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Diffusion, drivers and trends on integrated management systems evolution among Portuguese companies

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Abstract

This paper aims to update and report the diffusion and forecasting models of Portuguese integrated management systems (IMSs) encompassing the ISO 9001, ISO 14001 and OHSAS 18001 standards (QES). A research method similar to that described by a previous relevant research on diffusion of QES in Portugal was adopted. Data concerning the evolution of the amount of multiple MSs in Portugal (ranging from 1999 to 2016) was retrieved from a periodical Portuguese publication (*Barómetro da Certificação*). The evolutionary behavior of the number of MSs over the years was studied adopting both the Gompertz and the simple logistic models. The results obtained by fitting the data to these models were dissected enabling a forecast for the forthcoming years. In opposition to the results of the original study (based on a higher percentage of extrapolated data) the data seem to be properly fitted by the simple logistic model. Similarly to the conclusions of the original study the diffusion throughout the years of the number of MSs presents an S-shaped behavior and the Gompertz model predicts a higher amount of IMSs at the saturation level (which is in line with the original conclusions).

1. INTRODUCTION

1.1. Contextualization

Integrated management systems (IMSs) have been actively, extensively and comprehensively studied by the mainstream research community over the last two decades. However, several research gaps remain unanswered. Recently a joint effort by four research teams from south European countries (including Portugal) unfolded the behavior and forecasted the diffusion of IMSs (Cabecinhas et al., 2018). This paper intends to test and update the Portuguese diffusion model taking into account the data (now available) from the last years. The paper is structured as follows: The “Literature Review” section addresses and dissects the latest published contributions in the domain of IMSs and diffusion of standardized MSs. The research method is described in the

following section and the “Results” section presents and discusses the soundest research outputs. The “Conclusions” section summarizes the results, dissects the implications and points out future research avenues.

1.2. Integrated Management Systems among Portuguese companies

Solely the most common integrated typologies were considered in the analysis. The integrated typology encompassing the three subsystems accounts for around 45% of the population (Figure 1) and the typologies encompassing two subsystems, combined, account for 55%. The geographic diffusion of the IMSs (Figure 2) throughout Portugal matches the density of the Portuguese industrial complex.

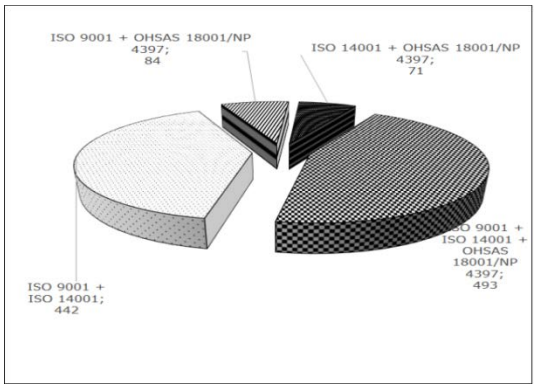


Figure 1. Portuguese IMSs (Breakdown by typology).

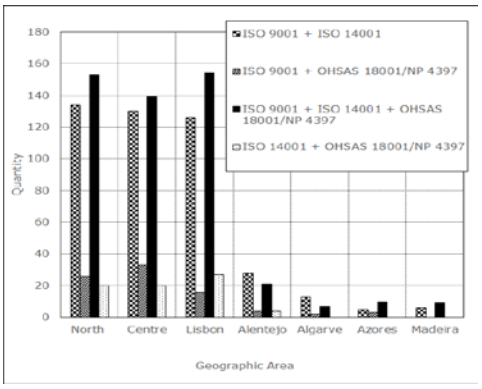
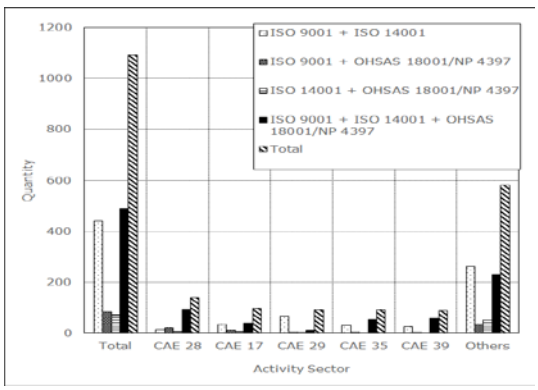


Figure 2. Portuguese IMSs (Breakdown by geographic area).

More than 95% of the studied population is located at the Lisbon, north and center regions. According to the results displayed by Figure 2 all these NUTS II regions (EU statistical territorial subdivision of the 2nd level) present the three component typology as the most representative. It should be highlighted that not all regions present all typologies, namely, Algarve, Azores and Madeira regions where no systems encompassing simultaneously the EMSs and OHSs were reported.

The analysis by activity sector is presented in Figure 3. The ‘Construction’ (Code 28) and the ‘Basic metal & fabricated metal products’ (Code 17) activity sectors are those where one may find the higher amount of integrated IMSs with a remarkable percentage of them encompassing the three subsystems. It should be mentioned that all the activity sectors that pertain to the Top Ten of IMSs have the three sub-systems typology as the most representative.

Concerning the certification bodies (Figure 4) more involved in the certification of multiple MSs one may see that APCER (*Associação Portuguesa de Certificação*) leads the ranking. This result matches the result attained if one considers the entire population of certified companies. It should be mentioned that, according to Figure 4, SGS and TÜV (*Technischer Überwachungsverein*) are the other certification bodies deeply involved in the certification of multiple management systems.



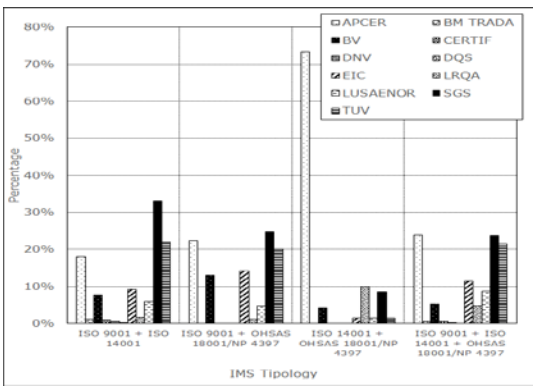


Figure 3. Portuguese IMSs (Breakdown by activity sector).

Figure 4. Portuguese IMSs (Breakdown by certification body).

2. LITERATURE REVIEW

2.1 Management Systems Integration

As previously stated, the MSs integration topic still has some research gaps that were not yet addressed and/or answered. However throughout the last years several relevant and groundbreaking contributions were reported and published through different streams of bibliography. In a first stream, the soundest benefits attained by companies who implement an IMS, the major expectations and the difficulties faced were extensively reported by several authors (e.g. Santos, G., Mendes, F., & Barbosa, J. (2011)). Additionally several integration levels were identified, a great deal of integration strategies were depicted and some specific organizational functions (such as audits) were dissected. Later on, in a second stream of bibliography, integration models and best practices were proposed, concepts revolving around the MSs integration concept were identified, guidelines aiming at a successful integration were reported and patterns identified. In the current stream of bibliography authors address often the maturity of IMSs and how an IMS may be tailored and designed to be in line with concepts such as sustainability, corporate social responsibility (CSR), innovation, risk management, total quality management (TQM) and lean practices. In addition, some recent publications addressed the impact and the financial performance of companies operating with multiple MSs and the diffusion of these multiple certificates at country level.

Table A1 (Appendix) summarizes some of the most recent published studies addressing the phenomenon of MSs integration. A great deal of these recent studies report tools, methods and models aiming at the assessment of the maturity of IMSs (Domingues, Sampaio, & Arezes, 2016; Dragomir, Popescu, Neamțu, Dragomir, & Bodi, 2017; Moumen & El Aoufir, 2018; Poltronieri, Ganga, & Gerolamo, 2018) and some innovative integration strategies/frameworks and how to proceed with a successful implementation (Bernardo, Gotzamani, Vouzas, & Casadesus, 2018; Chountalas & Tepaskoualos, 2018; Ezzat, Bahi, & Nasreldeen, 2017; Gracia, Lara, Quintero, & Santis, 2018; Jimenez, Novoa, Ramos, Martinez, & Alvarino, 2018; Llonch, Bernardo, & Presas, 2018; Muthusamy, Palanisamy, & Mohanraj, 2018; Muzaimi, Hamid, & Chew, 2018; T. . Nunhes, Motta, & Oliveira, 2017; T. V. Nunhes, Bernardo, & Oliveira, 2019; Shevchenko, Pagell, Johnston, Veltri, & Robson, 2018; Sui, Ding, & Wang, 2018). A relevant amount of papers address some concepts and their linkage with IMSs, such as, risk management (Emetumah, 2017; Rebelo, Silva, & Santos, 2017) and the latest standards revisions (Majerník, Daneshjo, Chovancová, & Sančiová, 2017), CSR (Gianni, Gotzamani, & Tsiotras, 2017; Ionescu, Firoiu, Pîrvu, Bădîrcea, & Drăgan, 2018), sustainability (Başaran, 2018; Mustapha, Manan, & Wan Alwi, 2017; Souza & Alves, 2018), innovation (Hernandez-Vivanco, Bernardo, & Cruz-Cázares, 2018), TQM (Talapatra, Uddin, & Rahman, 2018) and lean management (Jewalikar & Shelke, 2017). It should be pointed out that Bernardo, Gianni, Gotzamani, & Simon, (2017) identified some similar and dissimilar integration patterns in Greek and Spanish companies, Nunhes, Motta, & Oliveira, (2016), Cuevas Castañeda (2018), Moumen & El Aoufir (2017) and Tuczek, Castka, & Wakolbinger (2018) analyzed and dissected some of the research gaps in the existing literature, Medina (2018) summarized the soundest integration theories and the financial performance of companies operating with multiple certifications was a topic addressed by Martí-Ballester & Simon (2017), Hernandez-Vivanco, Domingues, Sampaio, Bernardo, & Cruz-Cázares (2018) and Llonch et al (2018). The remaining papers dissected some sector specific issues within IMSs (Gianni, Gotzamani, & Vouzas, 2017; Gurina, Poddubsky, & Sinenko, 2018; Pal Pandi, Paranitharan, & Jeyathilagar, 2018; Pratama, Kumar, Kumari, Garza-Reyes, & Nadeem, 2018), the Information/IT requirements to support the resulting IMS (Balabanov & Davletshin, 2018; Lança & Brito, 2017; Pop & Ţîţu, 2018), the impact of multiple certifications (Alfredo & Nurcahyo, 2018; Wiengarten, Humphreys, Onofrei, & Fynes, 2017), some theoretical models (Benyettou &

Abdellatif, 2018) and mediating variables of the integration process (Arda, Bayraktar, & Tatoglu, 2018).

Figure 5 summarizes the countries from each these recent studies were originated (orange). One may conclude that this research topic is an active, up to date research domain encompassing contributions from different industrial and geographic contexts.

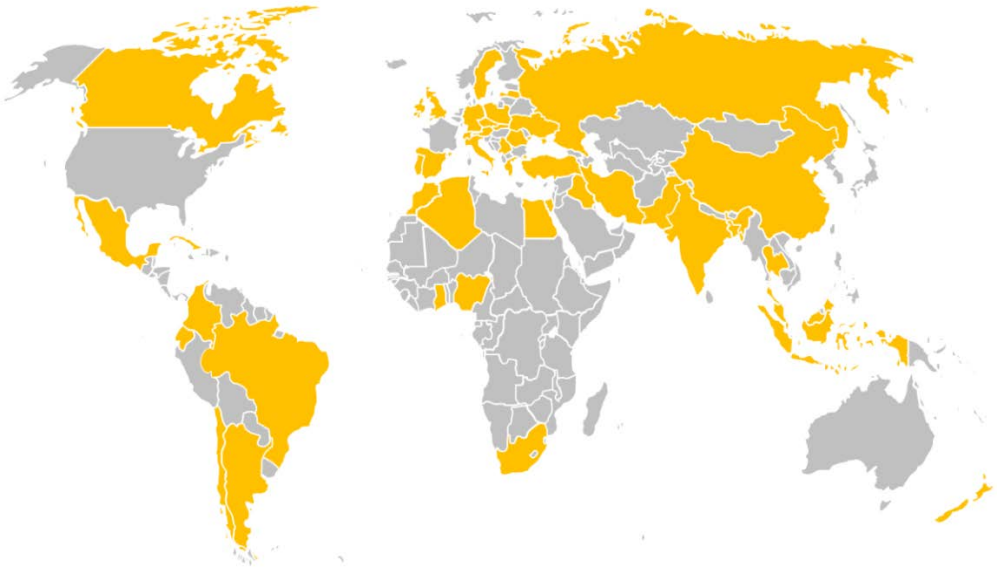


Figure 5. Countries affiliations of the authors that addressed recently the IMSs research topic.

2.2 Diffusion of Management Systems Standards

The studies on the diffusion of MSs standards aim at addressing several research questions simultaneously, namely (among others), at which extent the MSs standards will be implemented, has the saturation stage been reached, which patterns emerge, and which diffusion model fits accurately the data available.

The first efforts on the topic of MSs diffusion models were reported by Corbett & Kirsch, (2001) throughout the latest years of the last century and early years of the new millennium. The last contributions were reported by a joint venture encompassing four European research groups from Portugal, Spain, Italy and Greece and addressing companies holding multiple certifications schemes (Cabecinhas et al., 2018) - Table 1.

The published studies focused mainly on the diffusion of different standards and management tools, such as, the ISO 9001 standard (Albuquerque, Bronnenberg, & Corbett, 2007; Almeida, Fá, & Marimon, 2009; María del Mar Alonso-Almeida, Marimon, & Bernardo, 2013; Chen & Liu, 2009; F. Franceschini, Galetto, & Cecconi, 2006; F. Franceschini, Galetto, Maisano, & Mastrogiacomo, 2010; Grajek, 2004; Kale & Arditi, 2006; Llach, Marimon, & Bernardo, 2011; Marimon, Heras, & Casadesús, 2009; Marimón, Heras, & Casadesús, 2008; Ribeiro, Beijo, Salgado & Nogueira, 2019; Salgado, Beijo, Sampaio, Pereira Mello, & Saraiva, 2015; Sampaio, Saraiva, & Rodrigues, 2009, 2011; Viadiu, Fa, & Saizarbitoria, 2006), the ISO 14001 (Albuquerque et al., 2007; Casadesús, Marimon, & Heras, 2008; Corbett & Kirsch, 2001; Delmas & Montes-Sancho, 2011; Hikichi, Salgado, & Beijo, 2017b; Marimon et al., 2009; Marimón et al., 2008; Perkins & Neumayer, 2010; Qi et al., 2011; Viadiu et al., 2006), Eco-Management and Audit Scheme (EMAS) (Heras-Saizarbitoria, Arana, & Boiral, 2015), UN Global Compact (Perkins & Neumayer, 2010), the ISO/TS 16949 standard (F. Franceschini, Galetto, Maisano, & Mastrogiacomo, 2011), the SA 8000 standard (Llach, Marimon, & Alonso-Almeida, 2015), the ISO 22000 standard (Mohammed & Zheng, 2016) and the Spanish "Q" standard (Almeida et al., 2009; M. del M. Alonso-Almeida, Marimon, & Bernardo, 2013).

Table 1. Latest published studies in the domain of standardized MSs diffusion

Authors	Year	Region	Comments	Topic/Standard
Cabecinhas *et al.*	2018	Portugal/ Spain/ Italy	---	IMS (ISO 9001+ISO 14001+OHSAS 18001)
Cabecinhas *et al.*	2019	Portugal	---	
Hikichi *et al.*	2017a	American Continent (13 countries)	Breakdown by country and activity sector.	
Casadesús *et al.*	2008	Selected countries	---	
Ikram *et al.*	2019	Selected Countries		
Corbett and Kirsch	2001	Worldwide	Report some explanatory factors.	
Prajogo *et al.*	2014			
Prakash, & Potoski	2007			ISO 14001/ISO 14000
Delmas and Montes-Sancho	2011	139 countries	Report some explanatory factors.	
Hikichi *et al.*	2017b	America	Breakdown by country.	
Hikichi *et al.*	2016	American Continent	---	
Qi *et al.*	2011	China	Breakdown by province.	
To and Lee	2014	Worldwide/ Regional/ Countries	Report some explanatory factors.	
Albuquerque *et al.*	2007	Selected countries	Selected countries.	
Marimon *et al.*	2009	Worldwide	Breakdown by country.	
Castka, & Corbett	2013		Decertification phenomenon is dissected.	ISO 9000/1 and ISO 14000/1
Marimon *et al.*	2006	Worldwide	Breakdown by activity sector.	
Marimón *et al.*	2008	Spain/Serbia	---	
Chen and Liu	2009	China	---	
Franceschini *et al.*	2010	Europe	---	
Llach *et al.*	2011	Worldwide	Breakdown by activity sector.	
Salgado *et al.*	2015	America	Breakdown by country.	
Sampaio *et al.*	2009	Wordwide/ EU	---	ISO 9000/1
Sampaio *et al.*	2011	Worldwide	Report some explanatory factors.	
Grajek	2004	Selected countries	Relationship with bilateral trade.	
Franceschini *et al.*	2006	Selected countries	---	
Kale and Arditi	2006	Turkey	Precast concrete industry.	
Alonso-Almeida *et al.*	2013	Spain	Hospitality industry.	ISO 9001 and "Q" standard.
Franceschini *et al.*	2011	Worldwide	Automotive industry.	ISO/TS 16949
Heras-Saizarbitoria *et al.*	2015	Europe	High and low polluting industries.	EMAS
Llach *et al.*	2015	Worldwide	Breakdown by country and activity sector.	SA 8000
Perkins and Neumayer	2010	Worldwide	---	ISO 14001 and Global Compact
Almeida *et al.*	2009	Spain	Hotel industry.	Q standard.
Mohammed and Zheng	2016	Worldwide	Breakdown by country. Food industry.	ISO 22000
Raweni and Majstorovic	2016	European countries	---	ISO standards.

It should be pointed out that some of these studies addressed a single activity sector (Almeida et al., 2009; M. del M. Alonso-Almeida et al., 2013; F. Franceschini et al., 2011; Kale & Arditi, 2006; Mohammed & Zheng, 2016), some considered solely selected

countries or macro-regions (Albuquerque et al., 2007; Hikichi, Salgado, & Beijo, 2017a; Hikichi et al., 2017b; Qi et al., 2011; Raweni & Majstorovic, 2016; Salgado et al., 2015), some of them tested and/or reported explanatory factors (Corbett & Kirsch, 2001; Delmas & Montes-Sancho, 2011; Grajek, 2004; Sampaio et al., 2011; To & Lee, 2014) and some compared between two clusters of companies (Heras-Saizarbitoria et al., 2015).

3. RESEARCH METHOD

The current work is supported in the methodology adopted in the research of Cabecinhas *et al.* (2018) which focus the analysis of the diffusion of simultaneously certified Quality, Environmental and Safety (QES) MSs among companies. Concurrently, this paper aims at updating the previous reported model considering that its performance is affected by the number of observations collected and by the inclusion of the inflexion point in the range of the variation of the data. This fact demands for a continuous update of the model (fitted through the available data) to check its validity throughout time (Cabecinhas et al., 2018; Meade & Islam, 1998). The update of the models is extremely important, since the growth curve should be according to the dynamics of the phenomenon (Martino, 1993). Therefore, when the data is extrapolated outside of the data range, the future dynamic match with the phenomenon (Martino, 1993).

In this case, the models tested follow an S-shaped curve (Gompertz and simple logistic curves). These are characterized by three different phases named in the following points (Buchanan, Whiting, & Damert, 1997; Cabecinhas et al., 2018; Fiorenzo Franceschini, Galetto, & Gianni, 2004):

- Lag phase: it is the beginning of the phenomenon. Some organizations start to introduce the ISO Standards, as a way to distinguish themselves from the competition;
- Exponential phase: after achieving the certification successfully, more and more organizations start to adopt the standards. The number of certifications starts to increase exponentially and the difficulties faced in the beginning of the process were surpassed. However, the growth speed decreases after the interest apex due to factors such as: the limited number of organizations interested in the certification and the reduction of the competitive advantage of the certification;
- Stationary phase or saturation level: the maximum number of certification is achieved.

None of the curves chosen consider the possibility of a next phase (decrease or increase after the saturation level).

3.1. Gompertz curve

The Gompertz curve is a widely used model to characterize the S-shape behaviour (Equation 1) (Carrillo & González, 2002; Winsor, 1932; Wu & Chu, 2010; Zwietering, Jongenburger, Rombouts, & van 't Riet, 1990). This model is characterized by his asymmetry relatively to the point of inflexion, i.e., this point emerge prior to achieving half of the time needed to reach the saturation level (Carrillo & González, 2002; Mar-Molinero, 1980; Meade & Islam, 1995). The value ***a*** represents the saturation level, *i.e.*, the maximum number of companies certified that can be expected and achieved.

$$y(t) = a.e^{-e^{[-k.(t-t_c)]}} \quad (1)$$

3.2. Simple Logistic curve

The simple logistic curve is one of the most adopted curves in the literature. In opposition to the Gompertz curve the simple logistic curve is symmetric to the point of

inflexion, meaning that this will occur in the middle of the time needed to achieve the saturation level (Carrillo & González, 2002; Mar-Molinero, 1980; Meade & Islam, 1995). Similarly to the Gompertz curve, the value ***a*** represents the saturation level. The simple logistic curve is represented by the Equation 2 (Carrillo & González, 2002; Winsor, 1932; Wu & Chu, 2010; Zwietering et al., 1990).

$$y(t) = \frac{a}{1 + e^{[-k.(t-t_c)]}} \quad (2)$$

Detailed information regarding the models can be found in previous works (Cabecinhas et al., 2018; Meade & Islam, 1995; Winsor, 1932). The non-linear least square regression was the approach adopted to fit both curves (Martino, 1993; Meade & Islam, 1995; Seber & Wild, 1989; Zwietering et al., 1990).

3.3. Materials

The data sample was collected from the study of Cabecinhas *et al.* (2018) with additional data obtained from more recent years (2014, 2015 and 2016). Similarly to the previous study, the data was collected through the contact with local certification bodies operating in Portugal that provided their available information regarding the number of certified IMSs (available at *Barómetro da Certificação*). Table 2 presents the data used to analyse the diffusion of the QES, with the additional data highlighted in bold.

In this case, the data reflects the evolution of the number of certificates entailing that the decertification phenomenon is also considered. In line with the study authored by Cabecinhas *et al.* (2018) the data used do not consider the level of integration of the MSs implemented meaning that these certificates account for MSs simultaneously certified with, at least, the three more common certified MSs, i.e. the ISO 9001, ISO 14001 and OHSAS 18001 standards.

4. RESULTS

Both curves were fitted to the data by Origin from Table 2. The variable “Counter” was used as an independent variable to identify temporal scale. The updated parameters obtained for each model are presented in the Table 3. Figure 6 and Figure 7 depict the updated curves fitted according the Gompertz and Simple Logistic models, respectively.

Table 2. Data used to fit the models

Year	Counter	Nº of QES
1999	1	7
2000	2	12
2001	3	25
2002	4	40
2003	5	77
2004	6	131
2005	7	170
2006	8	199
2007	9	281
2008	10	-
2009	11	347
2010	12	429
2011	13	468
2012	14	577
2013	15	670
2014	**16**	**679**
2015	**17**	**569**
2016	**18**	**580**

Table 3. Updated parameters obtained for each model

Curve Parameters	Gompertz	Simple Logistic
a	735.29	662.59
xc	8.85	10.09
k	0.22	0,40
Degrees of Freedom	14	14
Residual Sum of Squares	29733.73	25976.07
R-Square	0.97	0.97

The results presented in Table 3 suggest that both models properly fit the diffusion of QES in Portugal. However, including the new added data and looking at the residual sum of squares, the simple logistic model seems to describe more accurate the dynamics of this phenomenon than the Gompertz model. Comparing the results obtained for the forthcoming saturation level of QES in both models, it is possible to observe a decrease of the expected number of organizations holding simultaneously these MSs in both cases (if one benchmark against the original study). However, the difference for the saturation level of the Gompertz curve is bigger than the difference obtained for the Simple Logistic curve suggesting that the Gompertz model experience bigger changes than the Simple Logistic curve, so it can be more sensitive to the amount of data needed to get an improved prediction of what will happen in the future. Like in the previous study, the Gompertz curve seems to predict a higher amount of QES than the Simple Logistic curve at the saturation level.

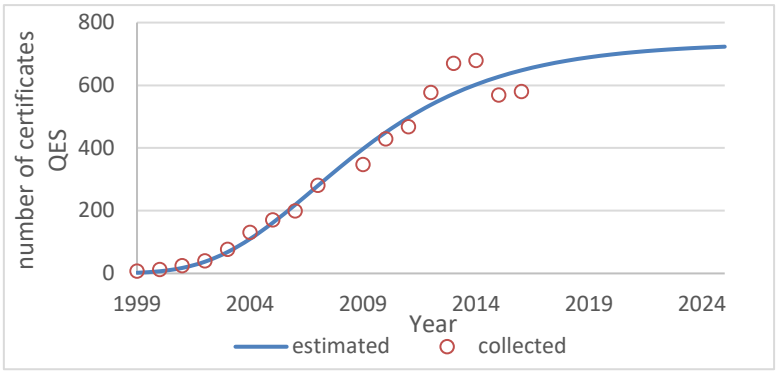


Figure 6. Updated Gompertz curve (Portugal)

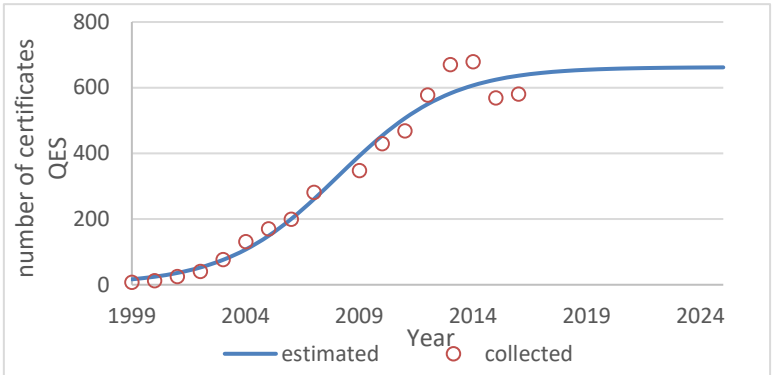


Figure 7. Updated Simple logistic curve (Portugal)

5. CONCLUSIONS

This study aimed at updating the work developed by Cabecinhas et al. (2018) taking into account more recent data and to dissect the forthcoming trend of the diffusion of IMSs. The presented study shows the fluctuations that could happen in the process of analyzing the diffusion of IMSs, showing the importance of updates with these kinds of studies since, the more recent data added could result in huge changes when compared with the more incomplete data set. The actual update showed differences in the saturation levels predicted and in the model that better describes the phenomenon. The differences identified could result from the revision of the standards, since ISO 9001 standard and ISO 14001 were revised in 2015. It would be of great interest to analyze the impact of the update of standards in the diffusion of the IMSs and the development of a model that could explain what generally happen in times of transition of the standards. It was also possible to observe that the Gompertz model seems to present a more positive view of the future of the IMSs, in other words, for the second time predicted values for the saturation level higher than the simple logistic model. Some shortcomings can be identified in this study like the consideration of companies that presented the three management system standards “simultaneously certified” and not actually integrated, so the level of integration of the standards is not assessed or considered in this study.

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REFERENCES

Abisourour, J., Hachkar, M., Mounir, B. & Farchi, A. (2019). Methodology for integrated management system improvement: combining costs deployment and value stream mapping. *International Journal of Production Research, in press*.

Acuña, G., Brollo, F., & Torres, L. (2019). Safety Management and Integrated Management Systems for nuclear research reactors: Approach and experience gained from Argentinian RA6 reactor. *Proceedings of International Conference on Research Reactors: Addressing Challenges and Opportunities to Ensure Effectiveness and Sustainability*, 25–29 November 2019, Buenos Aires, Argentina.

Al Ghani, A.N.J. (2019). Achieving total quality audit through proper auditing management practices. *Academy of Accounting and Financial Studies Journal, 23*(2), 1-15.

Albuquerque, P., Bronnenberg, B.J., & Corbett, C.J. (2007). A spatiotemporal analysis of the global diffusion of ISO 9000 and ISO 14000 certification. *Management Science*, *53*(3), 504–527.

Ahidar, I., Sarsri, D. & Sefiani, N. (2019). Approach to integrating management systems: Path to excellence application for the automotive sector using SYSML language. *TQM Journal, 31*(2), 183-204.

Algheriani, N.M.S., Majstorovic, V.D., Kirin, S., & Spasojevic Brkic, V. (2019). Risk model for integrated management system. *Tehnički vjesnik, 26*(6), 1833-1840.

Alfredo, E.I., & Nurcahyo, R. (2018). The impact of ISO 9001, ISO 14001, and OHSAS 18001 certification on manufacturing industry operational performance. *In Proceedings of the International Conference on Industrial Engineering and Operations Management Bandung*.

Almeida, M.M.A., Fá, M.C., & Marimon, F. (2009). The diffusion of standardised quality management in hotel industry in Spain. In *Proceedings of POMS 20th Annual Conference Orlando, Florida U.S.A, May 1 to May 4*.

Alonso-Almeida, M. del M., Marimon, F., & Bernardo, M. (2013). Diffusion of quality standards in the hospitality sector. *International Journal of Operations & Production Management*, *33*(5), 451–468.

Alonso-Almeida, M.M., Marimon, F., & Bernardo, M. (2013). Diffusion of quality standards in the hospitality sector. *International Journal of Operations & Production Management*, *33*(5), 504–527.

https://doi.org/10.1108/01443571311322706.

Allur, E., Heras-Saizarbitoria, I., Boiral, O. & Testa, F. (2018). Quality and Environmental Management Linkage: A Review of the Literature. *Sustainability, 10*, 4311.

Arda, O.A., Bayraktar, E., & Tatoglu, E. (2018a). How do integrated quality and environmental management practices affect firm performance? Mediating roles of quality performance and environmental proactivity. *Business Strategy and the Environment*.

Arda, O.A., Tatoglu, E. & Alpkan, L. (2018b). Integrated quality and environment management practices: A model proposition. *Journal of Administrative Sciences, 16*(31), 11-40.

Asah-Kissiedu, M. (2019). Development of an integrated safety, health and environmental management capability maturity model (SHEMCMM) for Ghanaian construction companies. PhD Thesis, Faculty of Environment and Technology, University of the West of England, Bristol.

Azadeh, A., Nasirian, B. & Motevali Haghighi, S. (2019). An intelligent framework for performance optimisation of integrated management system and resilience engineering in pharmaceutical plants. *Total Quality Management and Business Excellence, 30*(9-10), 953-989.

Balabanov, I.P., & Davletshin, F. (2018). Implementation of ISO 9001, ISO 14001, ISO 45001 requirements with the systems of electronic document turnover. *International Journal of Engineering & Technology*, *7*(4.7), 78–81.

Bąk, P., & Nowak, A. (2019). The method of improving the functioning of an integrated management system in a mining enterprise. *Mineral Resources Management, 35*(2), pp. 175-186.

Barbosa, L.C.F.M., de Oliveira, O.J. & Santos, G. (2018). Proposition for the alignment of the integrated management system (quality, environmental and safety) with the business strategy. *International Journal for Quality Research, 12*(4), 925-940.

Başaran, B. (2018). Integrated Management Systems and Sustainable Development. *Quality Management Systems Leo D. Kounis, IntechOpen*. https://doi.org/10.5772/intechopen.71468

Benyettou, S., & Abdellatif, M. (2018). Empirical study on the integrated management system in Algerian companies. *Journal of Industrial Engineering and Management*, *11*(1), 135–160.

Bernardo, M., Gianni, M., Gotzamani, K., & Simon, A. (2017). Is there a common pattern to integrate multiple management systems? A comparative analysis between organizations in Greece and Spain. *Journal of Cleaner Production*, *151*, 121–133.

Bernardo, M., Gotzamani, K., Vouzas, F., & Casadesus, M. (2018). A qualitative study on integrated management systems in a non-leading country in certifications. *Total Quality Management and Business Excellence*, *29*(3–4), 453–480.

Blasco-Torregrosa, M., Perez-Bernabeu, E., Palacios-Guillem, M. & Gisbert-Soler, V. (2019). How do firms integrate management systems? A comparative study. *Total Quality Management & Business Excellence*, in press, DOI: 10.1080/14783363.2019.1635447.

Buchanan, R., Whiting, R., & Damert, W. (1997). When is simple good enough: a comparison of the Gompertz, Baranyi, and three-phase linear models for fitting bacterial growth curves. *Food Microbiology*, *14*(4), 313–326.

Cabecinhas, M., Domingues, P., Sampaio, P., Bernardo, M., Franceschini, F., Galetto, M., … Hernandez-Vivanco, A. (2018). Integrated management systems diffusion models in South European countries. *International Journal of Quality & Reliability Management*, *35*(10), 2289–2303. https://doi.org/10.1108/IJQRM-03-2017-0044.

Cabecinhas, M., Domingues, P., Sampaio, P. & Arezes, P.M. (2019). Revisiting Diffusion Models: Portuguese Integrated Management Systems Evolution (Chapter). *In book Occupational and Environmental Safety and Health*, Springer International Publishing. 661-675.

Carrillo, M., & González, J.M. (2002). A new approach to modelling sigmoidal curves. *Technological Forecasting and Social Change*, *69*(3), 233–241.

Carvalho, F., Domingues, P. & Sampaio, P. (2019a). Communication of commitment towards sustainable development of certified Portuguese organisations: Quality, environment and occupational health and safety. *International Journal of Quality & Reliability Management, 36*(4), 458-484.

Carvalho, F., Santos, G., & Gonçalves, J. (2019b). Critical analysis of information about integrated management systems and environmental policy on the Portuguese firms' website, towards sustainable development. *Corporate Social Responsibility and Environmental Management, in*

press.

Casadesús, M., Marimon, F., & Heras, I. (2008). ISO 14001 diffusion after the success of the ISO 9001 model. *Journal of Cleaner Production*, *16*, 1741–1754.

Castka, P., & Corbett, C.J. (2013). Management systems standards: Diffusion, impact and governance of ISO 9000, ISO 14000, and other management standards. *Foundations and Trends in Technology, Information and Operations Management, 7*(3-4), 161-379.

Chaudhuri, A. & Jayaram, J. (2019). A socio-technical view of performance impact of integrated quality and sustainability strategies. *International Journal of Production Research, 57*(5), 1478-1496.

Chen, Y., & Liu, E. (2009). The diffusion of ISO 9000 certification in China: A trend analysis based on Grey Verhulst model. In *Proceedings of 2009 International Conference on Information Management, Innovation Management and Industrial Engineering* (pp. 223–226).

Chountalas, P.T., & Tepaskoualos, F.A. (2019). Selective integration of management systems: a case study in the construction industry. *The TQM Journal*, *31*(1), 12-27.

Contreras, R.I.M. (2018). Metodología de implementación de un sistema integrado de gestión de las normas ISO 9001 e ISO 30301 para mejorar el desempeño del sector notarial. MSc Thesis, Escuela Colombiana de Ingeniería Julio Garavito, Colombia.

Corbett, C.J., & Kirsch, D.A. (2001). International diffusion of ISO 14000 certification. *Production and Operations Management*, *10*(3), 327–342.

Cyplik, P., Adamczak, M., Malinowska, K. & Piontek, J. (2019). The concept of an integrated company management system combining the results in favour of sustainable development with the company indicator system. *Advances in Intelligent Systems and Computing*, Volume 835, 2019, Pages 337-349 2nd International Conference on Intelligent Systems in Production Engineering and Maintenance, ISPEM 2018; Wroclaw; Poland; 17 September 2018 through 18 September 2018; Code 216809.

Cuevas Castañeda, A.L. (2018). Inputs and contributions to the integration of management systems: an international vision of the ISG 2015. *Signos- Investigación En Sistemas de Gestión*, *10*(2), 193–201.

Ćurčić, M., Petronić, S., Katnić, Đ., Balić, R., Dubravka Milovanović, D. (2018). Establishing integrated management system (IMS) through integration of standard ISO 9001, ISO 14001 and ISO 45001 in the scientific department of Institute of Nuclear Science 'VINCA'. *International Journal ''Advanced Quality'', 46*(3-4), 40-45.

Dahlin, G., & Isaksson, R. (2018). Integrated management systems- interpretations, results, opportunities. *The TQM Journal*, *29*(3), 528–542.

Darabi H., Ranjbar Vakilabadi D., Keshmiri, S., Ramavandi, B., Ziayei, M., & Omidvar, M. (2019). Necessity of Academic Education in Health, Safety and Environment (HSE) at Postgraduate Level. *Iranian South Medical Journal, 22*(4), 248-263

Darabont, D.-C., Bejinariu, C., Baciu, C. & Bernevig-Sava, M.-A. (2019). Modern approaches in integrated management systems of quality, environmental and occupational health and safety. *Quality- Access to Success, 20*, 105-108.

De, J. & Quadros, V.V. (2019). Factors in management systems contributing to business excellence: A case study of Veoneer Sweden AB. MSc Thesis, Master's Programme in Industrial Management and Innovation, Faculty of Science and Technology, Uppsala University, Sweden.

Delmas, M.A., & Montes-Sancho, M.J. (2011). An institutional perspective on the diffusion of international management system standards: The case of the environmental management standard ISO 14001. *Business Ethics Quarterly*, *21*(1), 103–132.

Domingues, J.P.T., Sampaio, P., & Arezes, P.M. (2016). Integrated management systems assessment: A maturity model proposal. *Journal of Cleaner Production*, *124*, 164–174.

Domingues, P., Sampaio, P. & Arezes, P.M. (2017). Management systems integration: survey results. *International Journal of Quality & Reliability Management, 34*(8), 1252-1294.

Domínguez, J.F.C. & Gaytán, J.C.T. (2019). Single Integrated Management System: Quality, Environment, Safety and Health. *Teuken Bidikay, 10*(14), --.

Đorđević, V, & Pecić, L. (2018). The management system integration on the production process level. *Journal of Economics, Management and Informatics, 9*(1), 31-45.

Dragomir, M., Popescu, S., Neamțu, C., Dragomir, D., & Bodi, Ș. (2017). Seeing the immaterial: A new instrument for evaluating integrated management systems' maturity. *Sustainability*, *9*(9), 1643.

Dragomir, M., Neamțu, C., Popescu, S., Popescu, D. & Dragomir, D. (2018). With the trio of standards now complete, what does the future hold for integrated management systems?. *In proceedings of the International Symposium for Production Research*, 769-778.

Emetumah, F.C. (2017). Integrated management systems as a risk management tool: Combining ISO 9001, ISO 14001 & OHSAS 18001 standards in process industries. In *Risk, Reliability and Safety: Innovating Theory and Practice- Proceedings of the 26th European Safety and Reliability Conference, ESREL 2016*.

Ezzat, A., Bahi, S., & Nasreldeen, T. (2017). Towards better environmental performance: A framework for IMS. *International Journal of Scientific and Engineering Research*, *8*(2), 105–130.

Ferreira, C.S., Poltronieri, C.F., & Gerolamo, M.C. (2019). ISO 14001:2015 and ISO 9001:2015: analyse the relationship between these management systems standards and corporate sustainability. *Gestão & Produção, 26*(4), e3906.

Fonseca, L., & Carvalho, F. (2019). The reporting of SDGs by Quality, Environmental, and Occupational Health and Safety-certified organizations. *Sustainability*, 11, 5797.

Franceschini, F., Galetto, M., & Cecconi, P. (2006). A worldwide analysis of ISO 9000 standard diffusion-Considerations and future development. *Benchmarking: An International Journal*, *13*(4), 523–541.

Franceschini, F., Galetto, M., Maisano, D.A., & Mastrogiacomo, L. (2011). ISO/TS 16949: analysis of the diffusion and current trends. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, *225*, 735–745. https://doi.org/10.1177/2041297510394061

Franceschini, F., Galetto, M., Maisano, D., & Mastrogiacomo, L. (2010). Clustering of European countries based on ISO 9000 certification diffusion. *International Journal of Quality &Reliability Management*, *27*(5), 558–575.

Franceschini, F., Galetto, M., & Gianni, G. (2004). A new forecasting model for diffusion of ISO 9000 standard certifications in European countries. *International Journal of Quality & Reability Management*, *21*(1), 32–50.

Gianni, M., Gotzamani, K., & Tsiotras, G. (2017). Multiple perspectives on integrated management systems and corporate sustainability performance. *Journal of Cleaner Production*, *168*, 1297–1311.

Gianni, M., Gotzamani, K., & Vouzas, F. (2017). Food integrated management systems: dairy industry insights. *International Journal of Quality and Reliability Management*, *34*(2), 194–215.

González, Y.C.O. (2018). Sistemas integrados de gestión, HSEQ, implementación, impactos, dificuldades. Revista Chilena de Economia Y Sociedad, Deciembre, 76-93.

Gracia, J., Lara, L., Quintero, D., & Santis, A. (2018). Formulation of strategies for the implementation of integral management system based on ISO 9001:2015 and 14001:2015 in the company Surtiapliques (Bogotá-Colombia). *Chemical Engineering Transactions*, *67*.

Grajek, M. (2004). Diffusion of ISO 9000 standards and international trade. *WZB Discussion Paper, No. SP II 2004-16, Wissenschaftszentrum Berlin Für Sozialforschung (WZB), Berlin*.

Guillem, M.P. (2019). Nueva metodología desarrollada para la integración de Lean Manufacturing, Kaizen e ISO 31000:2009 basados en la ISO 9001:2015. *3C Empresa. Investigación y pensamiento crítico, 8*(2), 12-43.

Guina, P.A.R. (2018). La responsabilidad social de Starbucks como um modelo a seguir para una nueva franquicia adaptado al entorno de Guayaquil Ecuador. MSc Thesis, Universidad Técnica de Machala, Ecuador.

Gurina, R., Poddubsky, A., & Sinenko, V. (2018). Integrated quality management system at food enterprises in Russia. *Engineering for Rural Development*, *17*, 883–886.

Hannigan, L., Deyab, G., Al Thani, A., Al Marri, A., & Afifi, N. (2019). The implementation of an integrated management system at Qatar Biobank. *Biopreservation and Biobanking, 17*(6), 506-511.

Hassan, N.A., Zailani, S.H.M. and Hasan, H.A. (2020). Integrated internal audit in management system: A comparative study of manufacturing firms in Malaysia. *The TQM Journal, 32*(1), 110-126.

Heras-Saizarbitoria, I., Arana, G., & Boiral, O. (2015). Exploring the dissemination of environmental

certifications in high and low polluting industries. *Journal of Cleaner Production*, *89*(50–56).

Herghiligiu, I.V., Robu, I.-B., Pislaru, M., Vilcu, A., Asandului, A.L., Avasilcăi, S., & Balan, C. (2019). Sustainable environmental management system integration and business Performance: A balance assessment approach using fuzzy logic. *Sustainability, 11*, 5311.

Hernandez-Vivanco, A., Bernardo, M., & Cruz-Cázares, C. (2018a). Sustainable innovation through management systems integration. *Journal of Cleaner Production*, *196*, 1176–1187.

Hernandez-Vivanco, A., Domingues, P., Sampaio, P., Bernardo, M., & Cruz-Cázares, C. (2018b). Assessing the financial effects of adopting multiple certifications. In *Proceedings of the 3rd ICQEM Conference*, 20-39.

Hernandez-Vivanco, A., Domingues, P., Sampaio, P., Bernardo, M., Cruz-Cázares, C. (2019). Do multiple certifications leverage firm performance? A dynamic approach. *International Journal of Production Economics, 218*, 386-399.

Hikichi, S.E., Salgado, E.G., & Beijo, L.A. (2017a). Characterization of dissemination of ISO 14001 in countries and economic sectors in the Americas. *Journal of Environmental Planning and Management*, *60*(9), 1554–1574.

Hikichi, S.E., Salgado, E.G., & Beijo, L.A. (2017b). Forecasting number of ISO 14001 certifications in the Americas using ARIMA models. *Journal of Cleaner Production*, *147*, 242–253.

Hikichi, S.E., Salgado, E.G., & Beijo, L.A. (2016). Analysis of the certification intensity levels on ISO 14001: Trends for the American continent. *Desenvolvimento e Meio Ambiente, 38*, 769-785.

Ikram, M., Zhou, P., Shah, S.A.A. & Liu, G.Q. (2019). Do environmental management systems help improve corporate sustainable development? Evidence from manufacturing companies in Pakistan. *Journal of Cleaner Production, 226*, 628-641.

Ikram, M., Mahmoudi, A., Shah, S.Z.A., & Mohsin, M. (2019). Forecasting number of ISO 14001 certifications of selected countries: application of even GM (1,1), DGM, and NDGM models. *Environmental Science and Pollution Research, 26*(12), 12505–12521. doi: 10.1007/s11356-019-04534-2.

Ikram, M., Sroufe, R., & Qingyu, Z. (2020). Prioritizing and overcoming barriers to integrated management system (IMS) implementation using AHP and G-TOPSIS. *Journal of Cleaner Production, in press*.

Ionescu, G.H., Firoiu, D., Pîrvu, R., Bădîrcea, R., & Drăgan, C. (2018). Implementation of integrated management systems and corporate social responsibility initiatives- A Romanian hospitality industry perspective. *Sustainability*, *10*, 3684.

Jaroenroy, T. & Chompunth, C. (2019). An alternative integrated occupational health, safety and environmental management system for small and medium-sized enterprises (SMEs) in Thailand. *International Journal of GEOMATE, 17*(62), 84-91.

Jewalikar, A. D., & Shelke, A. (2017). Lean integrated management systems in MSME- Reasons, advantages and barriers on implementation. *Materials Today: Proceedings*, *4*(2), 1037–1044.

Jimenez, G., Novoa, L., Ramos, L., Martinez, J., & Alvarino, C. (2018). Diagnosis of initial conditions for the implementation of the integrated management system in the companies of the Land Cargo Transportation in the City of Barranquilla (Colombia). In *Stephanidis C. (eds) HCI International 2018 – Posters' Extended Abstracts. HCI 2018. Communications in Computer and Information Science*. Springer.

Kale, S., & Arditi, D. (2006). Diffusion of ISO 9000 certification in the precast concrete industry. *Construction Management and Economics*, *24*(5), 485–495.

Kensen, M. (2019). Assessing the limitations of integrating energy and environmental standards into seaports of small island developing states. *World Maritime University Dissertations.* 1166. https://commons.wmu.se/all_dissertations/1166.

Khalili, A., Ismail, M.Y., Karim, A.N.M., & Daud, M.R.C. (2019). Linkages of QMS and soft EMS: perceptions of operations managers as modelled by SEM. *International Journal of Services and Operations Management, 34*(3), 341.

Kopia, J. (2019). Effective implementation of management systems: Management systems as a success factor for the efficiency of organizations, Springer Gabler, Wiesbaden, ISBN: 978-3-658-26508-3.

Laal, F., Pouyakian, M., Madvari, R.F., Khoshakhlagh, A.H. & Halvani, G.H. (2019). Investigating the

impact of establishing integrated management systems on accidents and safety performance indices: A case study. *Safety and Health at Work, 10*(1), 54-60.

Lança, A.C.J., & Brito, I.S.S. (2017). Towards an information system for information dissemination for an integrated management systems QHSE. *Atas Da Conferencia Da Associação Portuguesa de Sistemas de Informação*, pp. 233–244.

Llach, J., Marimon, F., & Alonso-Almeida, M. del M. (2015). Social Accountability 8000 standard certification: analysis of worldwide diffusion. *Journal of Cleaner Production*, *93*, 288–298.

Llach, J., Marimon, F., & Bernardo, M. (2011). ISO 9001 diffusion analysis according to activity sectors. *Industrial Management & Data Systems*, *111*(2), 298–316.

Llonch, M., Bernardo, M., & Presas, P. (2018). A case study of a simultaneous integration in an SME: Implementation process and cost analysis. *International Journal of Quality & Reliability Management*, *35*(2), 319–334.

López, M.B. (2019). Difficulties to integrate management systems in a consultancy company of Bogotá D.C. MSc Dissertation, Facultad de Ingeniería, Universidad Militar Nueva Granada, Bogotá, Colômbia.

Ma, Y, Zhang, Q., & Yin, H. (2020). Environmental management and labor productivity: The moderating role of quality management. *Journal of Environmental Management, 255*, --.

Majerník, M., Daneshjo, N., Chovancová, J., & Sančiová, G. (2017). Design of integrated management systems according to the revised ISO standards. *Polish Journal of Management Studies*, *15*(1), 135–143.

Malleuve-Martínez, A., Alfonso-Robaina, D., Lavandero-García, J. & Ramos-Díaz, V.C (2018). Strategic management model with enterprise architecture approach for integration management system in enterprises. *DYNA, 85*(207), 297-305.

Mantini, M., Celiento, D. & Scalabrini, M. (2019). ENI innovative approach to HSE integrated management system (IMS) to enhance sustainability values. *Offshore Mediterranean Conference and Exhibition 2019, OMC 2019, Offshore Mediterranean Conference and Exhibition 2019, OMC 2019*; Ravenna; Italy; 27 March 2019 through 29 March 2019; Code 148084.

Mar-Molinero, C. (1980). Tractors in Spain: a logistic analysis. *Journal of the Operational Research Society*, *31*(2), 141–152.

Marimon Viadiu, F., Casadesús Fa, M., & Heras Saizarbitoria, I. (2006). ISO 9000 and ISO 14000 standards: an international diffusion model. *International Journal of Operations & Production Management, 26*(2), 141–165.

Marimon, F., Heras, I., & Casadesús, M. (2009). ISO 9000 and ISO 14000 standards: A projection model for the decline phase. *Total Quality Management and Business Excellence*, *20*(1), 1–21.

Marimón, F., Heras, I., & Casadesús, M. (2008). ISO 9001 and ISO 14001 diffusion- The case of Spain and Serbia. In *Proceedings of Quality Festival 2008, 2nd International Quality Conference, Kragujevac, May 13-15*.

Martí-Ballester, C.P., & Simon, A. (2017). Union is strength: The integration of ISO 9001 and ISO 14001 contributes to improve the firms' financial performance. *Management Decision*, *55*(1), 81–102.

Martino, J.P. (1993). *Technological Forecasting for Decision Making*. (M. K. Badawy, Ed.) (3rd ed.).

Masuin, R., & Latief, Y. (2019). Development of integration risk on integrated management system in order to increase organizational performance of construction company. *IOP Conference Series: Materials Science and Engineering, 620*(1), 012024.

Masuin, R., Latief, Y. & Zagloel, T.Y. (2019). Development of information systems in integrated management systems in order to increase organisational performance in a construction company. *IOP Conference Series: Earth and Environmental Science, 258(1)*, 10 May 2019, Article number 012012. International Conference on Science, Infrastructure Technology and Regional Developmen 2018, ICoSITeR 2018; Institut Teknologi Sumatera CampusLampung Selatan; Indonesia; 19 October 2018 through 20 October 2018; Code 148185.

Masuin, R., Latief, Y. & Yuri Zagloel, T. (2018). Information system development on web-based in integrated management system through improving knowledge management to increase organization performance of construction company (A conceptual framework). *Proceedings of 2018 International Conference on Information Management and Technology*, ICIMTech 2018 8

November 2018, Article number 8528099, Pages 49-54, 3rd International Conference on Information Management and Technology, ICIMTech 2018; Bina Nusantara University, Alam Sutera CampusJakarta; Indonesia; 3 September 2018 through 5 September 2018; Category numberCFP18H83-ART; Code 142373.

Meade, N., & Islam, T. (1995). Forecasting with growth curves: An empirical comparison. *International Journal of Forecasting*, *11*(2), 199–215.

Meade, N., & Islam, T. (1998). Technological forecasting- Model selection, model stability, and combining models. *Management Science*, *44*(8), 1115–1130.

Medina, A.M. (2018). Systematic review of integration theories of standardized management systems. *Signos- Investigación En Sistemas de Gestión, 10*(1), 177–191.

Mjakuškina, S., & Lapiņa, I. (2018). Product conformity assessment within the integrated management system: Manufacturing compliance and customer safety. In *Proceedings of the 22nd World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI 2018)* (pp. 19–24). United States of America, Orlando.

Mohammed, R., & Zheng, Y. (2016). International diffusion of food safety standards: The role of domestic certifiers and international tradein. In *Proceedings of Southern Agricultural Economics Association's 2016 Annual Meeting, San Antonio, Texas, February 6-9*.

Mora-Contreras, R. (2019). Integrated management systems on ISO 9001 and ISO 30301 standards in the Colombian notarial context. *Estudios Gerenciales, 35*(151), 203-218.

Moumen, M., & El Aoufir, H. (2017). Quality, safety and environment management systems (QSE): analysis of empirical studies on integrated management systems (IMS). *Journal of Decision Systems*, *26*(3), 207–228.

Moumen, M., & El Aoufir, H. (2018). An integrated management system: from various aspects of the literature to a maturity model based on the process approach. *International Journal of Productivity and Quality Management*, *23*(2).

Muhamad Khair, N.K., Lee, K.E., Mokhtar, M. & Goh, C.T. (2019). Simplified and integrated management system for responsible care (SIMS-RC) in chemical industries. *Management of Environmental Quality: An International Journal, 30*(3), 624-642.

Mustapha, M.A., Manan, Z.A., & Wan Alwi, S.R. (2017). Sustainable Green Management System (SGMS)- An integrated approach towards organisational sustainability. *Journal of Cleaner Production*, *146*, 158–172.

Muthusamy, G., Palanisamy, C., & Mohanraj, M. (2018). A comprehensive model and holistic approach for implementing an integrated management systems. *Journal of Computational and Theoretical Nanoscience*, *15*(1), 392–401.

Muzaimi, H., Hamid, S.R., & Chew, B.C. (2018). Integrated management system for quality management system accreditation. *Journal of Advanced Manufacturing Technology*, *12*(1), 87–100.

Muzaimi, H., Hamid, S.R., Isa, S. & Chew, B.C. (2019). Integrated management system: The converging of key quality standards into single standard. *International Journal of Human & Technology Interaction, 3*(1), 75-82.

Nadae, J. & Carvalho, M.M. (2019a). Integrated management systems as a driver for sustainability: the review and analysis of the literature and the proposition of the conceptual framework. *Produção, 29*, --.

Nadae, J., Carvalho, M.M. & Vieira, D.R. (2019b). Exploring the influence of environmental and social standards in integrated management systems on economic performance of firms. *Journal of Manufacturing Technology Management, 30*(5), 840-861.

Naidoo, S., & Ramphal, R. (2019). Different management systems: integration or combination?. *International Journal of Productivity and Quality Management, in press*.

Nunhes, T.V., Bernardo, M., & Oliveira, O.J. (2019a). Guiding principles of integrated management systems: Towards unifying a starting point for researchers and practitioners. *Journal of Cleaner Production*, *210*, 977–993.

Nunhes, T.V., Bernardo, M., & Oliveira, O.J. (2019b). Rethinking the way of doing business: A reframe of management structures for developing corporate sustainability. *Preprints 2019, 2019110066 (doi: 10.20944/preprints201911.0066.v1).*

Nunhes, T.V., Motta, L.C.F., & Oliveira, J. (2017). Identification and analysis of the elements and functions integrable in integrated management systems. *Journal of Cleaner Production*, *142*, 3225–3235.

Nunhes, T.V., Motta, L.C.F., & Oliveira, J. (2016). Evolution of integrated management systems research on the Journal of Cleaner Production: Identification of contributions and gaps in the literature. *Journal of Cleaner Production*, *139*, 1234–1244.

Ortiz, J.A.A. & Lopez, L.J.R. (2019). Integrated management systems and modern management. *In proceedings of 2018 Congreso Internacional de Innovacion y Tendencias en Ingenieria*, CONIITI 2018 - Proceedings 21 December 2018, Article number 8587060, 4th Innovation and Trends in Engineering Congress, CONIITI 2018; Bogota; Colombia; 3 October 2018 through 5 October 2018; Category numberCFP18M41-ART; Code 143844.

Pal Pandi, A., Paranitharan, K.P., & Jeyathilagar, D. (2018). Implementation of IEQMS model in engineering educational institutions- a structural equation modelling approach. *Total Quality Management and Business Excellence*, *29*(1–2), 29–57.

Pedriali, D., Azevedo, M.M., Arima, C.H. & Neves, J.M.S. (2020). Similarities between ISO standards that address management systems. *Research, Society and Development, 9*(2), e49922031.

Perkins, R., & Neumayer, E. (2010). Geographic variations in the early diffusion of corporate voluntary standards: comparing ISO 14001 and the Global Compact. *Environment and Planning A*, *42*(2), 347–365.

Poltronieri, C.F., Ganga, G.M.D., & Gerolamo, M.C. (2018). Maturity in management system integration and its relationship with sustainable performance. *Journal of Cleaner Production*, *207*, 236–247.

Pop, A.B., & Ţîţu, A.M. (2018). Implementation of an integrated management system: Quality-information security in an industrial knowledge-based organization. *Quality- Access to Success*, *19*(166), 87–93.

Prajogo, D., Tang, A.K.Y., & Lai, K.-H. (2014). The diffusion of environmental management system and its effect on environmental management practices. *International Journal of Operations and Production Management, 34*(5), 565-585.

Prakash, A., & Potoski, M. (2007). Investing up: FDI and the cross-country diffusion of ISO 14001 management systems. *International Studies Quarterly, 51*(3), 723-744.

Pratama, N.A., Kumar, V., Kumari, A., Garza-Reyes, J.A., & Nadeem, S.P. (2018). Investigating the benefits and challenges of the implementation of ISO 9001 and ISO 14001 in the aerospace industry. In *Proceedings of the International Conference on Industrial Engineering and Operations Management Bandung*.

Purwanto, A., Asbari, M., & Santoso, P. (2020). Effect of integrated management system of ISO 9001:2015 and ISO 22000:2018 implementation to packaging industries quality performance at Banten Indonesia. *Jurnal Ilmiah MEA (Manajemen, Ekonomi, & Akuntansi), 4*(1), 17-29. https://doi.org/10.31955/mea.vol4.iss1.pp17-31

Qi, G.Y., Zeng, S.X., Tam, C.M., Yin, H.T., Wu, J.F., & Dai, Z.H. (2011). Diffusion of ISO 14001 environmental management systems in China: rethinking on stakeholders' roles. *Journal of Cleaner Production*, *19*(1250–1256).

Rampasso, I.S., Melo Filho, G.P., Anholon, R., de Araujo, R.A., Alves Lima, G.B., Perez Zotes, L., & Leal Filho, W. (2019). Challenges presented in the implementation of sustainable energy management via ISO 50001:2011. *Sustainability, 11*, 6321.

Rampini, G.H.S., Berssaneti, F.T. & Saut, A.M. (2019). Insertion of risk management in quality management systems with the advent of ISO 9001:2015: Descriptive and content analyzes. *Springer Proceedings in Mathematics and Statistics Volume 281, 2019,* Pages 209-221, 24th International Joint Conference on Industrial Engineering and Operations Management, IJCIEOM 2018; Lisbon; Portugal; 18 July 2018 through 20 July 2018; Code 225439.

Raweni, A.M.S., & Majstorovic, V.D. (2016). ISO certifications diffusion in European countries 2007-2014 and forecasting for 2022- Stare of the art. *International Journal ''Advanced Quality''*, *44*(1), 53–58.

Rebelo, M.F., Silva, R., & Santos, G. (2017). The integration of standardized management systems: managing business risk. *International Journal of Quality and Reliability Management*, *34*(3), 395–405.

Ribeiro, L., Beijo L., Salgado E. & Nogueira, D. (2019): Modelling of ISO 9001 certifications for the American countries: a Bayesian approach, *Total Quality Management & Business Excellence*, DOI: 10.1080/14783363.2019.1696672

Roslin, E.N., Ghani, H.A., Ishak, M.H.A., Ibrahim, M.F., Zain, N.M. & Ahamat, M.A. (2017). The implementation of integrated management system in automotive service industry: A review. *International Journal of Applied Engineering Research, 12*(24), 14460-14465.

Rostamkhani, R, Abbasi, M., Karimi, M.H., & Karbasian, M. (2020). Presenting a productive and sustainable model of integrated management system for achieving an added value in organizational processes. *International Journal of Productivity and Quality Management, in press*.

Salgado, E.G., Beijo, L.A., Sampaio, P., Pereira Mello, C.H., & Saraiva, P. (2015). ISO 9001 certification in the American continent: A statistical analysis and modelling. *International Journal of Production Research*, 1–18.

Sampaio, P., Saraiva, P., & Rodrigues, A.G. (2009). An analysis of ISO 9000 data in the world and the European Union. *Total Quality Management & Business Excellence*, *20*(12), 1303–1320.

Sampaio, P., Saraiva, P., & Rodrigues, A.G. (2011). ISO 9001 certification forecasting models. *International Journal of Quality and Reliability Management*, *28*(1), 5–26.

Santos, G., Mendes, F., & Barbosa, J. (2011). Certification and integration of management systems: The experience of Portuguese small and medium enterprises. *Journal of Cleaner Production*, *19*(17-18), 1965-1974. doi:10.1016/j.jclepro.2011.06.017

Saraiva, C., Domingues, P., Sampaio, P. & Arezes, P.M. (2018). Latest efforts aiming at upgrading the IMS-MM. *In book Occupational Safety and Hygiene VI*, 189-194.

Saraiva, C., Domingues, P., Sampaio, P. & Arezes, P.M. (2019). Bibliometric analysis on the topic of "integrated management systems": A first glance. *In proceedings of SHO 2019*, Guimarães, Portugal, 236-240.

Seber, G.A.F., & Wild, C.J. (1989). *Nonlinear regression*. (J. Wiley, Ed.). New York. https://doi.org/http://dx.doi.org/10.1002/0471725315.

Selvam, P.K.P. & Thangavelu, R. (2019). The IMBES model for achieving excellence in manufacturing industry: an interpretive structural modeling approach. *International Journal of System Assurance Engineering and Management, 10*(4), 602-622.

Serralheiro, A.R.V.S. & Morais, G. (2018). The SL attachment, the integrated management systems and the challenges for internal auditing: Companies in the central region- Case study. *In proceedings of the 13th Iberian Conference on Information Systems and Technologies (CISTI)*, IEEE Publisher.

Setyorini, Y.H. & Latief, Y. (2019). Influential factors in development of integrated management system (quality, occupational safety and health and environment management system) in monitoring and evaluation system for performance improvement in Indonesia construction company. I*OP Conference Series: Materials Science and Engineering*, Volume 508, Issue 1, 1 May 2019, Article number 012046 1st Tarumanagara International Conference on the Applications of Technology and Engineering, TICATE 2018; Campus of Universitas Tarumanagara (UNTAR)Jakarta; Indonesia; 22 November 2018 through 23 November 2018; Code 147990.

Shah, S.A.R., Jamaludin, K.R., Talib, H.H.A., & Yusof, S.M. (2019). Integrated quality environmental management implementation in food processing SMEs: A case study of a developing country. *The TQM Journal, 31*(5), 740-757.

Shevchenko, A., Pagell, M., Johnston, D., Veltri, A., & Robson, L. (2018). Joint management systems for operations and safety: A routine-based perspective. *Journal of Cleaner Production*, *194*, 635–644.

Sfreddo, L.S., Vieira, G.B.B., Vidor, G. & Santos, C.H.S. (2018). ISO 9001 based quality management systems and organisational performance: a systematic literature review. *Total Quality Management & Business Excellence*, in press, DOI: 10.1080/14783363.2018.1549939.

Sobczyk, A., Pobędza, J., Sobczyk, M. (2018). Improvement of quality by using an integrated management system of construction processes. MATEC Web of Conferences, 183.

Sousa, J.F. (2019). Management system integrated in a company for the provision of collection and waste disposal service II-A and II-B: considerations on the operation of the SGI. MSc Dissertation, Programa de Mestrado Profissional em Administração- Gestão Ambiental e Sustentabilidade)- Universidade Nove de Julho, São Paulo.

Souza, J.P.E., & Alves, J.M. (2018). Lean-integrated management system: A model for sustainability improvement. *Journal of Cleaner Production*, *172*, 2667–2682.

Sui, Y., Ding, R., & Wang, H. (2018). An integrated management system for occupational health and safety and environment in an operating nuclear power plant in East China and its management information system. *Journal of Cleaner Production*, *183*, 261–271.

Talapatra, S., Uddin, K., & Rahman, H. (2018). Development of an implementation framework for integrated management system based on the philosophy of total quality management. *American Journal of Industrial and Business Management*, *8*(6), 1507–1516.

Talapatra, S., Santos, G., Uddin, K., & Carvalho, F. (2019). Main benefits of integrated management systems through literature review. *International Journal for Quality Research, 13*(4), 1037–1054.

Tavares, C.L. (2019). Sistemas integrados de gestão da Qualidade, Ambiente e Segurança e Saúde no Trabalho (SIGQASST)- Contributo para a sustentabilidade empresarial. MSc. Dissertation, Instituto Superior de Engenharia de Lisboa, Área Departamental de Engenharia Química.

Tene, C.V.T., Yuriev, A., & Boiral, O. (2018). Adopting ISO management standards in Africa: Barriers and cultural challenges. *In Heras-Saizarbitoria, I. editor, ISO 9001, ISO 14001, and New Management Standards*, Springer Publishing, ISBN 978-3-319-65675-5.

Tepaskoualos, F. & Chountalas, P. (2018). Implementing an integrated health, safety, and environmental management system: The case of a construction company. *International Journal for Quality Research 11*(4), 733-752.

To, W.M., & Lee, P.K.C. (2014). Diffusion of ISO 14001 environmental management system: Global, regional and country-level analyses. *Journal of Cleaner Production*, *66*(489–498).

Tuczek, F., Castka, P., & Wakolbinger, T. (2018). A review of management theories in the context of quality, environmental and social responsibility voluntary standards. *Journal of Cleaner Production*, *176*, 399–416.

Ubohov, S.H., Trokhymchuk, V.V., Todorova, V.I. & Zahoriy, V.A. (2019). Process model of the pharmaceutical integrated management system. *Wiadomosci lekarskie, 72*(2), 201-208.

Vásquez-Tejos, J. & Torres-Vallejos, J. (2018). Characterization of management system auditors belonging to certification bodies in Chile. *Signos, 10*(2), 55-69.

Velmakina, Y.V., Aleksandrova, S.V. & Vasiliev, V.A. (2018). Basics of forming an integrated management system. *Proceedings of the 2018 International Conference ''Quality Management, Transport and Information Security, Information Technologies'', IT and QM and IS* 2018 5 November 2018, Article number 8524955, Pages 77-78, 2018 IEEE International Conference ""Quality Management, Transport and Information Security, Information Technologies"", IT and QM and IS 2018; St. Petersburg; Russian Federation; 24 September 2018 through 28 September 2018; Category numberCFP18J17-ART; Code 142117.

Velmakina, Y.V., Vasiliev, V.A., & Chernogorskiy, S.A. (2019). Methodology for assessing the performance of the integrated management system. Quality Management and Reliability of Technical Systems, IOP Conf. Series: Materials Science and Engineering 666 (2019) 012042.

VWiengarten, F., Humphreys, P., Onofrei, G., & Fynes, B. (2017). The adoption of multiple certification standards: Perceived performance implications of quality, environmental and health & safety certifications. *Production Planning & Control*, *28*(2), 131–141.

Will, M., Brauweiler, J., Zenker-Hoffmann, A., & Delakowitz, B. (2019). An inquiry to consider CSR in integrated management systems. *Social Responsibility and Sustainability, In book Social Responsibility and Sustainability, World Sustainability Series,* pp. 335-356.

Winsor, C.P. (1932). The Gompertz curve as a growth curve. *Proceedings of the National Academy of Sciences*, *18*(1), 1–8.

Wu, F.-S., & Chu, W.-L. (2010). Diffusion models of mobile telephony. *Journal of Business Research*, *63*(5), 497–501. https://doi.org/10.1016/j.jbusres.2009.04.008.

Zimon, D., & Madzík, P. (2020). Standardized management systems and risk management in the supply chain. *International Journal of Quality & Reliability Management, 37*(2), 305-327.

Zimon, D. & Zimon, G. (2019). The impact of implementation of standardized quality management systems on management of liabilities in group purchasing organizations. *Quality Innovation Prosperity, 23*(1), 60-73.

Zimon, D., Madzik, P., & Sroufe, R. (2019). Management systems and improving supply chain processes: Perspectives of focal companies and logistics service providers. *International Journal of Retail & Distribution Management, in press*.

Zwietering, M.H., Jongenburger, I., Rombouts, F.M., & van 't Riet, K. (1990). Modelling of the bacterial growth curve. *Applied and Environmental Microbiology*, *56*(6), 1875–1881.

Appendix

Table A1. Latest published studies in the domain of IMSs.

Authors	Year	Country	Sub-topic
Domingues *et al.*	2016	Portugal	
Dragomir *et al.*	2017	Romania	
Saraiva *et al.*	2018	Portugal	IMSs maturity
Moumen & El Aoufir	2018	Morocco	
Poltronieri *et al.*	2018	Brazil	
Nunhes *et al.*	2017	Brazil	
Chountalas & Tepaskoualos	2019	Greece	
Llonch *et al.*	2018	Spain	
Velmakina *et al.*	2018	Russian Federation	
Ezzat *et al.*	2017	Egypt	
Đorđević & Pecić	2018	Serbia	
Domínguez & Gaytán	2019	México	
Jimenez *et al.*	2018	Colombia	
Shevchenko *et al.*	2018	Canada	
Ikram *et al.*	2020	China	Integration strategies/ Frameworks/ Difficulties/ Benefits/ Motivations
Sui *et al.*	2018	China	
Bernardo *et al.*	2018	Greece	
López	2019	Colombia	
Barbosa *et al.*	2018	Brazil/Portugal	
Talapatra *et al.*	2019	Bangladesh/ Portugal	
Muthusamy *et al.*	2018	India	
Muzaimi *et al.*	2018	Malaysia	
Blasco-Torregrosa *et al.*	2019	Spain/Czech Republic	
Gracia *et al.*	2018	Colombia	
Nunhes *et al.*	2019a	Brazil/Spain	
Rebelo *et al.*	2017	Portugal	
Algheriani *et al.*	2019	Serbia	
Masuin & Latief	2019	Indonesia	Risk management
Zimon, & Madzík	2020	Poland	
Emetumah	2017	Nigeria	
Gianni *et al.*	2017	Greece	
Ferreira *et al.*	2019	Brazil	
Guina	2018	Ecuador	
Tavares	2019	Portugal	
Will *et al.*	2019	Switzerland	CSR
Nunhes *et al.*	2019b	Brazil/Spain	
Muhamad Khair *et al.*	2019	Malaysia	
Fonseca & Carvalho	2019	Portugal	
Ikram *et al.*	2019	Pakistan	
Ionescu *et al.*	2018	Romania	
Carvalho *et al.*	2019a	Portugal	
Carvalho *et al.*	2019b	Portugal	
Nadae & Carvalho	2019a	Brazil	Sustainability
Souza & Alves	2018	Brazil	
Rostamkhani *et al.*	2020	Iran	
Mantini *et al.*	2019	Italy	

Cyplik *et al.*	2019	Poland	
Chaudhuri & Jayaram	2019	22 European countries	
Başaran	2018	Turkey	
Mustapha *et al.*	2017	Malaysia	
Hernandez-Vivanco *et al.*	2018a	Spain	Innovation
Talapatra *et al.*	2018	Bangladesh	TQM
Guillem	2019	Spain	Lean integration
Jewalikar & Shelke	2017	India	
Nunhes *et al.*	2016	Brazil	
Cuevas Castañeda	2018	Colombia	
Saraiva *et al.*	2019	Portugal	
González	2018	Colombia	Research gaps/ Literature analysis
Sfreddo *et al.*	2018	Brazil	
Moumen & El Aoufir	2017	Morocco	
Tuczek *et al.*	2018	Austria/New Zealand	
Allur *et al.*	2018	Spain	Integration theories/Potential integration theories
Medina	2018	Colombia	
Martí-Ballester & Simon	2017	Spain	
Nadae *et al.*	2019b	Brazil	
Abisourour *et al.*	2019	Morocco	
De & Quadros	2019	Sweden	Costs/Financial performance/Business Performance/ Impact multiple certifications
Hernandez-Vivanco *et al.*	2018b	Portugal	
Hernandez-Vivanco *et al.*	2019	Portugal	
Herghiligiu *et al.*	2019	Romania	
Alfredo and Nurcahyo	2018	Indonesia	
Wiengarten *et al.*	2017	Ireland	
Gurina *et al.*	2018	Russian Federation	
Gianni *et al.*	2017	Greece	
Hannigan *et al.*	2019	Qatar	
Tepaskoualos & Chountalas	2018	Greece	
Darabi *et al.*	2019	Iran	
Azadeh *et al.*	2019	Iran	
Sousa	2019	Brazil	
Sobczyk *et al.*	2018	Poland	
Shah *et al.*	2019	Malaysia	
Acuña *et al.*	2019	Argentina	
Roslin *et al.*	2017	Malaysia	
Ćurčić et al.	2018	Serbia	
Jaroenroy & Chompunth	2019	Thailand	Sector specific IMS
Rampasso *et al.*	2019	Brazil	
Zimon, & Madzík	2020	Poland	
Bąk & Nowak	2019	Poland	
Asah-Kissiedu	2019	Ghana	
Laal *et al.*	2019	Iran	
Mora-Contreras	2019	Colombia	
Kensen	2019	Vanuatu	
Ahidar *et al.*	2019	Morocco	
Contreras	2018	Colombia	
Purwanto *et al.*	2020	Indonesia	
Pal Pandi *et al.*	2018	India	
Ubohov *et al.*	2019	Ukraine	

Pratama *et al.*	2018	UK	
Pop & Ţîţu	2018	Romania	Information security/ Information system/ IT issues
Lança & Brito	2017	Portugal	
Masuin *et al.*	2018	Indonesia	
Masuin *et al.*	2019	Indonesia	
Balabanov and Davletshin	2018	Russia Federation	
Arda *et al.*	2018b	Turkey	(Semi)Theoretical models
Malleuve-Martínez *et al.*	2018	Cuba	
Selvam & Thangavelu	2019	India	
Benyettou & Abdellatif	2018	Algeria	
Arda *et al.*	2018a	Turkey	Mediating/Moderating variables and Critical Success Factors
Kopia	2019	Germany	
Ma *et al.*	2020	China	
Setyorini & Latief	2019	Indonesia	
Cabecinhas *et al.*	2019	Portugal	IMSs diffusion
Cabecinhas *et al.*	2018	Portugal/ Spain/ Greece/ Italy	
Domingues *et al.*	2017	Portugal	Integration patterns
Bernardo *et al.*	2017	Spain/Greece	
Mjakuškina & Lapiņa	2018	Latvia	Product conformity
Dragomir *et al.*	2018	Romania	IMS concept
Muzaimi *et al.*	2018	Malaysia	
Muzaimi *et al.*	2019	Malaysia	
Naidoo & Ramphal	2019	South Africa	
Ortiz & Lopez	2019	Colombia	
Khalili *et al.*	2019	Malaysia	
Darabont *et al.*	2019	Romania	
Dahlin & Isaksson	2017	Sweden	
Vásquez-Tejos & Torres-Vallejos	2018	Chile	Audit function
Hassan *et al.*	2020	Malaysia	
Al Ghani	2019	Iraq	
Majerník *et al.*	2017	Slovak Republic	ISO 2015 Revision/ Standards
Zimon & Zimon	2019	Poland	
Pedriali *et al.*	2020	Brazil	
Rampini *et al.*	2019	Brazil	
Tene *et al.*	2018	Canada	
Serralheiro & Morais	2018	Portugal	