in adulthood: A systematic review. *Journal of Affective Disorders*, 221, 172-183. doi: <http://dx.doi.org/10.1016/j.jad.2017.06.027>
- Fraser, P., Moultrie, J., & Gregory, M. (2002). *The use of maturity models/grids as a tool in assessing product development capability*. Paper presented at the Engineering Management Conference, 2002. IEMC'02. 2002 IEEE International, Cambridge, UK, UK.
- Gericke, A., Rohner, P., & Winter, R. (2006). Networkability in the Health Care Sector- Necessity, Measurement and Systematic Development as the Prerequisites for Increasing the Operational Efficiency of Administrative Processes. *ACIS 2006 Proceedings*, 65. doi: <https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1059&context=acis2006>
- Goel, A., Schmidt, H., & Gilbert, D. (2009, 1-4 Sept. 2009). *Towards formalizing Virtual Enterprise Architecture*. Paper presented at the Enterprise Distributed Object Computing Conference Workshops, EDOCW, Auckland, New Zealand.
- González Díaz, R. R., & Becerra, L. A. (2015). Análisis financiero empresarial del sector comercio como factor de competitividad través de la lógica difusa. *Estrategia*, 1(1), 3-11.
- Hagerty, J. (2006). AMR Research's Business Intelligence/ Performance Management Maturity Model (Vol. 2): Gartner.com.
- Hostmann, B., & Hagerty, J. (2010). *IT-score overview for business intelligence and performance management*.
- Hribar Rajterič, I. (2010). Overview of business intelligence maturity models. *Management: Journal of Contemporary Management Issues*, 15(1), 47-67. doi: <https://hrcaak.srce.hr/file/81745>
- Kitchenham, B. (2004). Procedures for performing systematic reviews *Joint technical report* (Vol. 33, pp. 1-28). Empirical Software Engineering National ITC Australia Ltd (Australia): Department of computer sciences, Keele University (UK).
- Kitchenham, B. (2007). Guidelines for performing systematic literature reviews in software engineering *Technical report, EBSE Technical Report EBSE-2007-01* (pp. 1-57). Keele (UK): Keele University.
- Kitchenham, B., Brereton, O. P., Budgen, D., Turner, M., Bailey, J., & Linkman, S. (2009). Systematic literature reviews in software engineering—a systematic literature review.

- Information and software technology*, 51(1), 7-15. doi: <https://doi.org/10.1016/j.infsof.2008.09.009>
- Kurtyka, J. (2003). The limits of business intelligence: an organizational learning approach. *Information management*, 13(6), 36.
- Lahrman, G., & Marx, F. (2010). Systematization of Maturity Model Extensions. In R. Winter, J. L. Zhao & S. Aier (Eds.), *Global Perspectives on Design Science Research: 5th International Conference, DESRIST 2010, St. Gallen, Switzerland, June 4-5, 2010. Proceedings*. (pp. 522-525). Berlin, Heidelberg: Springer.
- Lahrman, G., Marx, F., Winter, R., & Wortmann, F. (2011). *Business intelligence maturity: Development and evaluation of a theoretical model*. Paper presented at the System Sciences (HICSS), 2011 44th Hawaii International Conference on, Kauai, HI, USA.
- Lankhorst, M. (2005). *Enterprise Architecture at Work: modelling, communication, and analysis* (third ed.). Berlin: Springer.
- Lih, O. I., & Hwa, S. P. (2013). *The impact of organization's demographic factors on business intelligence maturity in Malaysia*. Paper presented at the Research and Innovation in Information Systems (ICRIIS), 2013 International Conference on.
- Liyang, T., Zhiwei, N., Zhangjun, W., & Li, W. (2011). *A conceptual framework for business intelligence as a service (saas bi)*. Paper presented at the Intelligent Computation Technology and Automation (ICICTA), 2011 International Conference on.
- Lukman, T., Hackney, R., Popovič, A., Jaklič, J., & Irani, Z. (2011). Business intelligence maturity: the economic transitional context within Slovenia. *Information Systems Management*, 28(3), 211-222. doi: <https://doi.org/10.1080/10580530.2011.585583>
- Martínez, J. F., Castillo Osorio, B., & Díaz Pertúz, L. (2015). The concept of smart office or smart office as a business model in Colombia. *Estrategia*, 1(1), 12-33.
- Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., . . . Stewart, L. A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic reviews*, 4(1), 1.
- Najmi, M., Sepehri, M., & Hashemi, S. (2010). *The evaluation of Business Intelligence maturity level in Iranian banking industry*. Paper presented at the Industrial Engineering and Engineering Management (IE&EM), 2010 IEEE 17Th International Conference on.
- Olszak, C. M. (2013). *Assessment of business intelligence maturity in the selected organizations*. Paper presented at the Computer Science and Information Systems (FedCSIS), 2013 Federated Conference on.
- Olszak, C. M. (2016). Toward better understanding and use of Business Intelligence in organizations. *Information Systems Management*, 33(2), 105-123. doi: <https://doi.org/10.1080/10580530.2016.1155946>
- Olszak, C. M., & Ziemba, E. (2007). Approach to building and implementing business intelligence systems. *Interdisciplinary Journal of Information, Knowledge & Management*, 2. doi: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.465.1262&rep=rep1&type=pdf>
- Ong, I. L., Siew, P. H., & Wong, S. F. (2011). *Assessing organizational business intelligence maturity*. Paper presented at the Information Technology and Multimedia (ICIM), 2011 International Conference on.

- Palmarini, R., Erkoyuncu, J. A., Roy, R., & Torabmostaedi, H. (2018). A systematic review of augmented reality applications in maintenance. *Robotics and Computer-Integrated Manufacturing*, 49, 215-228. doi: <https://doi.org/10.1016/j.rcim.2017.06.002>
- Pellissier, R., & Nenzhelele, T. E. (2013). Towards a universal competitive intelligence process model. *South African Journal of Information Management*, 15(2), 1-7. doi: <https://doi.org/10.4102/sajim.v15i2.567>
- Petticrew, M., & Roberts, H. (2008). *Systematic reviews in the social sciences: A practical guide*: John Wiley & Sons.
- Pivka, M., Rozman, I., & Mohorič, T. (1996). *Kakovost v programskem inženirstvu -Quality in software engineering* (first ed.). Ljubliana, Slovenia: Desk.
- Prieto-Morales, R. D., Meneses-Villegas, C. J., & Vega-Zepeda, V. R. (2015). GMM-BI: A methodological guide to improve organizacional maturity in Business Intelligence. *Revista Facultad de Ingeniería Universidad de Antioquia*(76), 7-18. doi: <http://doi.org/10.17533/udea.redin.n76a02>
- Prieto Morales, R., Meneses Villegas, C., & Vega Zepeda, V. (2015). Análisis comparativo de modelos de madurez en inteligencia de negocio. *Ingeniare. Revista chilena de ingeniería*, 23(3), 361-371. doi: <https://doi.org/10.4067/S0718-33052015000300005>
- Proença, D. (2016). *Methods and techniques for maturity assessment*. Paper presented at the Information Systems and Technologies (CISTI), 2016 11th Iberian Conference on.
- Raber, D., Epple, J., Winter, R., & Rothenberger, M. (2016). *Closing the Loop: Evaluating a Measurement Instrument for Maturity Model Design*. Paper presented at the System Sciences (HICSS), 2016 49th Hawaii International Conference on.
- Raber, D., Winter, R., & Wortmann, F. (2012). *Using quantitative analyses to construct a capability maturity model for business intelligence*. Paper presented at the System Science (HICSS), 2012 45th Hawaii International Conference on, Maui, HI, USA.
- Raber, D., Wortmann, F., & Winter, R. (2013). *Situational business intelligence maturity models: An exploratory analysis*. Paper presented at the System Sciences (HICSS), 2013 46th Hawaii International Conference on.
- Rayner, N., & Schlegel, K. (2008). Maturity model overview for business intelligence and performance management. *Gartner, Stamford*.
- Rouhani, B. D., Mahrin, M. N., Nikpay, F., & Nikfard, P. (2013). *A comparison enterprise architecture implementation methodologies*. Paper presented at the Proceedings - 2013 International Conference on Informatics and Creative Multimedia, ICICM, Kuala Lumpur, Malaysia.
- Russell, S., Haddad, M., Bruni, M., & Granger, M. (2010). *Organic Evolution and the Capability Maturity of Business Intelligence*. Paper presented at the AMCIS.
- Santos, A. C. C. d., Delamaro, M. E., & Nunes, F. L. S. (2013, 28-31 May 2013). *The Relationship between Requirements Engineering and Virtual Reality Systems: A Systematic Literature Review*. Paper presented at the 2013 XV Symposium on Virtual and Augmented Reality.
- Santos, M., & Correia, A. M. R. (2010). *Competitive intelligence as a source of competitive advantage: an exploratory study of portuguese biotechnology industry*. Paper presented at the 11th European Conference of Knowledge Management, Famalacão, Portugal.
- Schekkerman, J. (2005). *The economic benefits of enterprise architecture: how to quantify and manage the economic value of enterprise architecture* (first ed.). London, UK: Trafford Publishing.

- Shen, C.-C., Chang, R.-E., Hsu, C. J., & Chang, I.-C. (2017). How business intelligence maturity enabling hospital agility. *Telematics and Informatics*, 34(1), 450-456. doi: <https://doi.org/10.1016/j.tele.2016.06.009>
- Spruit, M. R., & Sacu, C. (2015). DWCMM: The Data Warehouse Capability Maturity Model. *J. UCS*, 21(11), 1508-1534. doi: <https://doi.org/10.3217/jucs-021-11-1508>
- Tan, C.-S., Sim, Y.-W., & Yeoh, W. (2011). A maturity model of enterprise business intelligence. *Communications of the IBIMA*.
- Tavallaei, R., Shokohyar, S., Moosavi, S. M., & Sarfi, Z. (2015). Assessing the Evaluation Models of Business Intelligence Maturity and Presenting an Optimized Model. *International Journal of Management, Accounting and Economics*, 2(9), 1005-1019. doi: http://www.ijmae.com/files/accepted/345_final.pdf
- Trieu, T. V. H. (2013). *Extending the theory of effective use: The impact of enterprise architecture maturity stages on the effective use of business intelligence systems*. Paper presented at the International Conference on Information Systems (ICIS 2013): Reshaping Society Through Information Systems Design.
- Vukšić, V. B., Bach, M. P., Grublješić, T., Jaklić, J., & Stjepić, A. M. (2017). *The role of alignment for the impact of business intelligence maturity on business process performance in Croatian and Slovenian companies*. Paper presented at the Information and Communication Technology, Electronics and Microelectronics (MIPRO), 2017 40th International Convention on.
- Walter, S. A., & Bach, T. M. (2015). Adeus papel, marca-textos, tesoura e cola: Inovando o processo de análise de conteúdo por meio do ATLAS.ti/Goodbye to paper, highlighters, scissors and glue: Innovating the content analysis process through ATLAS.ti. *Administração: Ensino e Pesquisa*, 16(2), 275-308.
- Watson, H., Ariyachandra, T., & Matyska, R. J. (2001). Data Warehousing Stages of Growth. *Information Systems Management*, 18(3), 42-50. doi: 10.1201/1078/43196.18.3.20010601/31289.6
- Williams, S., & Williams, N. (2004). Assessing BI Readiness: A Key to BI ROI. *Business Intelligence Journal*, 9, 15-23.
- Williams, S., & Williams, N. (2007a). Appendix B - A business intelligence readiness assessment *The Profit Impact of Business Intelligence* (pp. 202-205). San Francisco: Morgan Kaufmann.
- Williams, S., & Williams, N. (2007b). Chapter 5 - Leading and managing a business intelligence-driven profit improvement program *The Profit Impact of Business Intelligence* (pp. 96-116). San Francisco: Morgan Kaufmann.
- Williams, S., & Williams, N. (2010). *The profit impact of business intelligence* (first ed.). Atlanta, USA: Elsevier.
- Wu, J.-Y. (2010). *Computational intelligence-based intelligent business intelligence system: concept and framework*. Paper presented at the Computer and Network Technology (ICCNT), 2010 Second International Conference on.
- Xavier, A. F., Naveiro, R. M., Aoussat, A., & Reyes, T. (2017). Systematic literature review of eco-innovation models: Opportunities and recommendations for future research. *Journal of Cleaner Production*, 149, 1278-1302. doi: <https://doi.org/10.1016/j.jclepro.2017.02.145>
- Zachman, J. A. (1997). Enterprise architecture: The issue of the century. *Database Programming and Design*, 10(3), 44-53.