ISO/IEC 15504, a Basis for Generally Accepted Sound Process Models in Financial Institutions
A Case Study about Venture Capital Fund Management

André Rifaut, Michel Picard
Centre de Recherche Public Henri Tudor – Luxembourg,
{andre.rifaut; michel.picard}@tudor.lu

Bernard Di Renzo
Process Management Expert
bernard_di_renzo@yahoo.com

Abstract

For the past 3 years, the interest of using ISO/IEC 15504 on core processes of the financial sector (i.e. non-IT processes) has been challenged in Luxemburg by Risk managers, Compliance managers and Supervisory Authorities. Although previous case studies has shown the effectiveness of ISO/IEC 15504 in that context, it was still necessary to find the right way to integrate the use of ISO/IEC 15504 with the sound practices of the financial sector. A practical solution has been provided with a constructive method to design ISO/IEC 15504 compliant process models[1]. This paper describes the method, and reports on a case study[2] concerning the management of venture capital funds. Not surprisingly, our method and the ISO/IEC 15504 standard formalize the current trends of methods proposed to the financial sector to increase the operational assurance in response to the rapid evolution of the financial sector operational risk profile.

1. Introduction

The recent subprime mortgage financial crisis is just one example of major changes in the risk profile faced by financial institutions, in particular operational risks such as the definition of a new financial product that is not sound when launched in the current financial system [32].

In response to that, the importance of sound practices has been addressed by a number of international bodies (e.g. the Basel Committee on Banking Supervision, the Financial Stability Forum) in regulations (e.g. as the "Core Principles Methodology" [3], and [4] for fund management).

Previous research results [15][33][39] have shown that ISO/IEC 15504 compliant models are an effective way to fill the gap between those requirements and their implementation into core business processes of the financial sector.

In the financial sector, there are lots of quantitative analyses, made for each sub-sector, correlating the financial value (e.g. stock exchange market value) of institutions of that sub-sector with critical factors, practices, regulations, or the kind of disclosed information specific to that sub-sector. This work builds on top of that in order to rigorously produce, for each sub-sector, process models that can be used to publicly disclose some information useful for shareholders or other interested parties. One aim of the Banking SPICE ™ initiative [2], is to increase the operational maturity of some targeted sub-sectors of the financial sector, and promote public disclosure of a part of the assessment with a potential increase of the (stock exchange) market values.

We refined our method to constructively engineer ISO/IEC 15504 process models adapted to each targeted financial sub-sector. Instead of addressing only the process models, we focus on each target sub-sector through its main factors in order to ensure a sound integration of the processes and the financial system. The techniques presented are: domain engineering modeling of the sub-sector, integration with audit and internal control standards of the sub-sector, quantitative correlation analyses with financial values (for instance, stock exchange market value) and financial risks of the sub-sector.

Venture capital funds are a specific kind of fund most often set up by wealthy investors that expect high returns (and accept very high risks) by funding, for instance, entrepreneurs of venture start-ups. Some problems arise from the inexistence a venture capital public market (i.e. inexistence of quotations and market volatility trends, no market liquidity, …). [19]

[1] In this paper, the term "process model" is used for ISO/IEC 15504 compliant process reference models (PRM), process assessment models (PAM), or both.

[2] The case study is not related to past and current authors' affiliations. Due to confidentiality constraints the case study is made anonymous.

After summarizing in the next Section our previous research results, this paper explains in Section 3 some important aspects of financial sub-sectors, then, in Section 4, how to adapt the method to these aspects. We present in Section 5 the case study concerning the ISO/IEC 15504 assessment of Venture Capital Fund Management made in the financial fund industry. In the last section conclusions and future works are described.

2. Process Model Engineering

With Project Management and Requirements Engineering techniques, in particular Goal Oriented Requirements Engineering (GORE), the method allows to engineer process models that are verified against ISO/IEC 15504 requirements and rigorously validated against the domain-specific expertise. [33] [36] [15] [37] [35] [34].

The global view of the method is given through a Process Reference Model (see Fig. 1). Our expertise gained through our participation in the construction of eight process models in very different domains (Statistics Management, Internal Control, Financial Fund Management, Accreditation, Knowledge Management, Operational Risk Management, and, of course, the IT Management domain) showed that the techniques used in the method must be adapted to each domain. This motivates the importance of the PRM shown in Fig. 1.

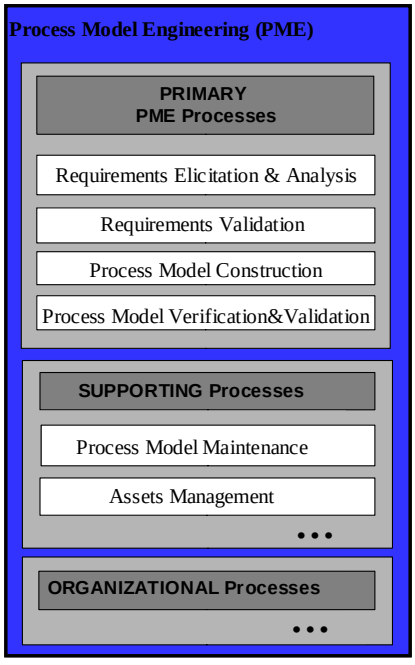

Figure 1. The Engineering Method

As soon as process models address non-IT domains, there is a gap between the ISO/IEC 15504 experts that are mostly IT experts and domain experts. Moreover, the intended usages of the new process models are not limited to ISO/IEC 15504 compliant process assessments. In addition to that the method overcomes acceptance issues of the ISO/IEC 15504 concepts in the financial sector [39]. Process model engineering must be made under a strict project management control, Requirements Engineering techniques must be used to understand the usages of the engineered process models, to model and to validate the domain knowledge belonging to the scope of the models and modeling techniques must be consistent through the complete life-cycle of the process models.

The *requirements elicitation and analysis* process ends with the identification of the main stakeholders, a model of the main usages that will be made with the ISO/IEC 15504 compliant models (often additional needs than pure ISO/IEC 15504 compliant assessment are also required), and a model of the domain concerned by the ISO/IEC 15504 compliant models to be produced (including a model of reference documents used by experts, such as laws, regulations, domain specific standards, and practices, see Fig. 2).

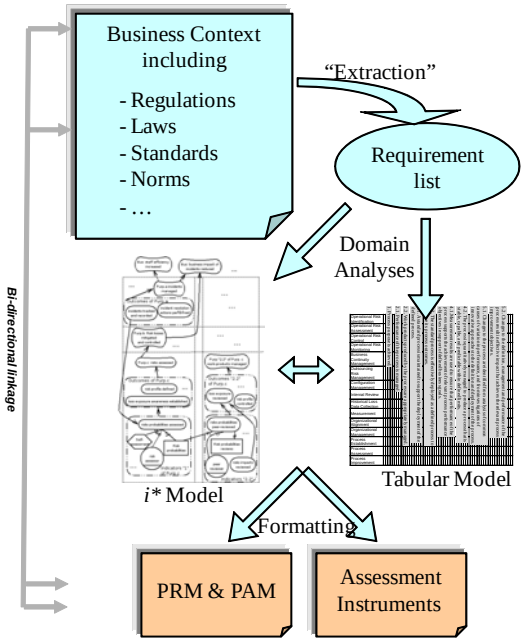

Figure 2. Process Model Engineering

At the very beginning of this process, indicators extracted from the requirements profile are defined to analyze and monitor the risks that can occur during the full lifecycle of the engineered process models. The following kind of indicators are used: the complexity of the domain knowledge, the amount of knowledge needed (i.e. its depth and extent), the maturity of the domain knowledge (e.g. inexistence of best practices and/or benchmarks), the degree of formality of the knowledge (e.g. no written documents), the (un)availability of the

knowledge (e.g. confidentiality of intellectual assets), the existence of divergences between stakeholders, the level of innovation (and acceptance effort needed for the stakeholders), and how much the expected usage of the process models deviates from a ISO/IEC 15504 compliant assessment [36].

Requirements validation and *process model construction* are based on the requirements elicited and analyzed. When *process model verification and validation* are made, one verifies that the engineered process model is compliant with the ISO/IEC 15504 requirements and with other regulations and standards required by the stakeholders, and assesses the adequacy of the engineered process model for its intended uses through trials.

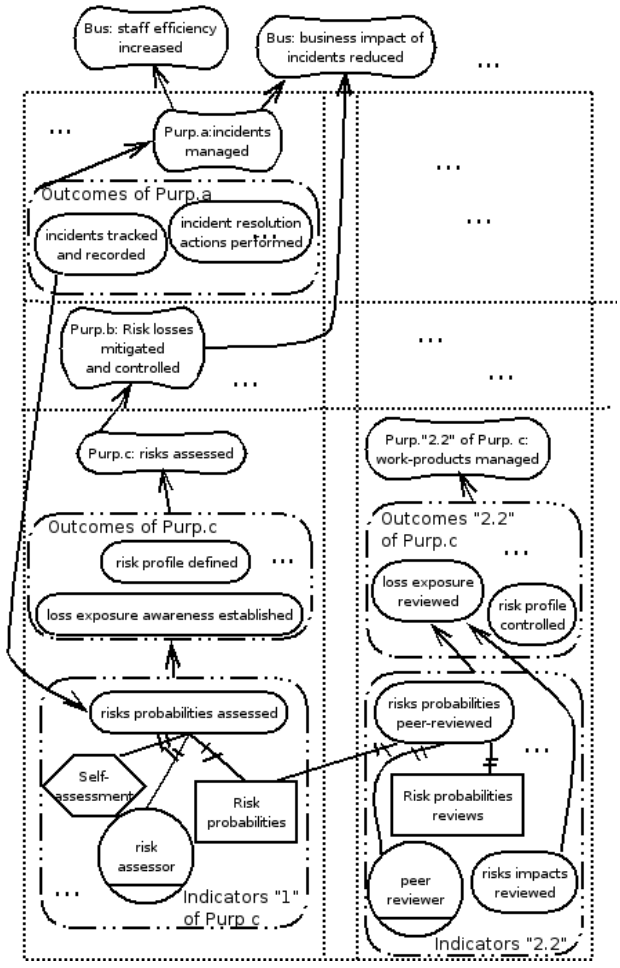

Figure 3. GORE analysis of requirements and process model architecture

In [33] it is explained how to use GORE techniques as a global framework for process model engineering, in particular for the requirements analysis, for the process model construction, and for the process model verification. GORE can model high-level goals, regulations, requirements (and their implementations into procedures and workflows), deviations to goals and risks. [45][46][30][10] (See Fig. 3)

The *process model maintenance* aims to improve the adequacy and the accuracy of the models, and also to adapt the models to a new or changed environment (e.g. a new set of stakeholders, or a new regulatory environment). The *assets management* aims to identify valuable knowledge concerning the process model domain for re-use (or for yet unforeseen uses), and manage the lifecycle of this knowledge. Those two processes are important because, in the financial sector one should not expect to cover the entire financial domain with process models within two or three years. A number of portfolios of process models will be created years after years. So, the asset management strategy must consider the management of process model portfolios. This opens the wide range of problems for getting a correct integration of all process models across the portfolios. The GORE method advocated in [33] provides a first answer to this with an example analyzing the integration of IT Service Management models (first row) and Operational Risk Management models (last 2 rows). (See Fig. 3.) [39]

3. Sound Financial Risk Management

3.1. Financial performance

When introducing new methods in the financial sector, one of the main acceptance factors is the impact on the financial performance.[3] One typical financial performance indicator is the stock exchange market value. The correlation between stock exchange market value and the use of methods based on maturity models has not been addressed yet. However, in the financial sector, this becomes an interesting area of research [16], in particular, the relationship of stock exchange market value with disclosed information concerning the maturity of critical processes. One of the most striking examples is the current use of assessment of the enterprise risk management (ERM) [17] processes by Standard & Poors for defining the rating of financial institutions [43] and the ERM maturity model of RIMS [40]. (Those maturity models are not standard, but find their roots in [13]).

For each financial sub-sector, one has to model the processes having an impact on market value through the disclosure of some information of the process assessment.

[3] Most often, correlations (and not causal relationships) are analyzed in the international financial system. The term “impact” should be read as “correlated events”.

The impact on the stock exchange market value through information disclosure is also an aim of the regulation on operational risk management processes (see Pillar III of Basel II [15][14]). This regulation imposes a public disclosure concerning the operational risk management, including the quality of the operational risk management processes: "capital should not be regarded as a substitute for addressing fundamentally inadequate control or risk management processes" ([5], p. 158). The ISO/IEC 15504 compliant model of operational risk management [15] has been developed with the Luxemburg' Supervisory Authority of the financial sector in response to this regulation. Increasing the market value of Financial Institution and their service providers through the public disclosure of part of ISO/IEC 15504 assessment reports is one aim of the operational risk management model, which is the first model to be introduced into the Banking SPICE™ initiative.

Concerning the financial impact on the use of maturity models, an overview of works shows that the correlation with the stock exchange market value has not been made [21]. However, the impact on operational performance is more extensively studied. Some concrete coupling between the use of maturity models and the financial performance of an institution has been made through the Balanced Score Card approach [22] [44].

3.2. Compliance

At the international level, and at some national levels (such as UK, Canada), there is a strong trend to go from prescriptive regulations (also called "rule-based" or "red tape") into more principle-based regulations (also called "smart tape"). This trend concerns supervisory authorities, auditors, risk managers (see e.g.[6]). Even accounting and reporting regulations, since long being at the core of financial sector processes, are being challenged to be transformed into principle-based regulations [7].

The ISO/IEC 15504 standard is well adapted to this trend of principle-based regulations due to its independence from system implementations. *However, it has to be noted that, although principles are clear, their expression into a process model, which is an "operational" formulation of those principles, is not straightforward.*

GORE is appropriate for both principle-based regulations and standards. In the case study of Venture Capital Fund Management, during the requirements elicitation and analysis process, it has been necessary to model principle-based regulations, rule-based regulations, high-level goals, procedures and risks. The main standards and regulations are the BIS recommendations [4], the IFRS IAS-39 [24], and professional associations standard internationally recognized [19]. Both BIS and EVCA recommendations are principle-based, whereas the IFRS IAS-39 is rule-based.

3.3. Internal Control and Audit

The internal control and audit aspects are also a main part of financial sector regulations. Current works made by Committee of Sponsoring Organizations of the Treadway Commission (COSO [11]) stresses the importance of quality of the internal control: "Internal control systems exist to help organizations meet their goals and objectives. They enable management to deal with changes in internal and external environments. They also promote efficiency, reduce the risk of loss, and help ensure financial statement reliability and compliance with laws and regulations (…) organizations need a mechanism for assessing the quality of their internal control systems' performance over time. That mechanism is monitoring." ([12], p. 7) Works has been done in this area showing that the ISO/IEC 15504 is appropriate to define the maturity of the internal control [9][25].

However, for any core business process of financial institutions, the ISO/IEC 15504 compliant models must be tightly coupled with internal control requirements.

3.4. Financial Product Innovation

Financial product innovation starts often with a model of the product based on mathematical analysis techniques (including probabilities and statistics) where the financial risks are assessed. When putting in operation the financial product, operational risks are introduced. A study ([28]) has shown that misspecification errors have a greater impact on financial value than the error made when estimating a risk on top of a model validated on past data. So, it is important not to use an inappropriate model, and accordingly, not to implement an operational system misrepresenting the mathematical model. ISO/IEC 15504 compliant process models are a first abstract representation of the operational system to be implemented, that process model must fairly implement the mathematical model.

In addition to that, the operational risk profile of financial institutions increase because they create new financial products that are not well understood. So, the knowledge to be introduced into the ISO/IEC 15504 compliant models is often difficult to extract.

Moreover, as already mentioned in our previous works [39], one very important problem to address is the lack of process-orientation in core business function and departments of most of the financial institutions.

Taking into account those weaknesses that can be found in the financial sector is an important aspect for the successful design of ISO/IEC 15504 compliant models.

Rigorous methods for overcoming those difficulties have still to be found. Indeed those difficulties are not found when dealing with ISO/IEC 15504 compliant models concerning the management of the development, deployment and operation of IT systems: those models are more mature, the stakeholders involved into the definition and assessments of those models have a better working knowledge of the process-orientation and most of the time, the software engineering *management* is not strongly related to mathematical models to be put into operation.

4. A Rigorous Engineering Method for Generally Accepted Sound Process Models

To gain acceptance by the financial sector at an international level, we improved our method to address the issues discussed in Section 3.

4.1. Domain Engineering

In order to get a coherent set of requirements of the financial sector, domain-engineering techniques are used. Those techniques aim to abstract details in order to analyze families of software tools used in the domain. This is a promising research area that helps to get a complete and consistent model of stakeholders, processes, management of organizational aspects, supporting technologies, and rules and regulations. [8]

In our case studies, we have already identified with domain experts the following characteristics of ISO/IEC 15504 process models that improve the acceptance of domain models: first the clear separation of concerns (assessment goals versus implementation details; specific aspects versus generic aspects); second the experts can still use the models without tool support (due to the objective judgments that can be made on outcomes, which are well-known concepts used by auditor, compliance officers, supervisors, and also, credit and fund managers).

Based on those characteristics, first results are presented in [37] showing that tabular notations like those used for defining safety-critical systems [23] are appropriate in the financial sector, in complement to the usual graphical representation of GORE models. The tabular notation has one row for each process and one column for each attribute. In Fig. 3, each cell has been filled with the graphical notation. Rows can further be subdivided into outcomes and indicators. Those notations are more appropriate for a systematic construction of models, and for completeness, consistency and ambiguity checks.

In the Venture Capital Fund Management case study, the risk analysis follows the two separations of concerns and the judgments about the identified operational risks are made in relationship to outcomes.

4.2. Acceptance

A high acceptance level of the process models is required to address the compliance, audit and innovation aspects of the financial sector (Subsection 3.2, 3.3, and 3.4). Conforming to internal control standards is a major acceptance factor. Our current research shows that COSO generic control objectives can be mapped with the attributes of the PAM (levels 2, 3, 4, and 5). An example of relationship of ISO/IEC 15504 Level 2 Attributes (containing a.o. the requirement that "resources and information necessary for performing the process are identified, made available, allocated and used") with COSO is the following: we further require, along COSO, that "information necessary for performing the process is accurate, timely made available, and allocated only to authorized users".[4]

Acceptance is also addressed in the requirements engineering elicitation, requirements validation, and the process model validation, in particular, ensuring the traceability to regulations and standards with the GORE method. Improving [33], we require that the following information have to be traced.

- First, at the domain expertise level, the risks (Sec. 3.1 and hereafter, Sec. 4.3), the content of regulations and standards, expert judgments about those regulations and standards (see e.g. [24]), current practices and related concepts (e.g. internal control templates, Basel II risk database categories)
- Second, the following design decisions: the process assessment architecture, the conceptual consistency of each process (e.g. concerns, timeframe, competencies), each process' interfaces (with other processes).

Traceability to other analyses can also be added, such as divergences and/or intentional dependencies between the stakeholders of the process [45], typical sets of roles and responsibilities for ensuring the reliability of the processes (by, e.g., separation of duties, redundancies) [20][38].

4.3. A financial and operational risk-based approach

[4] Additional research is needed on this topic because those additional generic requirements might be more difficult to assess than ISO/IEC 15504 compliant PAM.

A risk-based approach ([17], [31] and [42], [41] for a risk-based GORE technique[5]) has been introduced, mainly during Requirements Engineering & Analysis and during Process Model Construction.

First, factors having an impact on the financial risks are collected. For our case study, the set of processes concerning the valuation of venture capital was the most critical for the financial value [29]. Indeed, information (quantitative and qualitative) related to the valuation is useful for the fund strategy management, contract management between the fund manager and the fund partners, and also for compliance purposes to accounting regulations.

Second, within the scope of venture capital valuation, two risks encompass the main financial impacts (see Fig. 4) [19]: valuation not consistent with the potential market and non-independent factors biasing valuation.

Extracting those risks is not easy. Indeed, this information is rarely explicitly addressed into principle-based (or rule-based standards) and regulations. However, it is easier to validate the main risks with principle-based regulations: in Fig. 4 the risks are related to the principle of using Fair Value for valuation.

Rarely, details about this risk analysis are found inside the main documents presenting a maturity model. However, for instance, in the eSCM series of models [18] one can see the importance of this information both for the design and for the correct use of the model.

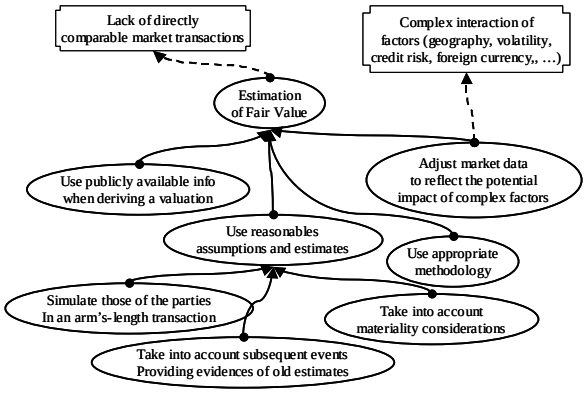

Figure 4. Risks related to goals

In addition to the preceding exogenous risks, one has to address the endogenous risks (i.e. operational risks) during the "process model construction" by using the ISO/IEC 15504 attributes integrated with the generic control objectives of [11] (as explained in Sec. 3.3). For instance, the valuation methodology (and its corresponding mathematical model, see Sec. 3.4) is different according the investment maturity (at the early stages, valuation is made at costs, then a fair value approach is used, and at later stages, just before the initial public offering, the valuation is based on stock market values of comparable assets). So, operational risks of the goal "use appropriate methodology" (right of Fig. 4) can be managed with level 2 attributes of work product management (e.g. definition of work product requirements, and work product review).

As can be seen, the risk-based approach is structured according the ISO/IEC 15504 concepts. *One can systematically spot operational risks and relate them to the financial risks found at process level and at the processes assessment architecture level.*

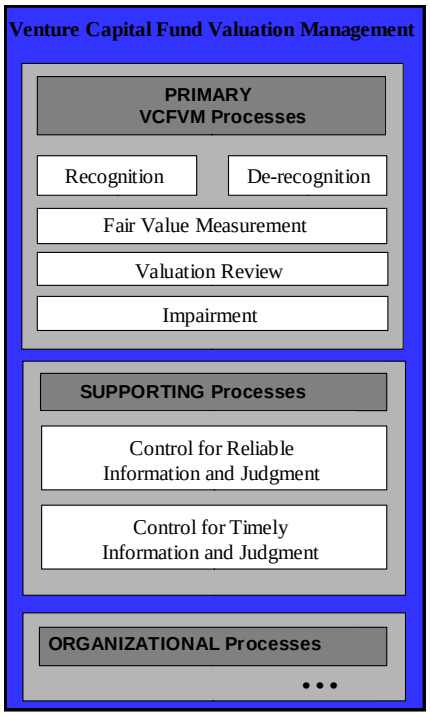

Figure 5. Venture Capital Fund Valuation Management

In our case study, the two most critical "endogenous" risks that have an impact on the financial performance are found in a quantitative analysis (benchmark) of venture capital fund: the fund valuation is not accurate (i.e. reliable) or not up-to-date (i.e. not timely valuated) [27]. As explained in Subsection 3.3, these two risks found in COSO [11] are related to the ISO/IEC 15504 Level 2 Attributes. Due to the importance of timeliness and reliability, two support processes have been added to the

[5] In a GORE a risk is defined just as a potential (negative and/or positive) deviation from a goal.

venture capital fund process model. Our risk-based approach guides the process model architecture.[6]

5. Assessment of Venture Capital Fund Management

The model was build with the method presented in the preceding section. The main processes (Fig. 5) are the recognition and de-recognition (i.e. including or excluding a venture capital for being fair-valued), impairment (i.e. decreasing the value of a venture capital), fair value measurement and review of the valuation. The two support processes reinforce the assurance of the timeliness and reliability of the valuation judgments.

Process ID	**VARE**
Process Name	**Valuation Review**
Process Purpose	The purpose of the valuation review process is to write a fair valuation statement based on a sound valuation judgment.
Process Outcomes	As a result of successful implementation of the Valuation Review process: 1. Information needs for the valuation judgments and information needs for the assessment of the fairness, accuracy, reliability and timeliness of the information are defined; 2. Valuation judgments are made on the basis of fair, accurate, reliable and timely information, and on the basis of a reasonable assessment of those aforementioned qualities (i.e. fairness, accuracy, reliability and timeliness); 3. Evidences sustaining the valuation judgments are produced; 4. Valuation statements are made accordingly to the results of the valuation judgments.

Process ID	**CORI**
Process Name	**Control for Reliable Information and Judgment**
Process Purpose	The purpose of the "Control for reliable information and judgments" process is to assess and monitor the reliability of the information about the fund, and the reliability of valuation judgments and statements.
Process Outcomes	As a result of successful implementation of "Control for reliable information and judgments": 1. Information needs for being able to collect reliability evidences (used for assessing the reliability confidence level) are defined; 2. Evidences showing the reliability (or reliability strengths or weaknesses) of the information and of the valuation judgment and statement are identified; 3. The confidence level of the reliability of the information and of the valuation judgment and statement is assessed.

Process ID	**COTI**
Process Name	**Control for Timely Information and Judgment**
Process Purpose	The purpose of the "Control for Timely Information and Judgments" process is to assess and monitor the timeliness of the information about the fund, and the timeliness of valuation judgments and statements.
Process Outcomes	As a result of successful implementation of Control for timely information and judgments process: 1. Information needs used for being able to identify the events, to assess their impact and to select mitigation actions are defined. 2. Events that had an impact or will have an impact on the timeliness of the information and of the valuation judgment and statement are identified; Note: past events as well as foreseen events must be considered. 3. The impacts on the timeliness of the information and of the valuation judgment and statement are assessed; 4. Non-timeliness mitigation actions, in accordance to the impacts of the identified events, are defined

Figure 6. Purposes and outcomes of the assessed processes

[6] Further works has to be done for being also a rigorous means to produce organizational maturity models [26].

The assessment was made with the risk management back-office and across three different front-offices sub-department. Each sub-department searches new venture capitals to add to their funds according to each fund strategy. Due to difficulties of acceptance of the ISO/IEC 15504 standard, a one-day tutorial has been made for all managers (including the compliance officer and IT manager not belonging to the assessment scope) and sufficient time was left between each step of the overall project (process engineering and assessment).

We assessed the processes shown in Fig. 6 with 6 interviews. In addition to being the most critical process, the valuation review process has been selected because it jointly involves all front office managers and the risk managers (in particular, for the final judgment about the fund value). The (confidential) results confirmed that the collaboration between the front-office and back-office was very tight during the review process, however conflicts of interests existed between core front-office activities (measured by front-office KPI's) and the valuation review process perceived as a back-office concern. Moreover, concerning the attributes (2 and 3), for each department, the number of identified weaknesses increased according to its creation date (i.e. the oldest has the most weaknesses).

6. Conclusions and Future Works

This paper has shown how to adapt the rigorous method for process assessment engineering to the specificities of the financial sector. Our method allows to "constructively" engineer the process models corresponding to the main critical aspects of a sub-sector. The risk-based approach, the identified information to trace and the adaptation of domain engineering to the ISO/IEC 15504 characteristics improves the acceptance of the models. Those results have been illustrated in a real-case study: the ISO/IEC 15504 compliant assessment of Venture Capital Fund Management.

Works is in progress for improving the soundness of the models through a deeper analysis of the relationship between ISO/IEC 15504 attributes and COSO framework generic control objectives.

More and more principle-based regulations are issued in order to increase the consistency of national and international regulations. Future works will be done in order to handle the different regulatory contexts (such as harmonization, standardization, normalization, reconciliation, and mutual recognition [1]) increasing the consistency of the regulations.

Works will also continue with case studies in order to relate process models with the mathematical models used in Financial Institutions, for a better understanding of the operational risks.

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