Chapter 11
Integrated Management Systems: A Model for Maturity Assessment

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Abstract Maturity models are adopted to minimise our complexity perception over a truly complex phenomenon. In this sense, maturity models are tools that enable the assessment of the most relevant variables that impact on the outputs of a specific system. Ideally a maturity model should provide information concerning the qualitative and quantitative relationships between variables and how they affect the latent variable, that is, the maturity level. Management systems (MSs) are implemented worldwide and by an increasing number of companies. Integrated management systems (IMSs) consider the implementation of one or several MSs usually coexisting with the quality management subsystem (QMS). It is intended in this chapter to report a model based on two components that enables the assessment of the IMS maturity, considering the key process agents (KPAs) identified through a systematic literature review and the results collected from two surveys.

11.1   Introduction

IMSs are being developed worldwide by companies operating on the most disparate activity sectors. At the present, there is not an ISO standard to assist companies during the IMSs implementation like the ISO 9001 or ISO 14001 standards guide companies on the implementation of QMSs and environmental management systems (EMSs), respectively. This fact leads to similar companies achieving different integration levels and adopting different integration paths which influence IMSs efficiency. Maturity models are being developed in several fields and are useful tools when aiming at the assessment of complex systems like the IMSs. These complex systems are usually characterised by a great deal of variables involved, often related to each other, but

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where the nature and intensity of those relationships is not fully known. Ultimately, a maturity model simplifies a complex problem so it may be manageable and understood enabling some forecasting by the identification of the most relevant variables.

11.2 Theoretical Background

11.2.1 Maturity Models

Maturity models may improve companies' efficiency, effectiveness and capability and in our days are essential tools to evaluate and assess a company capability aiding to implement the necessary improvements structurally. Several authors such as Cooke-Davies (2002) described the features that should be taken into account before any maturity model development (Table 11.1).

In this context one may add that the development of maturity models relates intimately to two concepts: maturity and capability. Maturity implies, generically, a stage favourable to a peculiar characteristic and from where is not advisable to proceed any more actions but various authors provided their own definitions encompassing the specific context where the maturity model was developed. While the maturity concept concerns with more than one relevant item to the maturation object the capability concept relates with just one of those items. Röglinger and Pöppelbuβ (2011) accurately defined maturity model as a set of sequential levels that, together, describe an anticipated, desired or logical path, from an initial stage to a final maturity stage. These models originated from the quality background (Demir & Kocabaş, 2010; Fitterer & Rohner, 2010; Sen, Ramammurthy, & Sinha, 2012) depicting a set of capability growth stages, both at quantitative and qualitative levels, of the maturation object.

Some features regarding the design of the model condition their applicability and diffusion, such as, the related costs, easiness to use, simplicity on interpreting it, coherence between successive editions and the degree of difficulty concerning the mandatory training. Disparate domains were the target of maturity models such as the quality management (Ivanovic & Majstorovic, 2006), the assessment of performance indicators (Aken, Letens, Coleman, Farris, & Goubergen, 2005), the development, testing and maintenance of software (April & Desharnais, 2005; Sen et al., 2011;

Table 11.1 Some features to be considered before developing a maturity model (Cooke-Davies, 2002)

Feature	
The meaning of the term "maturity" within the context of the maturity model development	The element being through the maturation process
The main features of the maturity model to be developed	The features that will sustain the model
The nature of maturation	The evolution of the elements or agents over time
The direction of evolution	

Wangenheim et al., 2010), the assistance to e-government by companies (Röglinger & Pöppelbuβ, 2011), the evaluation of suppliers (Mettler, 2010), the development of products (Bing, Shan, Tao, & Gang, 2010), innovation (Essmann & Preez, 2009), the development of projects and their management (Gareis, 2002; Guangshe, Li, Jiangguo, Shuisen, & Jin, 2008), the assessment of the communication level in collaborative activities (Maier, Eckert, & Clarkson, 2006), the risk management in IT activities (Mayer & Fagundes, 2009), the knowledge management (Jiankang, Jiuling, Qianwen, & Kun, 2011; Röglinger & Pöppelbuβ, 2011), the development of business intelligence (Chuah, 2010), the evaluation of leadership capabilities and the assessment of archives systems (Wetering, Batenburg, & Lederman, 2010).

11.2.1.1 Typologies of Maturity Models

Usually, maturity models describe, using some sentences, the typical behaviour or the relative position (maturity level) achieved by the object of maturation. Concerning their field of application models may be classified as described by Fig. 11.1.

Tonini, Carvalho, and Spínola (2008) regarding the design requirements of maturity models distinguish between generic requirements and specific requirements (Table 11.2). The involvement by all the agents (users and developers), their dynamic nature, the systemic based approach and traceability are characteristics that all
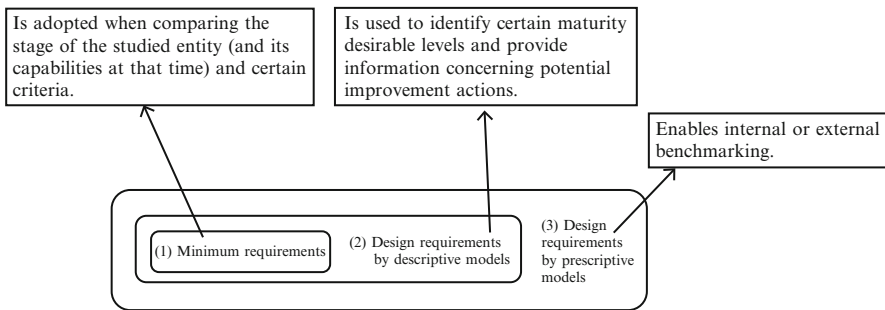
Fig. 11.1 Design requirements according Typologies of maturity models

Table 11.2 Maturity models requirements (adapted from Tonini et al., 2008)

Generic requirements	Specific requirements
Abstraction; to involve all the agents	Relevance; to highlight the features that add value to the company
Dynamic; to allow adaptations	Opportunity; to be used in order that business opportunities may be explored
Systematic; to be sustained by a system	Specificity; to take into account specific features from the company
Traceable; to allow a posteriori analysis so strengths and weaknesses may be identified	Feasible; to be implemented according a suitable cost/benefit relationship

maturity models should present. The specific requirements should be outlined considering the intrinsically characteristics of the entities that will adopt the model and to whom the model was developed.

11.2.1.2 Questions that Should be Taken in Account When Developing Maturity Models

The design of a maturity model is a multi-methodological task and, as previously mentioned, the proliferation of maturity models was reported in several research domains. However, concerning their design all maturity models present several common features (Röglinger & Pöppelbuβ, 2011; Sen et al., 2011) that are listed in Table 11.3.

Röglinger and Pöppelbuβ (2011) listed the main design principles (Table 11.4) that a generic maturity model should observe according to its own nature (comparative, descriptive or prescriptive). By analysis of Table 11.4 one may see that the minimum requirements do not consider the principles related to improvement actions and their assessment. The design features encompassing those principles are solely considered

Table 11.3 Common features to maturity models

A limited number of maturity levels (usually 4–6)	Each maturity level is characterised by certain key process agents (KPAs)	The maturity levels are sequentially ordered

Table 11.4 Design requirements according to the typology of the maturity model. (Röglinger & Pöppelbuβ, 2011)

Group		Design principles
(1) Minimum requirements	1.1	Basic information
		Domains of application and pre-requirements
		Adoption
		Target group
		Entity class under research
		Models differentiation from related maturity models
		Design process and extension of the empirical validation
	1.2	Definition of critical features concerning maturity and maturation
		Maturity and its dimensions
		Maturity levels and maturation paths
		Theoretical foundations sustaining the model
	1.3	Definition of critical features concerning the domain of application
	1.4	Documentation concerning the target group
(2) Descriptive	2.1	Verifiable criteria concerning each maturity level
	2.2	Methodology to assess the target group
		Procedure model
		Consulting process concerning the assessment of the criteria
		Consulting process concerning adaptability and criteria configuration
		Experts know-how based on other applications

Table 11.4 (continued)

Group		Design principles
(3) Prescriptive	3.1	Improvement actions for each maturity level
	3.2	Decision calculus concerning the selected improvement actions
		Explanation on the relevant system objectives
		Explanation on the relevant influent features
		Distinction between an external report and the internal improvement perspective
	3.3	Decision methodology focused on the target group
		Procedure model
		Consulting process concerning the assessment of the variables
		Consulting process concerning concretisation and adaptability level of the improvement actions
		Consulting process concerning adaptability and decision calculus configuration
		Experts know-how based on other applications

by prescriptive models since the requirements from verifiable criteria and related methodological assessment were already taken into account by descriptive models.

The desirable relationships and correspondences that an operational maturity model should present (Fig. 11.2) were synthetised by Burnstein, Suwanassart, and Carlson (1996).

Each level deploys on several objectives (sub-objectives) each one focusing a specific KPA. In addition, relevant information concerning the capability of each KPA should be provided. Tasks, allocation of responsibilities, methodological changes, among other, may be adopted to attain the sub-objectives.
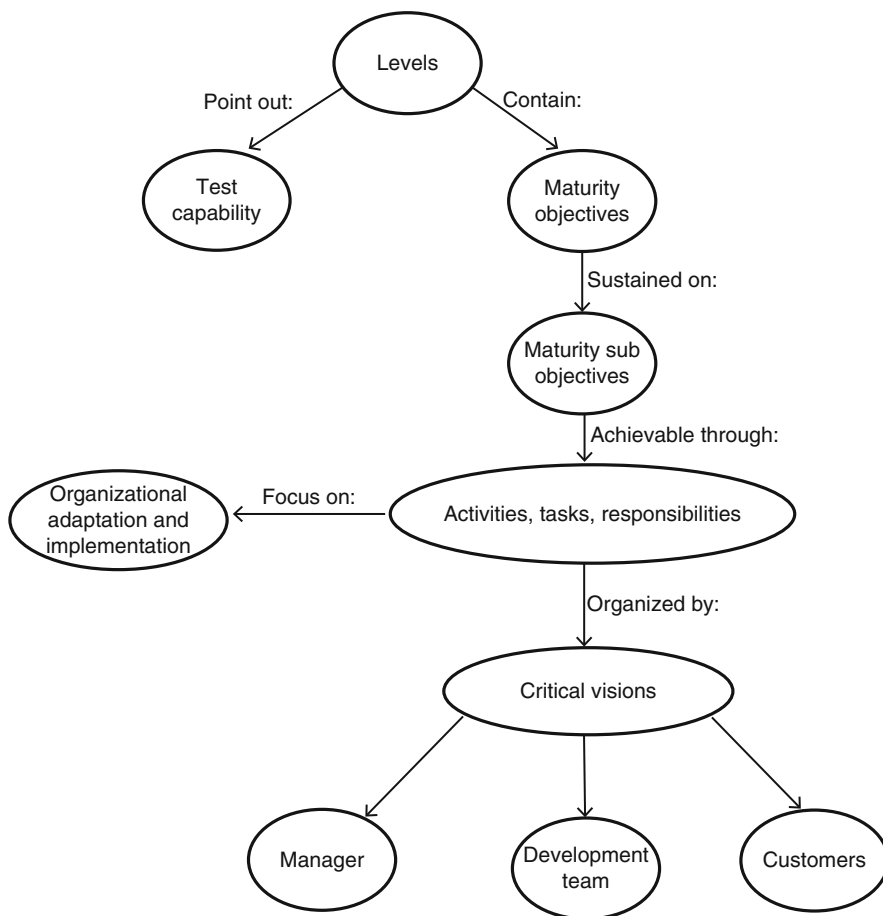
11.2.1.3 Maturity Models Limitations

Several authors pointed out several shortcomings of maturity models such as those listed in Table 11.5 (Becker, Knackstedt, & Pöppelbuβ, 2009). The major concerns relate with the development of maturity models lacked of methodologies commonly accepted by the mainstream scientific community. This leads to the recurrent criticism on the excessive simplification of a phenomenon when compared to its real performance.

Some authors suggest that the minimisation of the above-mentioned limitations may be achieved assuring a continuous and iterative assessment as well a comparison with other adopted models aiming at the same objective.

11.2.2 Integrated Management Systems

Based on several bibliographic sources, such as the ISO Survey, there is some evidence that the number of IMSs is increasing worldwide. This fact relates with the new shareholders to whom the companies fulfil requirements: the environmental

Fig. 11.2 Desirable relationships and correspondences on a maturity model (adapted from Burnstein et al., 1996)

**Table 11.5** Limitations pointed out in the revised literature

Some shortcomings ascribed to maturity models	
Over simplistic when compared with reality	Lack of scientific foundations
Focus on a single path to achieve maturity neglecting potentially advantageous alternate paths	The applicability may be constrained by internal factors (available technology, intellectual property, relationships with suppliers) or by external factors (market position)
There are several identical maturity models	Lack of documentation concerning the maturity model design
The continuous adoption of the CMM (Capability Maturity Model) as a parent model	Generically they are adopted by a company being difficult to implement them in megaprojects

concerns by Society and the occupational health and safety (OHS) of the employees. Historically, after attending the quality requirements demanded by their customers (ISO 9001 certification), companies improved their MSs through environmental (ISO 14001) and occupational health and safety (OHSAS 18001) certifications. In addition to these certifications a great deal is available focusing some sector specific requirements such as the ISO 22000 (food safety MSs), the ISO/IEC 27001 (information security MSs), the ISO 50001 (energy management), the ISO 13485 (medical devices) and the ISO/TS 16949 (automotive production and relevant service part organisations). Hence, it is a subject of utmost importance to assess an IMS, namely, to evaluate the degree of articulation of the various MSs implemented. The efficacy of an IMS may be assessed by answering the question: Are the requirements from the shareholders being fulfilled? Other questions relates with the efficiency: How are the requirements being fulfilled? How many resources are being consumed? Are there duplicity among tasks, procedures and human resources?

A great deal of literature addressed various topics on the matter of IMSs and several reference publications are available. The attained benefits collected from the proper integration of MSs were targeted by the work of Simon, Karapetrovic, and Casadesus (2012), Zeng, Xie, Tam, and Shen (2011), Almeida, Domingues, and Sampaio (2014) and Wright (2000). The major obstacles and drawbacks concerning the IMSs implementation was a topic addressed by the work of Bernardo, Casadesús, Karapetrovic, and Heras (2012) and Beckmerhagen, Berg, Karapetrovic, and Willborn (2003a). Karapetrovic (2002, 2007), Karapetrovic and Casadesús (2009) and Sampaio, Saraiva, and Domingues (2012) discussed the strategies adopted during the implementation of an IMS, whereas the integration degrees were focused by Bernardo, Casadesús, Karapetrovic, and Heras (2008, 2012), Bernardo, Casadesús, and Karapetrovic (2011), Jørgensen, Remmen, and Mellado (2006) and Pojasek (2006). Models to integrate MSs were proposed, among others, by Karapetrovic and Willborn (1998), Renfrew and Muir (1998) and Zeng, Shi, and Lou (2007) and the specifics of the audit function were dissected by Beckmerhagen et al. (2003b), Bernardo, Casadesús, and Heras (2009), Domingues, Sampaio, and Arezes (2011, 2014a) and Kraus and Grosskopf (2008). Recently some lessons learned from integrated management abandonment cases were listed (Gianni & Gotzamani, 2015), the relationship within safety and quality MSs was pointed out (Karanikas, 2014) and MSs integration as a pillar for organisational sustainability was discussed by Mohamad, Abdulllah, Mohammad, and Kamaruddin (2014). Although a large stream of bibliography is available not a great deal of them, if any, concerns with the assessment of the IMS, its features and the level of articulation between its different components.

11.3 Methodology

The methodological path (Fig. 11.3) adopted during the current research enabled the identification of boundaries, limitations and scope of the collected results. The research methodology considered several stages. At first, an exploratory literature review focusing maturity models and IMSs involving the more sound scientific data
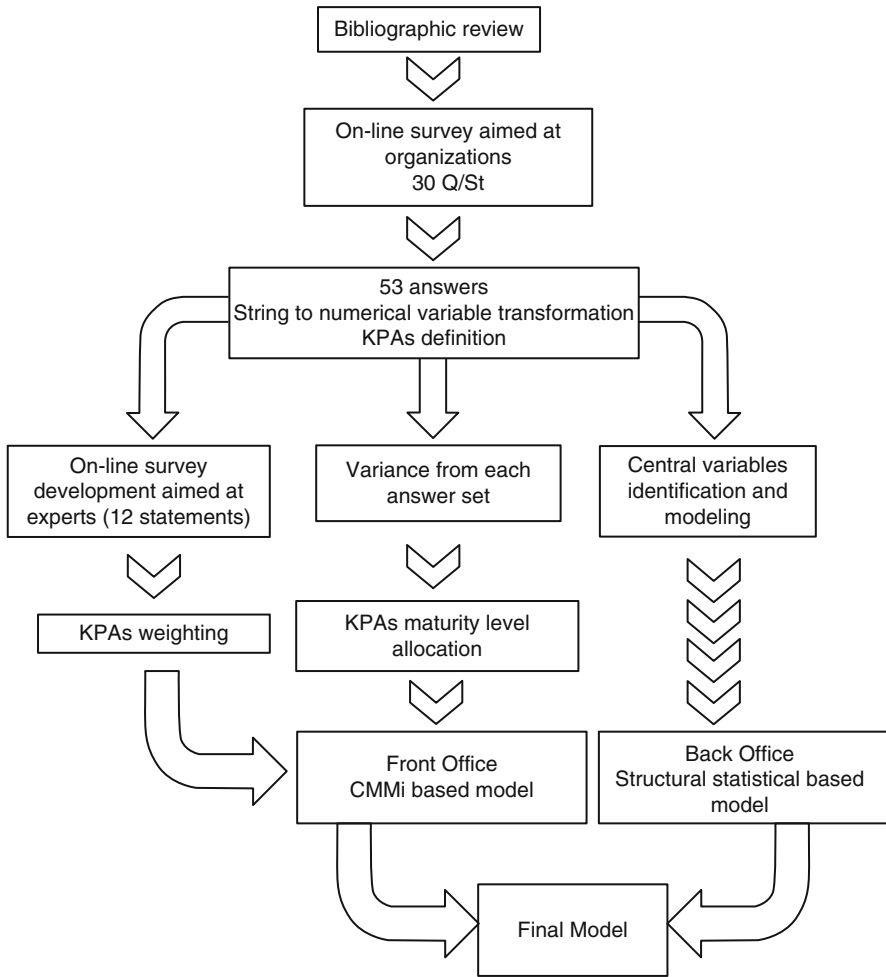
Fig. 11.3 Methodological path

bases and institutions proved to be crucial on the identification and definition of the KPAs. This stage enabled the development of two surveys where the opinions and perceptions of companies' professionals (Survey 1) and academic and industry experts (Survey 2) were taken into account. This latter survey was supported on a 1–5 scale type of answers (1—Reveal minimum integration level, …, 5—Reveal maximum integration level) considering 10 questions/statements (Q/St).

The hereby reported model is supported by two components: the back office and the front office. The back office component is a statistical structured based component expressing the statistical relationships between the variables and taking into account the results collected from the survey conducted amid companies and identifying which of them were the most relevant (Domingues, Sampaio, & Arezes,

2012, 2014b). Based on the results from the companies' survey, a multiple regression linear model enabling the assessment of variables correlation was tested and validated. The front office component is supported by a Capability Maturity Model Integration/ed (CMMi) presenting the conditions and relevant parameters that enable an IMS to evolve till an ultimate maturity level throughout a discrete number of stages. The definition of which KPAs were to be considered by level and the weighing ascribed to each one considered the results collected from the two surveys and some insights from the revised literature. The front office component was designed to be handled by the respondent while the back office component was designed to process the information collected through the front office.

A 15 % response rate (53 valid answers) was attained by the survey conducted among the companies and a 70 % response rate was achieved by the survey conducted amid the experts' panel. Statistical analysis was carried out by IBM *Statistical Package for the Social Sciences* (SPSS Statistics) version 20, *network licence*.

11.4   The Model

Figure 11.4 presents the conceptual diagram expressing the underlying hybrid philosophy inherent to the final model. Similarly to software related 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 IMSs like a monitor enables friendly software user interactions. In the processing unit, i.e., "behind the curtains", the structural statistical component (not accessible to the user) processes all the collected information, considering the relationships and modelling of variables, providing outputs to be displayed by the front office component (Fig. 11.4).

The predictor variables (Q/St10, Q/St23 and Q/St24) constitute the multiple linear regression model with an $R^2_{adjusted} = 0.540$, thus explaining 54 % of variable Q/St25 variation. 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 (Fig. 11.5). The *Pearson* correlation coefficient is displayed at the arrows. Q/St8, Q/St27, Q/St28 and Q/St29 contribute to the maturity level but a meaningful correlation with the predictor variables Q/St10 (Integrated vision by top management), Q/St23 (Integration level classification) and Q/St24 (Audit typology) was not statistically evidenced. The Fig. 11.5 solely presents the relationships between non central variables and predictor variables.

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 with a higher and negative *Pearson* coefficient. As an example, a company that achieve higher scores at the Q/St10, Q/St23 and Q/St24 will output an IMS

Fig. 11.4 Conceptual
diagram (adapted from
Domingues et al., 2014b)
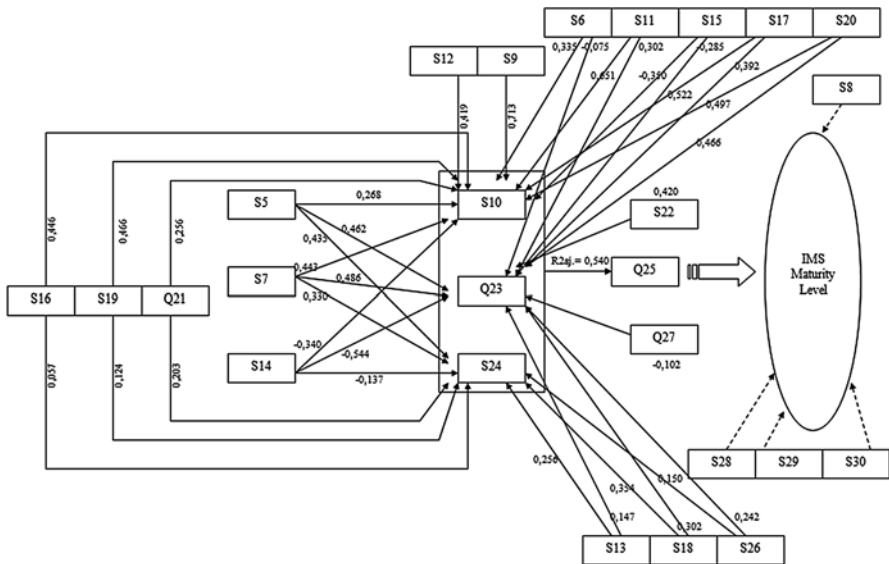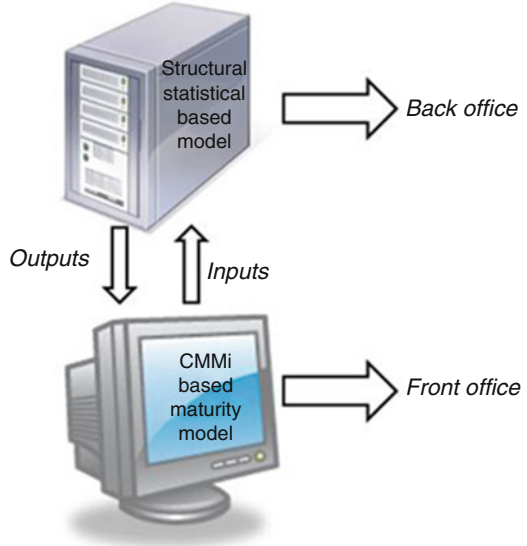
Fig. 11.5 Statistical based structured model aiming at IMS efficiency assessment (back office)
(adapted from Domingues et al., 2014b)

classified as more efficient since it observe the parameters that contribute mostly to
a high integration level and, thus, to the "Maturity level" latent variable. A company
that intends to achieve the same maturity level based on different parameters than
those described by Q/St10, Q/St23 and Q/St24 variables will need more variables
and higher scores.

11.4.1 The CMMi Based Front Office Component Development

The KPAs were sorted by each level (1—Uncertainty; 2—Awakening; 3—Enlighten; 4—Wisdom; 5—Certainty) based on the results variance of the companies survey data set and on the information collected on the revised literature. To each KPA a factor (1–6) was ascribed according to the results from the expert's group survey. The critical KPAs, according to the revised literature, are identified by an asterisk (*). Companies intending to assess the maturity of their IMS, according to the model, should evidence that critical KPAs are fulfilled in order to access to a higher maturity level. Table 11.6 lists the KPAs, their ascribed maturity level and the relative weighing ascribed by the experts group.

Table 11.6 KPAs, maturity level and weighing

KPA	Level	Weighing	Observations
Policies integration	1	X4	KPA1*
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
Organisational tools, methodologies and objectives alignment	3	X6	KPA5*
Perception that the IMS genesis originates organisational interactions	1	X1	KPA6
Non residual authority by environmental and/or OHS managers	4	X4	KPA7*
At least one integrating concept had been taken into account during the integration process	1	X2	KPA8
System bureaucratisation	3	X3	KPA9
Management procedures integration	1	X4	KPA10
Documental integration	2	X3	KPA11
Integrated objectives adoption	1	X5	KPA12
At the organisational structure there is an IMS manager	2	X4	KPA13*
Processes monitoring by KPIs, OPIs and MPIs	3	X5	KPA14
Integrated indicators adoption	5	X5	KPA15
Good correlation between the integrated organisational structure and the integration level perception	4	X3	KPA16
Audit typology	3	X4	KPA17*
Identification of organisational 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*

11.4.2 Allocation of the KPAs by Level

Table 11.7 presents, simplistically, the fundamental justification to the distribution of the KPAs on the different levels. The results variance was classified as follows:

- Low, if higher or equal than zero and lesser than 0.5;
- Reasonable, if higher than 0.5 and lesser than 1.0;
- High, if higher or equal than 1.0.

Table 11.7 KPAs allocation by maturity level

KPA ID	Variance	Level	Weighing	Level justification
KPA.1	0.39	1	X4	Low variance
				Reasonable weighing
KPA.2	0.72	2	X5	Reasonable variance
				High weighing
KPA.3	1.09	4	X3	High variance
				Reasonable weighing
KPA.4	0.51	2	X1	Reasonable variance
				Low weighing
KPA.5	0.68	3	X6	Reasonable variance
				High weighing
KPA.6	0.51	1	X1	Low variance
				Low weighing
KPA.7	0.79	4	X4	Reasonable variance
				Reasonable weighing
KPA.8	0.44	1	X2	Low variance
				Low weighing
KPA.9	1.23	3	X3	High variance
				Reasonable weighing
KPA.10	0.33	1	X4	Low variance
				Reasonable weighing
KPA.11	0.64	2	X3	Reasonable variance
				Reasonable weighing
KPA.12	0.34	1	X5	Low variance
				High weighing
KPA.13	0.44	2	X4	Low variance
				Reasonable weighing
KPA.14	0.84	3	X5	Reasonable variance
				High weighing
KPA.15	0.67	5	X5	Revised literature
KPA.16	0.51	4	X3	Revised literature
KPA.17	0.34	3	X4	Revised literature
KPA.18	0.25	5	X3	Results analysis
KPA.19	0.23	2	X3	Low variance
				Reasonable weighing
KPA.20	0.17	4	X5	Low variance
				High weighing
KPA.21	0.51	1	X5	Revised literature

The weighing was classified as follows:

- Low, if classified as 1 or 2;
- Reasonable, if classified as 3 or 4;
- High, if classified as 5 or 6.

As stated previously in addition to these parameters the distribution was performed based also in the revised literature. The KPA18 was ascribed to level 5 since the data set collected by the companies survey revealed a 55 partition by each answer potential typology. The fact that a company considers that there are several organisational features not susceptible of integration was understood as high maturity level and as a deeper integration. The KPA15, also pertaining to level 5, indicates a high maturity level based on the companies survey results and based on the revised literature. The adoption of integrated indicators reveals that all system monitoring (crucial task) is performed based on organisational features from the QMS, EMS and OHSMS thus revealing a high integration level. Concerning level 4, constituted by KPA3, KPA16, KPA7 and KPA20, it is characterised by the high variance or weighing from these KPAs, or, at least, by a reasonable variance and weighing. The distribution of the remaining KPAs through the lower levels was performed according the same parameters, but in this case, considering a low variance or weighing.

11.4.3 Final Front Office Component Incorporating Externalities and Management Pillars

One of the features emphasised by literature concerning maturity models development is that it should be an iterative procedure. So, after the internal KPAs identification by literature review and by conducting 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 (Fig. 11.6). As displayed by Fig. 11.6, concepts such as successful sustainability, macro ergonomics, life cycle analysis and management and social responsibility were inserted on the model, reflecting their relevance and contribution to the IMS maturity.

MSs integration should be an assurance of sustainability by the company that implement it. An IMS implementation reflects the commitment by the top management with the requirements by several stakeholders, and so, 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 (Mohamad et al., 2014; Rebelo, Santos, & Silva, 2014). Accordingly, a company addressing the sustainability concept evidences a higher maturity level if compared with other company that do not address to this concept.

Macro ergonomics addresses and optimises simultaneously the worker, machine and involving factors through an holistic approach similar to that adopted by MSs integration that addresses and optimises the requirements from several stakeholders (customers, workers and society) (Domingues et al., 2012). The
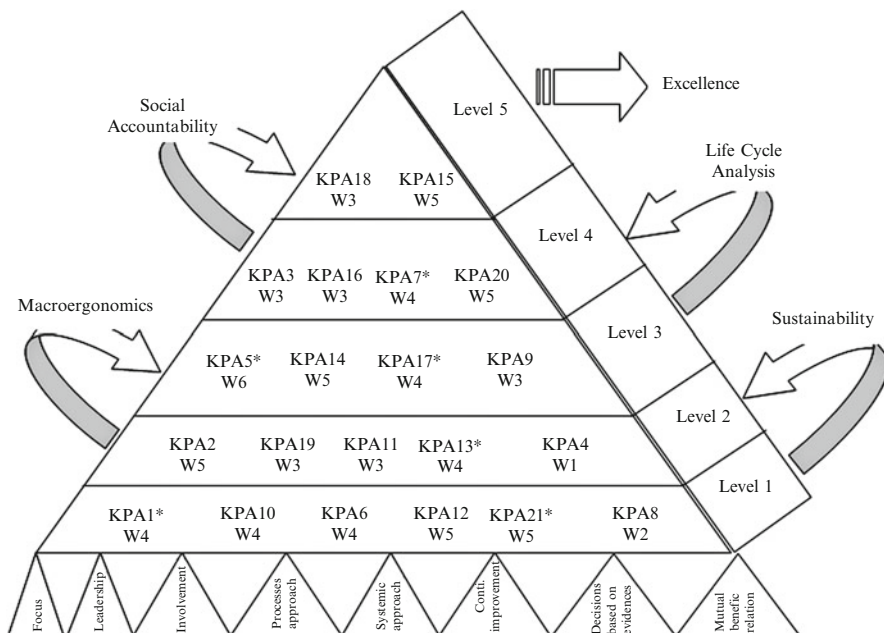
Fig. 11.6 IMS maturity assessment pyramidal version model including externalities and common features to the combined subsystems (adapted from Domingues et al., 2014b)

organisational structure that better suits to an IMS is a relevant parameter and is one of the research topics of macro ergonomics.

Life cycle analysis and management is an organisational tool that enables companies the comprehension the environmental incidences of the materials, processes and those from the products, and the information collected may be used to develop new products and to detect new research and development domains. In addition, several studies relate life cycle management with MSs integration (Löfgren, 2012).

Concerning social responsibility, companies should operate as sustainable development promoters among the society, considering social concerns at a personal and community levels. The eight pillars that should sustain any MS 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.

Concerning the focus one should consider if the IMS is oriented in a way that is able to comply with the requirements from all stakeholders, that is, if all stakeholders are effectively present on the IMS scope. Furthermore, is desirable that the stakeholders be equitably targeted by the IMS.

Leadership, a fundamental concept shared by all MSs, should be validated based on the company organogram and with the responsibility degree affected to each MS responsible.

More than a processes approach, a systemic approach should be highlighted on an integration context. After integration, the boundaries from the initial system expand themselves and one should assess the extension and depth of the management actions undertaken by the IMS. At this stage, system monitoring, policies, objectives and goals definition may be suitable features to validate the systemic approach in an integrated context.

Continuous improvement or more precisely, how continuous improvement is materialised is a critical parameter defining an IMS maturity. The question to be observed is how improvement actions are implemented and managed. Do the improvement actions being implemented solely with the QMS inputs or the other MSs are considered too? Which are the criteria to open an improvement action? Who participate, by defect, in all the activities concerning the implementation and management of improvement actions? These are critical questions to determine if the continuous improvement philosophy embedded in all normative standards is being properly implemented in an IMS, contributing to higher maturities.

Decisions based on evidences take other dimension when in an integrated context. The question that should be putted over the table is in which evidences are the decisions based on, namely, are being considered all the facts from all the integrated MSs?

Finally, other crucial item to consider is if the IMS promotes the establishment of mutual beneficial relationships between the different stakeholders and if equally beneficial relationships are developed between the different MSs that constitute the IMS.

The final CMMi based component considers three dimensions. One dimension reserved to the KPAs that assesses internal organisational criteria. A second dimension deals with external features contributing to the IMS maturity. The third dimension assesses the common management pillars of the subsystems and how they sustain the IMS (Fig. 11.7).

Fig. 11.7 Model three-dimensional nature
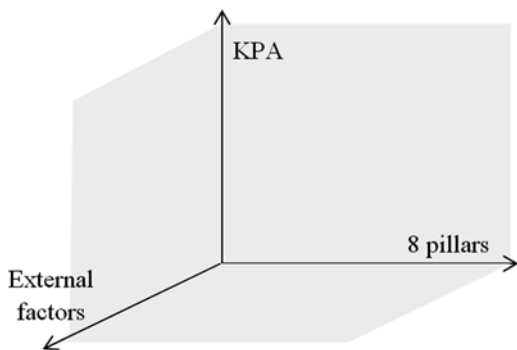
11.5   Conclusions

A hybrid model aiming at the assessment of IMSs maturity was reported considering two components. The back office component is sustained on a statistical based structured model where one may distinguish three variables that, statistically, contribute the most to the latent variable "IMS maturity". This component is not accessible to the end user of the final model being developed for data processing of the collected information provided by the user. Data processing enables the back office component to output information concerning the variables that should be rated higher and the related actions that will be listed by the front office component.

The front office component is based on a CMMi maturity model. This component intends to provide to the end user a graphical interface with an intuitive interpretation and utilisation which complies with the design principles identified on the revised literature. The statistical 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. A tabular grid considering the KPAs and each standard clause (ISO 9001, ISO 14001 and OHSAS 18001) evidences that the main requirements are covered by the developed KPAs. The final CMMi component version considers five maturity levels and a "zero level" that evaluates the evidences 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 current final version of the front office component concerns with external features or externalities that impact on the IMS maturity. Four externalities were identified and inserted on the model: successful sustainability, macro ergonomics, life cycle analysis and management and social responsibility. The third dimension concerns with the identified KPAs. The rise to an upper maturity level occurs only 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. Thus, this CMMi based component has a three dimensional nature sustained on the KPAs, externalities and the excellence management pillars.

To sum up, the reported maturity model 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 end user environment. Additionally, concerning future work, several assessment guides could be proposed with the potential to be adopted as an aid to evaluate some parameters encompassed by the model.

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