

A model proposal for integrated management systems maturity assessment

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Theme: Adaptability

Abstract

Maturity models enabling the assessment of integrated management systems (IMS) are crucial in order to provide a comparison between IMS from different companies. This paper intends to report the efforts made and the methodologies followed to develop an IMS maturity assessment model. Additionally, the paper aims at presenting such model, illustrate its usefulness, and demonstrate how companies may implement it as an organizational guide focusing an ultimate excellence level. Two surveys have been developed. An online survey with 30 questions/statements was held focusing Portuguese companies with more than one certified management subsystem according to the following standards: ISO 9001, ISO 14001 and OHSAS 18001/NP 4397. The survey was supported on Likert type scales, with categorical and multiple option answers/statements. A pre-test was performed in three companies in order to validate the survey. A second survey was developed and submitted to the appreciation of an experts group to assess in what extent each parameter could reflect the management system integration level. The maturity model reported in this paper provides companies with a guiding path in order to achieve an ultimate excellence level. The final model version is sustained on two components, namely, a back office component, describing the statistical relationships between variables, and a front office Capability Maturity Model integrated (CMMi) based component, enabling companies to interact with the model. The back office component was developed through linear and multiple regression models and by statistical significant variables identification affecting an “IMS maturity level” latent variable. Additionally, Pearson correlation was assessed among those variables not statistically related to the latent variable. Front office component has five maturity levels and a “zero level” acting as a pre-requirement and enabling, or not, the access to the maturity assessment model. To access at higher maturity levels the IMS should comply with excellence management requirements, external factors requirements and key process agents’ (KPA) requirements.

Keywords: maturity model, integrated management systems, back office component, front office component

INTRODUCTION

Maturity, capability, maturation object and maturity models

When facing a scientific problem one may choose between qualitative or quantitative approaches. These latter facilitate test hypothesis since they are supported on the natural sciences model. Qualitative research, supported on social sciences model, sustained on an inductive approach, is structured not to testing hypothesis but on building them (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Gasson, 2009; Glaser and Strauss, 2008; Kohlegger *et al.*, 2009; Lessard-Hébert *et al.*, 2010; Yin, 2009). According to this philosophy, maturity models are a valid option since they may be adopted in practical terms or they may be a conceptual abstraction being it assessment target people, processes, objects or social systems. The preliminary items to be considered, the design features, the development, the iterative process and the key concepts are topics usually addressed in the literature concerning maturity models. Some maturity models definitions were proposed by several authors and were listed elsewhere (Domingues *et al.*, 2014).

The notion of maturity relates with the system assessment as the notion of equilibrium relates to the chemical reactions. It is a stage favourable to a peculiar characteristic and from where is not advisable to proceed with any further actions. It is not a terminal stage due to the fact that is a dynamic and mobile objective (Tonini *et al.*, 2008). Several authors provide their own definition of maturity (Table 1), and some of them concerns to the peculiar context where the maturity model was developed.

Table 1: Some examples of maturity definitions.

Source	Definition
Paulk <i>et al.</i> (1993)	...specific process to, explicitly, define, manage, measure and control the evolutionary growth of an entity.
Anderson and Jessen (2003)	...a stage where a company is properly capable to achieve the proposed objectives.
Rosemann and de Bruin (2005)	...it is a measure to assess the related capabilities in a certain domain.
Tonini <i>et al.</i> (2008)	...it is a mobile objective, since its main elements (technology, methodology and management) change continuously according to the market, business and people. ...is only a dynamic stage.
Mettler (2009)	...the evolutionary progress on demonstrating a specific capability or on the prosecution of a certain objective from an initial stage to a final and desirable stage.
Franz (2009)	...the achievement of a stage or moment favourable to something.
Fitterer and Rohner (2010)	...relates to an assessment criterion or to the state of being complete, perfect or ready.
Looy <i>et al.</i> (2011)	...organization characteristic aiming at excellence.
Sen <i>et al.</i> (2011)	...concept to which is related a progress from an initial stage till a more advanced final stage, that is, to higher maturity levels.

Table 1(cont.): Some examples of maturity definitions.

Source	Definition
<i>Oxford Advanced Learner's dictionary</i> (2012)	...the quality of think and act sensibly and adult. ...the maximum stage of growth or development.
<i>Cambridge Dictionary on-line</i> (2012)	...an advanced stage. ...the state or quality of being fully growth or developed.

Paulk *et al.* (1993) defined maturity as a specific process to, explicitly, define, manage, measure and control the evolutionary growth of an entity. On other side, Anderson and Jessen (2003) defined maturity as a stage at which a company is fully capable to achieve the objectives proposed by it. Fitterer and Rohner (2010) suggested that maturity relates to an assessment criterion or to the state of being complete, perfect or ready and Sen *et al.* (2011) described it as a concept to which is implicitly a progress from an initial state till a more advanced final state. Similarly, Mettler (2009) related maturity with the evolutionary progress when demonstrating a specific capability or during the prosecution of a certain objective, from an initial stage to a final desirable stage. However, Amaral and Araújo (2008) emphasized that this final stage of perfection may be achieved through different paths. The distinction between companies with more or less mature management systems should not solely be based on the results provided by the adopted indicators due to the fact that mature companies monitor different indicators when compared with less mature companies (Cooke-Davies *et al.*, 2001).

While the maturity concept concerns with one or more relevant items to the studied object (Hillson, 2008) described as key process agents (KPAs) (Figure 1), the capability concept relates with just one of those items. Table 2 lists some examples of capability definitions identified during the literature review.

Table 2: Some examples of capability definition.

Source	Definition
Day (1994)	...the skills or the complex set of skills and cumulative knowledge, exerted through organizational processes, enabling the companies activities coordination and utilization of available resources.
Van Loon (2004)	...relates to the competence of a company to provide a specific or desirable performance consistently and predictably.
Tonini <i>et al.</i> (2008)	...proper competence, with more efficiency and effectiveness.
Chuah (2010)	...set of (capabilities) and competences from a person.
Valdés <i>et al.</i> (2011)	...it is a measure of the reaction state to the development support from a company.

Figure 1 displays some images with intent of describe what is a maturity level, what are the key process agents (KPAs) and what is the maturation object adopted to assess maturity.

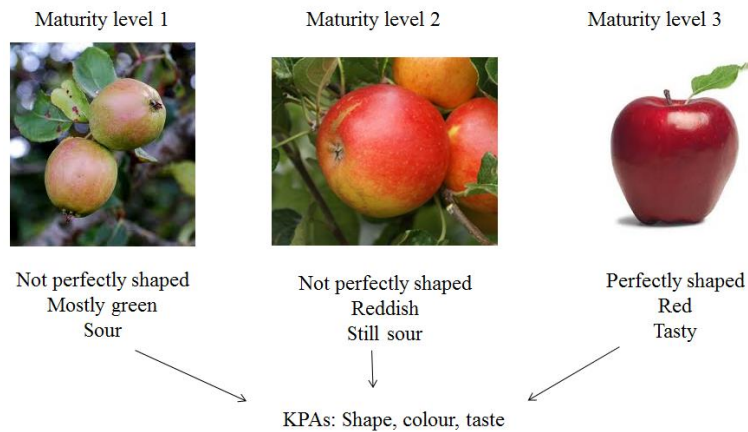


Figure 1: Maturity levels and KPAs.

In this case the maturation object is the apple (the object to be assessed), the KPAs are the features to be assessed (shape, colour and taste) and each maturity level presents several requirements concerning the KPAs assessment.

Similarly, if one considers the IMS as the maturation object and after the identification of the KPAs influencing the maturation object, one may describe through a discrete number of maturity levels the path till excellence is reached. Suitable assessment dimensions shall be defined for each KPA in order that the maturation object may be able to demonstrate its capability.

Integrated management systems

Management systems integration has been an organizational domain focused by several authors as a topic of interest (Almeida *et al.*, 2014; Bernardo and Simon, 2012; Bernardo *et al.*, 2012; Domingues *et al.*, 2012; Pires, 2012). The main reasons for the implementation of an IMS were also addressed in several papers (Crowder, 2013; Garengo and Biazzo, 2012; Sampaio *et al.*, 2012; Simon *et al.*, 2012) and even a research agenda concerning the management subsystems standards was recently proposed (Heras-Saizarbitoria and Boiral, 2013).

There are several critical success factors (CSFs) to consider when implementing an IMS, such as, top management commitment, workers involvement, suitable resources availability, active leadership and a clear objectives definition among other. In a recent study, Almeida *et al.* (2012) reported the main CSFs according the integration level achieved and some of them are more prone to be considered in high integration level organizations (HILO) than on low integration level organizations (LILO). Molina-Azorín *et al.* (2009) reported the main issues to be considered when analysing, implementing and managing an IMS at the time but, since then, new inputs have been provided that ask for a new publication addressing the global development on this issue till now. Recently, Bernardo *et al.* (2012) concerning integration difficulties and their relationship with the integration level reported that companies with three implemented management systems did stated that some difficulties affect the integration level achieved.

Considering the above mentioned, it seems that are several KPAs to consider when developing a maturity model and that some of them do relate to each other.

MATERIALS AND METHODS

Two surveys have been developed. An online survey with 30 questions/statements (Table 3) was held focusing Portuguese companies with more than one certified management subsystem according to the following standards: ISO 9001, ISO 14001 and OHSAS 18001/NP 4397. The survey was conceptually supported on Likert type scales, with categorical and multiple option answers/statements. A pre-test was performed in three companies in order to validate the survey. A second survey (Table 4) was developed and submitted to the appreciation of an experts group to assess in what extent each parameter could reflect the management system integration level. Each expert was asked to classify each parameter according to the integration level it represents. If the expert felt that the parameter do not represent any kind of integration level he/she may choose the option- 'Non Relevant Parameter'. The experts' survey design was based on the companies' survey results and on the questions/statements that provided the most coherent results. Statistical development of the model was performed with IBM SPSS version 20.0.

Table 3: Companies survey Questions/Statements.

Q/S	Possible Answers
S1-The company main activity is:	Unstructured
Q2- How many workers employ the company?	Unstructured
Q3- Where is geographically located the company?	North; Centre; Lisbon; Alentejo; Algarve; Madeira; Azores
S4- The management system is certified according the following standards:	ISO 9001 + ISO 14001; ISO 9001 + OHSAS 18001; ISO 14001 + OHSAS 18001; ISO 9001+ISO14001+OHSAS 18001; Other
S5- Quality, environmental and occupational health and safety policies are integrated.	Totally disagree; Disagree; Nor agree or disagree; Agree; Totally agree
S6- Training related to management systems integration had been provided to top management.	“”
S7- Integration concept had been taken into account during IMS implementation.	“”
S8- Management system is bureaucratized.	“”
S9- The tools, methodologies and goals from each management sub-system are harmonized/aligned:	“”
S10- Top management reveals integrated vision.	“”
S11- Management procedures are integrated.	“”
S12- Organizational interactions derived from IMS implementation are perceived by responsible and top management.	“”
S13- The implementation process was supported on a guideline or in a framework.	“”
S14- Integration occurs at a documental level.	“”
S15- Authority from Environmental and/or OHS responsible is residual.	“”
S16- IMS is an add-value.	“”
S17- Integrated objectives are defined.	“”
S18- On the company organizational structure there is a clear responsible by the IMS.	“”

Table 3 (cont.): Companies survey Questions/Statements.

Q/S	Possible Answers
S19- The company monitors their processes based on KPI's, MPI's and OPI's.	""
S20- The company promoted the implementation of integrated indicators.	""
Q21- How do you classify the integration level of sub-systems standards?	Very easy; Easy; Reasonable; Difficult; Very difficult
S22- If the company did not had implemented an IMS the overall performance comparing with the actual reality would be:	Lower than the present status; Equal to the present status; Higher than the present status
Q23- How do you classify the management system integration level?	1- Documental/ 2- Management tools plus 1)/ 3- Policies and objectives plus 1) and 2)/ Common organizational structure plus 1), 2) and 3)
S24- Audits performed to management sub-systems are:	Integrated; Simultaneous; Overlapped; Sequential
Q25- In a 1 to 5 scale how do you characterize the IMS?	1- Minimum integration level/ 2- Low i.l./ 3- Medium i.l./ 4- High i.l./ 5- Total/Maximum i.l.
S26- The strategy followed during integration process was:	. Sequential . "All In"
Q27- Organizational items not susceptible of being integrated are identified?	. Yes . No
S28- The main motivations to implement the IMS were:	Internal/ Mainly internal/ External/ Mainly external
S29- The main benefits resulting from the integration of the management system were:	""
S30- The main obstacles found during IMS implementation were:	""

Table 4: Experts survey Questions/Statements.

ID	Statement
S1	The predominance of internal origin motivations, obstacles and benefits before, during and after the integration process.
S2	Environmental manager and/or OHS manager responsibility is not residual and formally there's a clear responsible by the IMS on the company organizational structure.
S3	The company monitors their processes based on integrated indicators (KPI's, MPI's and OPI's).
S4a	Workers have the perception that the management system overall performance is superior in an integrated context and that top management reveal integrated vision.
S4b	Workers have the perception the integrated system is an add value and the company performance would be lower in a non-integrated context.
S5	The identification of organizational items not susceptible of integration.
S6	Integrated audits performed on the management system.
S7	An "all in" sequence integration <i>versus</i> a sequential process.
S8	Same organizational tools and methodologies between sub-systems and objectives alignment.
S9	Implementation process supported on a guideline or in a framework.
S10	Implementation responsible has the opinion that sub-system standards are easy or relatively easy to integrate.
S11	The company has an integrated policy of Quality, Environment and Occupational, Health and Safety and management procedures are integrated as well.
S12	Integration does exist at a documental level and workers have the perception that the system is bureaucratized.
S13	Integration level perception by the workers matches with the integration level achieved by the company.

RESULTS AND DISCUSSION

Conceptual approach

As been stated previously, the final maturity model consists in two components: the front office and the back office. The front office component, structured similarly to the traditional maturity model concept, will be available to the companies aiming at the maturity assessment of their IMS. The back office component, not accessible to the companies, is a structured statistical component “translating” the relationships identified within the variables. Figure 1 presents the conceptual diagram expressing the related concepts. Similarly to software concepts one may consider that the CMMi component act as a “cover page” enabling interactions with the user (companies) aiming at assessing the maturity of their IMS like a monitor enables friendly software user interactions. In the processing unit, that is, “behind the curtains”, the structural statistical component (not accessible to the user) processes all the collected information, based on the relationships and modelling of variables, providing outputs to be displayed by the front office component (Figure 2). The back office component is in fact a *proto* pictorial approach to a structural equations model.

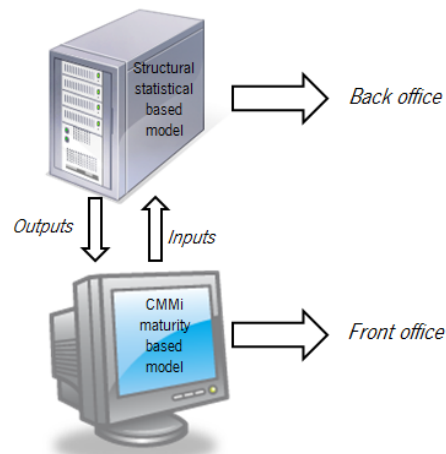


Figure 2: Conceptual diagram.

Front office component

One of the features emphasized by literature concerning a maturity model development is that it should be an iterative procedure. So, after the internal KPAs identification by literature review (Table 3) and through the conduction of some case studies, several external factors were identified as well some common subsystems features that were considered as affecting the IMS maturity and, thus, should be contemplated by the model (Figure 3).

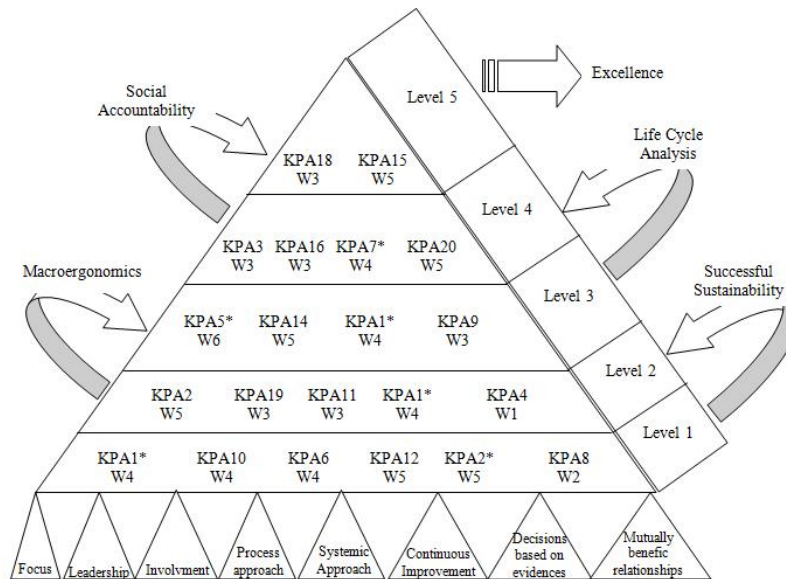


Figure 3: Front office component

To each KPA a coefficient (W) was ascribed according an importance scale rated by the experts group (Table 4) concerning the integration relevance. As displayed by Figure 3, concepts such as successful sustainability, macroergonomics, life cycle analysis and management and social responsibility were inserted on the model, reflecting their relevance and contribution to the IMS maturity.

Management systems integration should be a successful sustainability assurance by the company that implements it. An IMS implementation reflects the commitment by the top management with the requirements by several stakeholders, thus, with the requirements by people and entities that in some way interact with the company at different levels. This feature provides top management with a wider vision concerning the company position among society, enabling the identification and assessment of variables influencing the management component. Accordingly, a company addressing the sustainability concept evidences a higher maturity level if compared with other company that do not address to this concept.

Macroergonomics addresses and optimizes simultaneously the worker, the machine and the involving human factors through an holistic approach similar to that adopted by an integrated management system that addresses and optimizes several stakeholders requirements (customers, workers and society) (Domingues *et al.*, 2012). The organizational structure that better suits an IMS is a relevant parameter and is one of the research topics of macroergonomics.

Life cycle analysis and management is an organizational tool that enables companies the comprehension the environmental incidences of the materials, processes and products, and the information collected may be used to develop new products and to detect new research and development domains (Naturlink, 2013).

Concerning social responsibility, companies should operate as sustainable development promoters among the society, considering social concerns at a personal and community levels (Asif *et al.*, 2013; Fonseca, 2012).

The eight management pillars act as a zero level or pre-requirement to access the pyramidal assessment. The eight pillars that should sustain any management subsystem

are included by the model since they are, ultimately, common and crucial parameters that enable the IMS operation. However, these eight pillars assessment should be performed on an integrated context.

Table 5 presents the pre requirements to access the maturity assessment pyramid and the specific conditions that enable the access to each level. The KPA with a “*” are considered crucial or critical KPAs that should be observed on the respective level. The score is achieved by multiplying the coefficient “W” of the KPAs considered observed when assessing the IMS maturity according Figure 3.

Table 5: Conditions to assess IMS maturity.

Level	Score	Requirement	Action	Crosby
5	---	KPA.18; KPA.15✓	Excellence	Certainty
4	≥ 60	KPA.7* ✓	↑ level 5	Wisdom
3	≥ 72	KPA.17* ✓	↑ level 4	Enlighten
2	≥ 60	KPA.13* ✓	↑ level 3	Awakening
1	≥ 160	KPA.21*KPA.1*✓	↑ level 2	Uncertainty
Base	Eight excellence management pillars assessment		↑ level 1	

Back office component

Concerning the back office component, the predictor variables (S10, Q23 and S24) compose the multiple linear regression model with an $R^2_{adjusted}=0,540$ thus explaining 54% of variable Q25 variation. The model was developed by the *Enter* method. The remaining variables relate with these central variables by statistical significance of the Pearson correlation coefficient and, some of them, are statistically related through a single linear statistical relationship with the central variables (Figure 4). The Pearson correlation coefficient is displayed on the arrows. S8, Q27, S28 and S29 contribute to the maturity level but a meaningful correlation with the predictor variables S10, Q23 and S24. Figure 4 only presents the statistical relationships between non central variables and predictor variables.

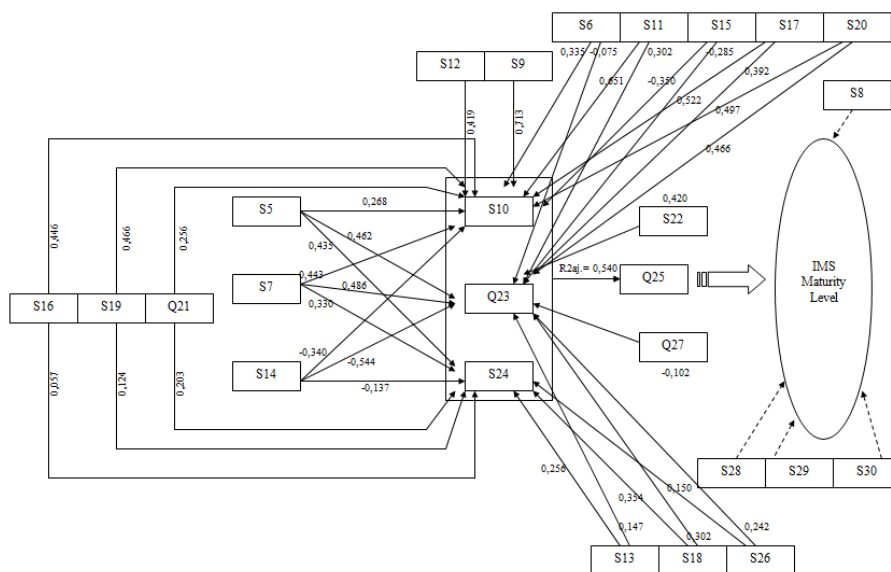


Figure 4: Back office component

The IMS efficiency may be assessed by the “path” (shorter or longer) that a company engages to the central variables. Additionally, the positive or negative correlation influences also the IMS efficiency level. An IMS would be more efficient as the higher value is ascribed to the central variables, to the non-central variables with positive and higher Pearson coefficient and lesser the value ascribed to non-central variables com a higher and negative Pearson coefficient.

CONCLUSIONS

A two-component maturity model was developed aimed at IMS maturity assessment. This model fills a research gap identified on the literature and through the conduction of several case studies among IMS ruled companies. The reported model enables companies to assess the maturity level of their IMS and provides information concerning the actions that should be implemented in order to increase maturity. Furthermore, the back office component may be potentially used in order to identify the most efficient path to increase the maturity level. Considering the iterative approach that characterizes any maturity model development it is, at the moment, a model that may be improved through validation and by any suitable observations.

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