



Integrated management systems assessment: a maturity model proposal



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ABSTRACT

This article intends to report the Integrated Management Systems Maturity Model, a hybrid six-level maturity model that allows the comparison between integrated management systems regarding their relative stage of evolution. This maturity model has a three-dimensional nature considering the following axes: the key process agents, externalities and the excellence management pillars. In addition, some potential guidelines to assess each key process agent, externality and pillar are proposed. This model considers, on one hand, a Capability Maturity Model integrated-based component and, on the other hand, a statistical-based component which expresses the relationships between three independent variables that encompass a multiple regression linear model and the remaining variables. The statistical relationships were ascertained by the analysis of the results collected from two surveys. Integration excellence may be achieved throughout an itinerary encompassing six maturity levels. Statistically, three variables contribute the most to the latent variable “Integrated management systems maturity”: the audits typology, the integrated vision revealed by top management and the attained level of organizational integration. Based on the revised literature, this appears to be the first attempt to “normalize” integrated management systems, which can be, hopefully, a relevant contribution to this research field enabling the comparison of integrated systems implemented on different companies or contexts.

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1. Introduction

A significant amount of research work has been reported over the last years concerning the domain of integrated management systems (IMSS). This research topic is particularly relevant if one consider the revisions issued in 2015 of both the ISO 9001 and ISO 14001 standards, namely the annex SL, where are described the common requirements or the high level structure that the MSs should comply with. The research methods traditionally adopted (case studies, surveys, cross-sectional analysis) are useful to disclose some features regarding specific topics that revolve around and within the wide topic of IMSS and seem appropriate taking into account a barely controllable contemporary phenomenon such as the integration of management systems (MSs) (Cassell and Symon, 2004; Silverman, 2000; Yin, 2009). Among these studied features, one may include the main motivations, drawbacks and benefits of MSs integration, the adopted strategies and models, the attained

integration level and how to increase it, the audit function and how to conduct it, and the issues concerning information flow in an integrated context. These research methods have some shortcomings and one hardly finds reported research that “normalizes” IMSS, *i.e.*, that enables the comparison of IMSS implemented on different companies or contexts.

Several studies pointed out that the implementation and further certification of MSs by the companies contributes to an overall improved performance including the financial component (Chatzoglou et al., 2015). The MSs integration phenomenon began as soon as more than one MS standard became available for certification and, conversely, managers felt that two or more MSs coexisting in the same company without any “strings attached” looked like a poor approach and contradicted the best practices of management. In addition, the MSs more often implemented and certified share the same philosophy (continuous improvement by the adoption of the PDCA cycle), as well as the same principles and values. Currently, there is evidence of the integration of MSs in companies operating in different activity sectors, in the majority of the countries and with a wide range in what concerns to their

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dimension. Several models for implementation were proposed considering different strategies, which led to different integration levels. As a matter of fact, one of the major research questions to be answered concerns with the comparison between IMSs and how this integration can be developed. The current paper intends to contribute to fulfil this scientific “gap” and deals, ultimately, with the question on how companies may assess IMSs and plan their activities and operations in order to avoid wastage of resources.

This paper follows with a brief description of the current topics addressed by the mainstream research concerning IMSs, where one can observe the topicality of the theme. The following section concerns with maturity models and points out the different domains where they have been developed, where they have been adopted, their main distinctive characteristics and shortcomings. After the description of the research methods adopted, the last sections deal with the Integrated Management Systems Maturity Model (IMS-MM[®]), presenting the two main components that sustain the model, how to interact with them and listing some of the potential information sources to assess each key process agent (KPA), externality and management pillar. The last section of the paper is devoted to conclusions and some final remarks and it sums up all the topics addressed concerning the IMS-MM[®].

2. Literature review

2.1. Integrated management systems

A great deal of literature addresses various topics on the matter of IMSs and several reference publications are available. Concerning the most recent published contributions one should point out the work of [Bernardo et al. \(2015\)](#), [Simon et al. \(2012\)](#), [Zeng et al. \(2011\)](#) and [Almeida et al. \(2014\)](#) addressing the attained benefits from the proper integration of MSs. The major obstacles, difficulties and drawbacks concerning the implementation of IMSs was a topic focused by the work of [Bernardo et al. \(2012\)](#) and [Simon et al. \(2012\)](#). [Karapetrovic \(2002\)](#), [Karapetrovic and Casadesús \(2009\)](#) and [Sampaio et al. \(2012\)](#) discussed the strategies adopted during the implementation of an IMS, whereas the levels of integration attained were dissected by [Bernardo et al. \(2011, 2012\)](#) and [Jørgensen et al. \(2006\)](#). Throughout the years models and approaches to integrate MSs were proposed, among others, by [Karapetrovic and Willborn \(1998\)](#), [Zeng et al. \(2007\)](#) and, more recently, by [Bernardo \(2014\)](#), [El Idrissi et al. \(2014\)](#), [Genaro and Loureiro \(2015\)](#) and [Rebelo et al. \(2014\)](#). The specifics of the audit function were detailed by [Beckmerhagen et al. \(2003\)](#), [Bernardo et al. \(2009\)](#), [Domingues et al. \(2015b\)](#) and [Kraus and Grosskopf \(2008\)](#) and, lately, [Kauppila et al. \(2015\)](#) dissected the major developments and patterns within IMSs and [Domingues et al. \(2015a\)](#) dissected the underlying complexity of an IMS. Other scientific issues, not yet addressed by the IMSs literature, emerge namely those related to the supply chains and how to manage them properly and sustainable ([Seuring and Müller, 2008](#)). [Table 1](#) summarizes the recent topics addressed by the mainstream research concerning IMSs, the main findings as well some reference publications.

The published research concerning the assessment of the IMS as a whole, its features and the level of articulation between the various components is very scarce. Moreover, and despite the relevant and crucial information reported in the mainstream literature, the conclusions derived seldom are easily incorporated in IMSs where and when the context changes or evolves.

2.2. Maturity models

Looking back from the last decades of the previous century, a remarkable fast-paced change occurred in the degree of complexity

of the goods, products and services that are available to the consumer. This same consumer “grew” on the demands from the producer and today, those demands, encompass more than just quality requirements, but consider also requirements related to environment, occupational health and safety and sustainability, amidst others. To deal with this increasing complexity, a set of new methods were developed overcoming the limitations of traditional methods. The statistical and stochastic approaches to production systems, the forecasting, heuristic and structural equations models, the black box, grey box and levelling methods, the fuzzy networks and maturity models are some of the new generation “tools” available to manage and to retrieve information from what it seemed a chaotic and impenetrable field of research. Concerning maturity models, a brief revision of the literature (2009 onwards) shows the extension of its applicability ([Table 2](#)). Concerning specifically organizational issues and quality MSs one should mention the maturity approach adopted by the European Foundation for Quality Management (EFQM) model.

A maturity model can be defined as a set of sequential levels that, together, describe an anticipated, desired or logical path, from an initial stage to a final maturity stage ([Röglinger and Pöppelbuß, 2011](#)). The development of a maturity model is a multi-method task however, concerning their design, all maturity models present, among other, some common features such as a limited number of maturity levels sequentially ordered, a discrete number of KPAs ascribed to each maturity level and an algorithm that describes how the object of maturation evolves usually developed by iterative related methods. Several authors, such as [Becker et al. \(2009\)](#), pointed out several shortcomings of maturity models and stressed that the major concerns relate with the development of maturity models lacked of methods commonly accepted by the mainstream scientific community, which leads to the recurrent criticism on the excessive simplification of a phenomenon when compared to its real performance.

3. Materials and methods

The development of the IMS-MM[®] relied on a multitude of methods. The initial process of literature review provided some insights on the identification of the KPAs that impact on the maturity of a generic IMS. Several queries were performed in the soundest data bases, such as the “Web of Science”, “Scielo” and “Scopus” and in the repositories of *e*-journals such as “Elsevier Scencedirect”, “IEEE Xplore”, “Springer” and “Taylor and Francis” containing academic bibliographic resources. The papers considered for analysis were the ones containing keywords such as “Integrated Management Systems”, “Management Systems Integration”, “Auditing Management Systems” and “ISO 9001” plus “ISO 14001” plus “OHSAS 18001” in the title and/or topic. Furthermore, although the desirable contribution from all the papers, a theoretical sampling took place of the bibliographical resources considering the topics closely related to the specific topic addressed in this paper- IMSs. Furthermore, based on the revised literature a 30 questions/statements (Q/Sts) survey focussing IMS managers was developed and held online ([Table A.1](#)). This initial process of revision of literature provided some insights on the identification of the KPAs that impact on the maturity of a generic IMS which enabled the development of this first survey. The collected results, amid other information sources, were taken into account throughout the development of the IMS-MM[®] and enabled the development of a second survey addressing a selected group of industrial and academic experts (auditors, Quality awarded personalities, consultants, ASQ fellows, members of APQ – Portuguese Quality Association, etc). The results from this latter survey proved to be crucial to classify the relevance of several concepts concerning the integration level attained by an IMS through the adoption of a triangulation approach between the

Table 1
Recent topics addressed by mainstream research concerning IMSs.

Feature	Reference sources	Main findings/scope/comments
Drivers for IMS implementation	Domingues et al. (2012) Sampaio et al. (2012)	<ul style="list-style-type: none"> - Some level of integration does occur in companies with more than one certified MS. - MSs integration prevents the development of organizational “islands” related to each subsystem.
Benefits from IMS implementation	Bernardo et al. (2015) Carvalho et al. (2015)	<ul style="list-style-type: none"> - Thorough revision of literature concerning the benefits of MSs integration. - Although the authors pointed out financial savings, the improvement in the routine management is the main benefit.
Obstacles/drawbacks throughout implementation	Zeng et al. (2011) Bernardo et al. (2012) Simon et al. (2012)	<ul style="list-style-type: none"> - Prior experience with MSs is relevant when implementing an IMS. - Companies with three implemented MSs experience difficulties in the integration process that affect the level of integration although the same is not straightforward for companies with two MSs. - Difficulties related to systems integration impact on the level of integration of several items of the MSs involved.
Integration strategies	Ivanova et al. (2014) Karapetrovic (2002) Karapetrovic and Casadesús (2009) Oliveira (2013) Su et al. (in press)	<ul style="list-style-type: none"> - The authors list some critical success factors, namely: focus on internal improvement, top management commitment, processes based design, adoption of ITs, positive employees’ attitude and usage of the MS. - Companies that intend to implement multiple MSs should sought and explore the benefits collected from a synergic approach by combining the subsystems into a “system of systems”. - The surveyed companies commonly implement ISO 9001 before ISO 14001; others do so simultaneously or even apply ISO 14001 first. - The author proposes a strategy comprising 3 stages to proceed with a successful integration process. - A company may collect benefits from the adoption of other ISO standards depending on the prior experience with ISO 9001.
Integration models (modelling)	El Idrissi et al. (2014) Olaru et al. (2014) Rebelo et al. (2014) Rößler and Schlieter (2015)	<ul style="list-style-type: none"> - The authors propose a model to integrate MSs. - Comprehensive examination of the existing models aimed at MSs integration. - The authors argue that the proposed model promotes the elimination of conflicts between MSs, resources optimization and elimination of organizational wastes. - The authors claim that although all prior research contributed to theory-based foundation for the integration phenomenon, barely provided methodological support for the practical implementation of an IMS.
Integration levels	Zeng et al. (2007) Abad et al. (2014) Almeida et al. (2014) Bernardo et al. (2011)	<ul style="list-style-type: none"> - The authors propose a model to integrate MSs. - Higher integration levels promote soundest internal benefits, namely, those concerning organizational and operational areas. - The authors conclude that integration of MSs contributes positively to the targeted organizations. - Companies that adopt a combination of different implementation methods achieve higher levels of integration than those using a single method.
Auditing IMSs	Jørgensen et al. (2006) Bernardo et al. (2009) Domingues et al. (2011) Hoy and Foley (2015) Kraus and Grosskopf (2008) Simon et al. (2014)	<ul style="list-style-type: none"> - The authors identify three potential levels of integration. - Companies favour integration of MSs audits over managing and conducting them separately. - The authors present a proposal for conducting audits in IMSs. - The authors claim that integrated audits lead to a decrease in the audit effort, in the number of audits and in the resources required. - Audits are usually structured to be conducted in one MS at the time. - Internal and external audits seem to be differently conducted regarding several features, namely: the audit team, the guidelines adopted and the time period between successive audits.
Sector specific implementation of IMSs	von Ahsen (2014) Beckmerhagen et al. (2003) Brendler and Brandli (2011) Gerolamo et al. (2014) Giacomello et al. (2014) Gianni et al. (2014) Khanna et al. (2010) López-Fresno (2010) Manzanera et al. (2014) Masood et al. (2014)	<ul style="list-style-type: none"> - Although some abandonment cases, German car manufacturers do integrate several specific organizational aspects. - Since safety is of such a paramount importance in nuclear plants, it makes sense to integrate safety requirements within a QMS, as a possible first step in the integration efforts. - In every integration process there is a need to evaluate the particularities of both the company and the MS. - The authors claim that the proposed strategy aimed at MSs integration decrease the difficulties faced by small businesses. - The adoption and implementation of an IMS leads to more efficient production processes. - Description of an IMS in a food company. - The authors identify the potential synergies between MSs, the combination of objectives and the prevention of duplicated procedures as the motivations for MSs integration. - The author identifies cost savings, better use of resources, improved internal communication, stronger customer orientation and employee motivation as the main benefits from MSs integration. - According to the authors, implementation of an IMS optimizes human and material resources and improves both internal and external communication as well employees’ motivation. - Several factors impact on the success of the implementation process: the experience and communication between members of the team and the inputs collected from the quality and OHS management, among others.

Table 1 (continued)

Feature	Reference sources	Main findings/scope/comments
Cross-sectional analysis	Mehrabi et al. (2013)	- The authors claim that IMSs promote employee's OHS.
	Quashie and Chileshe (2006)	- The authors stress that the proposed tool is a relevant resource and is appropriate for setting up, implementation and management of the MSs.
	Satolo et al. (2013)	- The existence of a previous QMS facilitates the implementation of the IMS.
	Walker and McAleer (2014)	- The authors describe how an IMS was used as a tool to improve performance, quality, environment, and OHS.
Abandonment cases	Al-Darrab et al. (2012)	- The authors conclude that the implementation of MSs is generally unproductive in Saudi Arabian companies and the concept of integration has not gained much acceptance.
	Vitoreli and Carpinetti (2013)	- The authors claim that the size of the company may impact on the structure established to oversee the IMS.
Less positive issues concerning MSs integration	Gianni and Gotzamani (2015)	- The withdrawal of top management commitment is the main determinant that causes the abandonment of integrated management.
IMSS as promoters of sustainable success	Castillo-Rojas et al. (2012)	- The authors point out that MSs integration may be a hindrance to innovation.
Standards/specifications	Mežinska et al. (2015)	- The understanding of IMS complexity, its integration levels and possibilities varies among companies.
	Mohamad et al. (2014)	- The authors argue that the integration of the QMS, EMS, OHSMS and Energy MSs has not been well established.
	Crowder (2013)	- The authors claim that ISO 27001 can be fully integrated into a single IMS with ISO 9001 and ISO 14001.
IT issues concerning MSs integration	Matias and Coelho (2002)	- The authors stress the need to pursue standards integration and list some gains by further integrating the MSs including ergonomics certification.
	Nowicki et al. (2013)	- Although PAS 99 may assist companies on the implementation of an IMS, the surveyed companies did not benefit from the guidelines contained in it, and adopt their own paths to attain integration.
	Mesquida and Mas (2015)	- The authors present a guide to assist in the implementation of an IMS encompassing the requirements of both IT service and QMSs.
Literature review	Pho and Tambo (2014)	- A proper management of electronic documentation is a key factor in establishing a technological support for IMSs processes.
	Domingues et al. (2015b)	- Comprehensive revision of literature concerning several features of the MSs integration phenomenon.
Other	Karanikas (2014)	- Comprehensive revision of literature regarding the OHSMS and the integration phenomenon.
	Domingues et al. (2015a)	- The authors postulate that IMSs may be approached as complex adaptive systems.
	Savino and Batbaatar (2015)	- The authors considered integrated audit as a core resource for SMEs.
	Simon and Bernardo (2014)	- There are several issues related to human resources that encompass the integration process and impact on the success or failure of the implementation of an IMS.
	Simon and Douglas (2013)	- There are some differences regarding the integration practices between the English and the Spanish companies.

Table 2

Latest reported efforts in the development of maturity models (2009 onwards).

Concept to evaluate (object of maturation)	Authors	Model's name
Legal risks	Buglione et al. (2009)	–
ISO 9001 implementation and quality practices	Morsal et al. (2009)	–
	Dellana and Kros (2014)	–
	Yeo and Ren (2009)	RM-CMM
Risk management in complex projects	Bititci et al. (2015)	–
Performance measurement	Baumgartner and Ebner (2010)	–
Corporate sustainability	Hsieh et al. (2009)	KNM – Knowledge Navigator Model
Implementation of knowledge MSs	Wetering and Batenburg (2009)	PACS-MM
Picture archiving and communication systems	Reyes and Giachetti (2010)	SC(M) ² – Supply Chain Maturity Model
Supply chain activities	Díaz-Ley et al. (2010)	MIS-PyME
Software programs in SMEs	Fitterer and Rohner (2010)	–
Networkability	CMMi product team (2011)	CMMi – Capability Maturity Model Integration/Integrated
Systems engineering	Jia et al. (2011)	PMOMIM-MCP – Program management organization maturity
Mega construction projects		integrated model for mega construction projects
Software inspection practices	Kollanus (2011)	ICMM – Inspection Capability Maturity Model
	Valdés et al. (2011)	eGov-MM
	Shareef et al. (2011)	GAM – e-Government adoption model
	Concha et al. (2012)	eGPO-MM – e-Government procurement observatory
	Pigosso et al. (2013)	–
Ecodesign	Garzás et al. (2013)	–
Spanish software industry	Vezzetti et al. (2014)	–
Product life cycle management	Antunes et al. (2014)	–
Energy management	Storm et al. (2014)	MM-HiAP
Health in all policies	Treviño and Gamboa (2014)	–
Software development centre	Koehler et al. (2015)	C3M
IT-based case management		

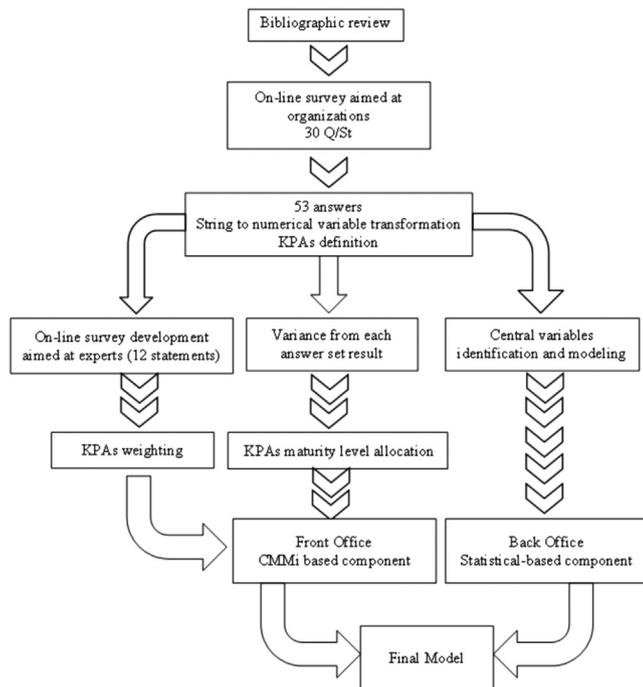


Fig. 1. Methodological path adopted to develop the final model.

results and the insights collected from the revised literature (Silverman, 2000; Yin, 2009). Although some statistical methods were adopted to develop new theory, this paper sought mainly the analytical generalization of the findings more than the statistical generalization (Yin, 2009). Statistical analysis was carried out by IBM *Statistical Package for the Social Sciences* (SPSS Statistics) version 20. The IMS-MM[®] final version is a hybrid model that considers, by one hand, a Capability Maturity Model integrated (CMMi)-based component and, on the other hand, a statistical-based component which expresses the relationships (Pearson correlation coefficient) between the variables (each set of results from each Q/St) and three independent variables that encompass a multiple regression linear model. Fig. 1 presents the methodological path adopted in order to develop the model.

Table 3
KPAs, maturity level and weighing.

KPA	Level	Weighing	Observations
Policies integration.	1	X4	KPA1 ^a
Top management integrated vision.	2	X5	KPA2
Implementation process supported on a guide or framework.	4	X3	KPA3
Top management training concerning systems integration.	2	X1	KPA4
Organizational tools, methodologies and objectives alignment.	3	X6	KPA5 ^a
Perception that the IMS genesis originates organizational interactions.	1	X1	KPA6
Non-residual authority by environmental and/or OHS managers.	4	X4	KPA7 ^a
At least one integrating concept was considered during the integration process.	1	X2	KPA8
System bureaucratization.	3	X3	KPA9
Management procedures integration.	1	X4	KPA10
Documental integration.	2	X3	KPA11
Integrated objectives adoption.	1	X5	KPA12
At the organizational structure there is an IMS manager.	2	X4	KPA13 ^a
Processes monitoring by KPIs, OPIs and MPIs.	3	X5	KPA14
Integrated indicators adoption.	5	X5	KPA15
Good correlation between the integrated organizational structure and the integration level perception.	4	X3	KPA16
Integrated audit typology.	3	X4	KPA17 ^a
Identification of organizational features not susceptible to integration.	5	X3	KPA18
Integration strategy.	2	X3	KPA19
MSs performance perceived better in an integrated context.	4	X5	KPA20
The IMS perceived as an add value.	1	X5	KPA21 ^a

^a Critical KPA.

All the statistical calculations regarding the development of the back office component (component expressing the relationships between the variables) and the previous versions of the CMMi-based component (front office) were reported elsewhere by Domingues (2013).

4. Results and discussion

A 15% response rate (53 valid answers) was achieved by the survey conducted among the companies and a 70% response rate was achieved by the survey conducted amid the experts' panel (7 respondents). It was estimated, at the time, that the amount of valid answers collected from the survey conducted among companies accounted for approximately 10% of the population. One of the major limitations of this study is the small sample size, which precludes the statistical generalization of the findings. Nevertheless, the collected results seem to converge with those reported by the mainstream bibliography which allows the analytical generalization through a triangulation approach (Yin, 2009).

The KPAs identified through the literature review and validated by both surveys (companies and an experts panel) are a crucial feature to the IMS-MM[®]. These KPAs can be defined as variables (related to concepts or constructs) that impact on the maturity of the IMSs, *i.e.*, it is possible to ascribe different dimensions to each KPA depending on the relative stage of evolution of the IMS or each KPA may be relevant in certain stage(s) of evolution and not in other(s). Table 3 lists each KPA, the level to where it was ascribed (one of the upper five maturity levels in the front office component) and the weighing. The allocation of the KPAs by level was performed based on a strict methodology that took into account several information sources. The insights provided by the revised literature, the statistical variance of each set of results collected from each Q/St of both surveys (indicating more or less agreement between the respondents) and the related arithmetic average (sorting the importance of each assessed KPA) were the features that most contributed in the deployment of such methodology.

4.1. The IMS-MM[®] and statistical treatment

The development of the IMS-MM[®] model, namely the back office component, adopted the methodology usually considered when proceeding with a linear multiple regression. After the

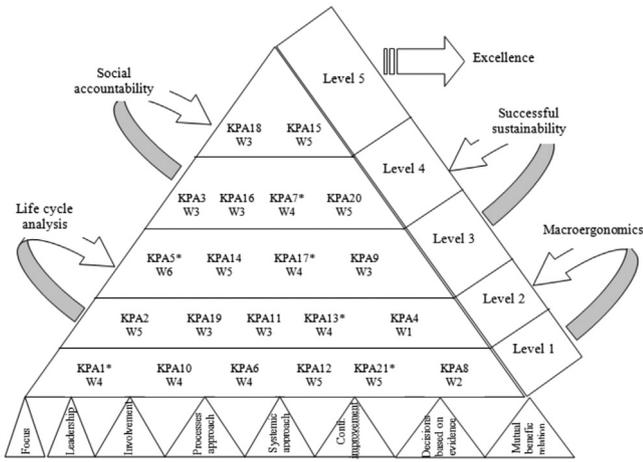


Fig. 2. Front office component including externalities and common features to the combined subsystems. Adapted from Domingues, 2013.

identification of the relevant variables, several assumptions were assessed between the independent variable and the dependent variables that comprise the model, namely, the linear relationship between the dependent variables and the response variable, the normal distribution of the errors, the variances homogeneity and

the independence of the errors. The complete and detailed statistical development of the front office component can be found in Domingues (2013).

The description of the development and purpose of the components that are encompassed by the model is reported in the following sections.

4.2. Front office component

The conceptual framework in which the model stands considers two components: the back office and the front office. This latter component (Fig. 2) acts as a showcase to be visualized by the companies that intend to assess their IMSs. The most relevant information, namely, in which maturity level the IMS is located, the critical KPAs (*), the score achieved and the externalities that impact on IMS maturity are displayed by the front office component. This is relevant information to IMS managers that intend to access to an upper maturity level and to attain a deeper integration level.

In addition to the KPAs, four so called externalities (external features or constructs that impact on the maturity level of the IMS) were identified in the literature and are encompassed by the model (Fig. 2). The externalities were allocated in ascending order taking into account their relevance to the external boundaries of the IMS, i.e., from the most related to the inner or internal organizational structure of the company (macroergonomics) to the one most related with the value that the company may add to the context

Table 4
Maturity assessment framework.

Level	Score	Requirements	Actions
5	–	KPA18; KPA15	Excellence
4	≥60	KPA7*; “Social responsibility” externality assessed as “Agree” or “Totally agree”	^ Level 5
3	≥72	KPA17*; “Successful sustainability” externality assessed as “Agree” or “Totally agree”	^ Level 4
2	≥60	KPA13*; “Life cycle analysis and management” externality assessed as “Agree” or “Totally agree”	^ Level 3
1	≥160	KPA21*; KPA1*; “Macroergonomics” externality assessed as “Agree” or “Totally agree”	^ Level 2
Base	Assessment of all pillars with “Agree” or “Totally agree”		^ Level 1

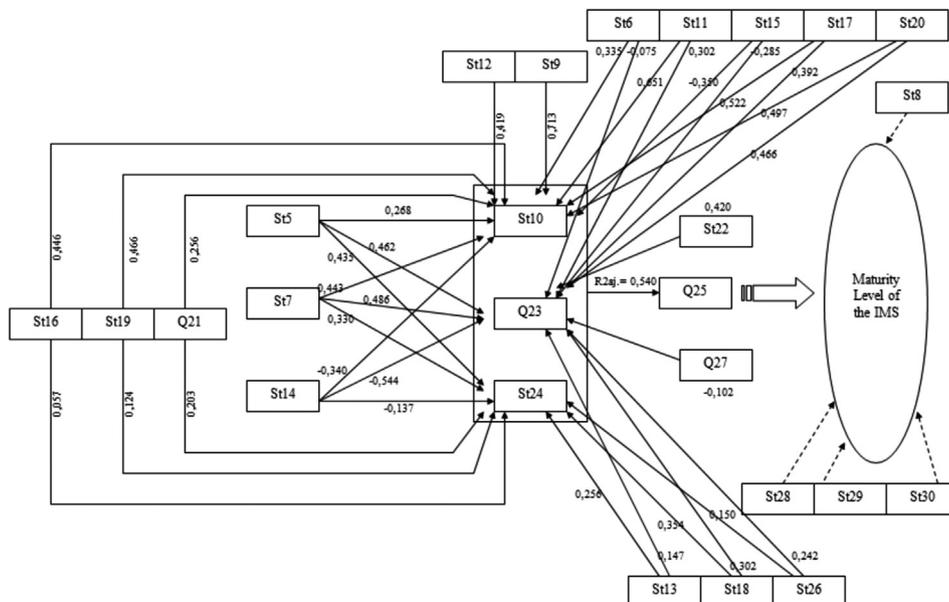


Fig. 3. Statistical-based component aiming at IMS efficiency assessment (back office). Adapted from Domingues, 2013.

that surrounds it (social accountability). The construct envisaged by each externality partially, but intentionally, overlaps the following externality so a consistent maturity path may be adopted in the development of the IMS. Furthermore, each externality addresses higher levels of excellence concerning the employees OHS, environment, successful sustainability and social responsibility, *i.e.*, comprise and emphasise the concepts encompassed by the MSs more often found combined with the QMS.

Table 4 displays the requirements to be fulfilled in order to an IMS evolve to an upper maturity level. The base or zero level intends to assess the implemented organizational system concerning the concepts that are usually reported as beacons of excellence management and are, in accordance with the Kano model (Kano et al., 1984), *must be* characteristics or features that, being fulfilled, enable the IMS to be considered as assessable by the IMS-MM[®]. These pillars of excellence management were selected because they are common features in any of the MSs that encompass an IMS.

The maturity level 1 considers two critical KPAs (KPA1 and KPA21) and the externality “Macroergonomics”. Maturity levels 2, 3 and 4 solely consider one critical KPA and, at level 5, to attain full maturity and the deepest integration level both the KPAs should be complied with.

To assess an IMS each question related to each KPA should be evaluated by selecting one of the multiple options answers (five

options *Likert* scale) or, for some cases and in alternative, by categorical type answers. In the first case (five options *Likert* scale) to score the weighing ascribed to the KPA the answer should be “Agree” or “Totally Agree”. In the second case the answer should be “Yes”. The final score is attained by multiplication of the weighing of the KPAs that comply with the above-mentioned. Moreover, the critical KPAs are *must be* characteristics, *i.e.*, both the score and the critical KPAs should be accomplished. Finally, the ascribed externality to the level should be assessed as “Agree” or “Totally Agree” based on a five options agreement *Likert* scale.

4.3. Back office component

The development of the back office component (Fig. 3) took into account, on one hand, the modelling of the variables by multiple linear regression which pointed out the three variables (statistically significant) that contributed the most to the latent “IMS maturity” variable ($R^2_{adj.} = 0,54$). On the other hand, it allowed the identification and quantification of the degree of correlation (Pearson correlation coefficient) between these three variables and those that did not, statistically, encompassed the multiple linear model. The dependent variable (Organizational classification) was found to be the most related to the latent variable “IMS maturity”.

Table 5
Checklist for evidence collection.

	Where/how to proceed with evidence collection	Likert scale ^a					Categorical scale	
		SD	D	NAOD	A	SA	Yes	No
KPA.1	Documentation that describes the company policy, its mission, its values and its commitments; Interview with the employees.						–	–
KPA.2	Documentation describing the company policy, its mission, values and commitments; Interview with top management and/or the representative; Top management review.						–	–
KPA.3	Interview with the IMS manager.	–	–	–	–	–	–	–
KPA.4	Training records, training program, training assessment records, <i>curricula vitae</i> from the trainers, training objectives and session plans.						–	–
KPA.5	Objectives by process and their monitoring, matrixes of objectives, non-conformities related actions and follow up, development of improvement opportunities, records and reports from the system review meetings, diagram between the processes and the system.						–	–
KPA.6	Interview with the IMS manager, communication.						–	–
KPA.7	Responsibilities flowchart, functions manual, and procedures describing the functions.						–	–
KPA.8	Interview with the IMS manager; documentation; processes description.						–	–
KPA.9	Documental structure.						–	–
KPA.10	Management procedure; Management documentation and records; system planning, review and monitoring; non-conformities and corrective and preventive actions; audits; equipment and infrastructures management; suppliers management.						–	–
KPA.11	Documental structure, system planning.						–	–
KPA.12	Deployment of objectives, development and monitoring; planning procedure, review and system monitoring; records from the system reviews meetings; objectives matrixes.						–	–
KPA.13	Organogram.						–	–
KPA.14	Objectives development and monitoring; planning procedure, review and system monitoring; records from the system reviews meetings; matrixes of objectives.						–	–
KPA.15	Objectives development and monitoring; planning procedure, review and system monitoring; records from the system reviews meetings; matrixes of objectives.						–	–
KPA.16	Communication.						–	–
KPA.17	Audit plan, audit records, actions plan, auditors' qualification and <i>curricula vitae</i> .						–	–
KPA.18	Interview with the IMS manager, documentation, processes description, exclusions, and communication.						–	–
KPA.19	Interview with the IMS manager.	–	–	–	–	–	–	–
KPA.20	Interview with top management and/or the representative, with the IMS manager, with each MSs manager and employees. Objectives monitoring evolution, comparison between before and after the integration process. Communication between the processes and the system.						–	–
KPA.21	Interview with top management and/or the representative, with the IMS manager, with each MS manager and employees.						–	–

^a SD – strongly disagree; D – disagree; NAOD – nor agree or disagree; A – agree; SA – strongly agree.

Table 6
Maturity assessment framework – 8 management pillars.

Pillar	Assessment question	Potential evidence	Likert scale ^a				
			SD	D	NAOD	A	SA
Focus	Is the IMS oriented so it complies with all stakeholders' requirements?	Policy, vision, objectives and goals.					
Leadership	Do the company organogram and the degree of responsibility ascribed to MSs managers entail an effective integration?	Organogram and functions description document.					
Involvement	Are the employees involved at the same degree regarding quality, environmental and OHS actions?	Interview with employees; training records.					
Processes approach	Does the processes description reference all the integrated benchmarks?	Processes.					
Systemic approach	Does an integrated approach is adopted when facing a problem?	Audit records.					
Continuous improvement	Is each MS considered when describing potential solutions concerning continuous improvement actions?	Preventive and corrective actions records.					
Decisions based on evidences	Are all the inputs that impact decision making from all the MSs?	PDCA cycle check.					
Mutual beneficial relationships	Are mutual beneficial relationships evidenced between the company and the stakeholders and within the implemented subsystems?	Processes diagram; assessment by customers and suppliers.					

^a SD – strongly disagree; D – disagree; NAOD – nor agree or disagree; A – agree; SA – strongly agree.

The back office component has the potential to assess the efficiency of the IMSs, *i.e.*, if one consider two or more IMSs that pertain to the same maturity level, the one more efficient is the one that complies with the concepts assessed by the three variables that are encompassed by the multiple regression model (St10, Q23 and St24) or the one that complies with those variables that have a positive and higher Pearson correlation coefficient when compared with these three variables.

4.4. Sources for evidence collection

Table 5 presents some potential sources where information may be collected in order to assess each KPA. The sources depicted in Table 5 were brought forth from a non-exhaustive selection of the documentation that should be present in any implemented individual subsystem. In addition to these sources, particularly accurate information can be collected by the analysis of how the system evolves and “learn”, *i.e.*, how the procedures design to assure the continuous improvement are carried out.

The assessment of the management pillars may be conducted based on a checklist of assessment questions. Some of the potential questions to be adopted in order to evaluate each management pillar are listed by Table 6. Evidence may be collected from several sources including those from the internal documental structure and by inspecting and dissecting the relationships that are developed within the individual MSs and between the company and customers, suppliers, other entities and stakeholders.

A potential maturity assessment guide concerning the externalities is presented at Table 7. Each externality relates with a construct that encompasses a broad range of potential indicators. It is not the aim of the current paper to list specific indicators and, in fact, we believe that the indicators to be adopted are strongly related to the context where the company develops its activities.

5. Conclusions

The IMS-MM[®], a two component hybrid model aiming at the assessment of the IMS maturity throughout six maturity levels, was reported and dissected in this paper. Although the above mentioned limitation concerning the small sample size there is not any argument that precludes the findings to be generalized from an analytical point of view, as discussed previously.

The back office component of the model has a structured and statistical-based nature, where one may distinguish three variables that, statistically, contribute the most to the latent variable “IMS maturity”. This component was developed in order to process the data provided by the end user (companies that intend to assess their IMSs), and thus, to retrieve information concerning the variables that should be rated higher and the proper actions to be developed in order to access to higher maturity levels.

The front office component is structured according to the CMMi framework. This component, acting as a showcase, intends to provide the end user with a friendly graphical interface promoting an intuitive interpretation and use and complying with the design principles identified earlier on the revised literature. The statistical

Table 7
Maturity assessment framework-externalities.

Externality	Assessment question	Potential evidences	Likert scale ^a				
			SD	D	NAOD	A	SA
Macroergonomics	Are suitable macroergonomics practices identified in the company?	Motivation and performance management. Ergonomic and OHS considerations					
Life cycle analysis	Is life cycle analysis and management adopted by the company?	Product/service life cycle management; Interview with the EMS manager.					
Successful sustainability	Does the IMS contribute to a successful sustainability?	Indicators monitoring, performance analysis prior and after integration.					
Social accountability	Does the IMS reflect concerns about social responsibility?	Process management concerning the hiring and extinction of employees' contracts; Interview with top management and/or human resources manager.					

^a SD – strongly disagree; D – disagree; NAOD – nor agree or disagree; A – agree; SA – strongly agree.

modelling through multiple regression enabled the identification of the statistically relevant parameters that contribute the most to the variation of the “IMS maturity” latent variable. The final CMMi-based component version considers five maturity levels and a “zero level” that evaluates the evidence from the adoption of the eight excellence management pillars. The “zero level” acts as a pre-requirement that any company, intending to assess IMS maturity, should observe. Other dimension on the final version of the front office component concerns with external features or externalities that were found to affect the IMS maturity. Four externalities were identified and considered in the model: macroergonomics, life cycle analysis and management, successful sustainability and social responsibility. The third dimension addresses the identified KPAs. Evolving to an upper maturity level occurs solely when the IMS complies with the critical KPAs from a certain level, with the related external feature ascribed to that level, and with the quantitative score previously defined. To sum up, the IMS-MM[®] considers a structured statistical component (back office) that has the potential to assess the efficiency of an IMS and a CMMi-based component (front office) that acts as an interface enabling a friendly user environment. Additionally, several assessment guides were proposed with the potential to be adopted as an aid to evaluate some parameters encompassed by the IMS-MM[®]. To authors' knowledge, the IMS-MM[®] is the first published initiative to “normalize”, and thus, to allow the comparison between IMSs that evolved in different contexts and environments.

It is expectable that, in the near future, companies face an increasing and overwhelming need to assess the level of articulation of the different implemented MSs. This model has the potential to deal with improved performance some managerial issues commonly addressed in the daily management of a certified company. This assumption is supported by the fact that the model encompasses those emergent constructs arisen from the integration process. Furthermore, regarding the potential implications of the model on the standardization and certification bodies it is not far-fetched to stress and emphasize the need of a tool to assess the visible efforts developed by these bodies in order to improve the “miscibility” of the standards. This model intends to be, hopefully, the first contribution in the development of such a tool.

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Appendix

Table A.1
Companies survey questions/statements.

Q/St	Possible answers and variable numerical transformation (parentheses)
St1 – The company main activity is:	Unstructured
Q2 – How many workers employ the company?	Unstructured
Q3 – Where is located the company?	North; Centre; Lisbon; Alentejo; Algarve; Madeira; Azores
St4 – The MS is certified according the following standards:	ISO 9001 + ISO 14001; ISO 9001 + OHSAS 18001; ISO 14001 + OHSAS 18001; ISO 9001 + ISO 14001 + OHSAS 18001; Other
St5 – Quality, environmental and OHS policies are integrated.	Totally disagree (–2); Disagree (–1); Nor agree or disagree (0); Agree (1); Totally agree (2)
St6 – Training related to MSs integration was provided to top management.	“”
St7 – An integration concept was considered during IMS implementation.	“”
St8 – The IMS is bureaucratized.	“”
St9 – The tools, methodologies and goals from each MS are harmonized/aligned.	“”
St10 – Top management reveals integrated vision.	“”
St11 – Management procedures are integrated.	“”
St12 – Organizational interactions derived from IMS implementation are perceived by middle and top management.	“”
Q13 – The implementation process was supported on a guideline or in a framework.	“”
St14 – Integration occurs at a documental level.	“”
St15 – Authority from environmental and/or OHS manager is residual.	“”
St16 – The IMS is an add-value.	“”
St17 – Integrated objectives are defined.	“”
St18 – The organizational structure of the company considers a manager (responsible) of the IMS.	“”
St19 – The company monitors their processes based on KPIs, MPis and OPis.	“”
St20 – The company promoted the adoption of integrated indicators.	“”
Q21 – How do you classify the easiness to integrate the subsystems standards?	Very easy (+2); Easy (+1); Reasonable (0); Difficult (–1); Very difficult (–2)
Q22 – If the company did not had implemented an IMS the overall performance comparing to the actual reality would be:	Lower than the present status (+1); Equal to the present status (0); Higher than the present status (–1)
Q23 – How do you classify the integration level?	1 – Documental (+1)/2 – Management tools plus 1 (+2)/3 – Policies and objectives plus 1 and 2 (+3)/Common organizational structure plus 1, 2) and 3) (+4)
St24 – Audits performed to MSs are:	Integrated (+4); Simultaneous (+3); Overlapped (+2); Sequential (+1)
Q25 – How do you characterize the IMS?	1 – Minimum integration level (–2)/2 – Low i.l. (–1)/3 – Medium i.l. (0)/4 – High i.l. (+1)/5 – Total/Maximum i.l. (+2).
Q26 – The strategy adopted during integration process was:	· Sequential (+1) · “All In” (+2)
Q27 – Organizational items not susceptible of being integrated are identified?	· Yes (+2) · No (+1)
Q28 – The main motivations to implement the IMS were:	Internal (+2)/Mainly internal (+1)/Mainly External (–1)/External (–2)
Q29 – The main benefits collected from the integration of the MSs were:	“”
Q30 – The main obstacles faced during IMS implementation were:	“”

i.l. – Integration level.

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