Conceptualisation of an internal control information system for
electronic invoices

Osvaldo Nuno Pereira Silva
Instituto Superior Técnico
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osvaldonpsilva@gmail.com

ABSTRACT

Avoiding accounting errors is important to ensure quality information for proper management of companies. With the development of new forms of document transmission by digital means, such as electronic invoices, the need for paper support may no longer make sense. However, neither the existence of electronic invoices, nor the automation processes of their formal validity, guarantee, by themselves, the elimination of errors, namely in accounting.

This study aimed to propose a conceptual model of an automated internal control system for supplier’s electronic invoices that meets the business validation objective, with the potential to prevent subsequent errors. It was evidenced that it is possible to design automatisms for internal control purposes, properly monitorable and comprehensive, based on the electronic invoice together with other elements present in business information systems, improving effectiveness and efficiency in error prevention and enhancing an improvement in data quality.

It was concluded through demonstration with a semi-functional prototype and evaluation through tests, complemented with concept validation through a focus group with potential IS users, that the proposed artefact has validity. However, there are limitations to make the model usable in a real context, since it is necessary to guarantee and provide the internal business and B2B processes with elements that allow communication and automated processing in the IS, highlighting, in the case of supplier’s electronic invoices, the adequate referencing of purchase orders and products.

KEYWORDS
Accounting Errors, Conceptual Model, Automated Internal Control, Accounting Information System, Electronic Invoice

1 Introduction

Digital transformation is currently an universal theme, with relevance in many aspects of most economic activities. The area of business accounting is no exception. The effects of the digital era on this activity are relevant, not only due to the automation of tasks using the new information technologies available, but also due to the impact on the most directly related professions [1], such as accountants and auditors. Is being a concern all over the planet, including the encouragement of academic research to search for proactive responses to digital technology changes [2]. The effects on accounting are complex, involving changes in processes and this has an impact on companies. Within this reality, in the context of commercial transactions, physical documents have been giving way to dematerialized forms of documentation, such as electronic invoices. The current perception is that the use of digital documents between companies will tend to enhance automation [3]. The introduction of digital or electronic invoices alone does not solve problems with potential accounting errors. These errors can occur in the way data from such documents are handled, processed and integrated into the accounting records. The potential and increasing use of electronic invoices has been a subject of study in the field of automation. The use of new technologies and the improvement of information systems, in particular the automation of the internal control system, is a factor that can contribute to the detection and consequent reduction of accounting errors [4].

Thus, it becomes relevant to understand how the digital system can reduce errors in the registration of electronic invoices, and in the area of information systems no reference models in this sense were found in the researched literature. The purpose objective of the study was to realize an artifact in this sense: to propose a conceptual model of an automated internal control system for supplier’s electronic invoices.

2 Initial literature review

To frame the object, theme and research question of the study, a literature search was conducted, summarized in the terms described below.

2.1 Accounting errors

The accounting system is an information system, and information can contain errors. Accounting errors are almost inevitable and inherent to accounting itself [5]. Errors are a constant of human activities, and accounting is one of these activities [6, 7]. The maintenance of accounting records is followed by the appearance of errors [7, 8].
Christensen points out that errors are important and often overlooked when evaluating the design of accounting systems [5]. Accounting mapping is a linear construct, and linearity results in structural errors. The system designer can counteract this by applying attribution mechanisms.

According to [7] the main areas that can influence the quality of accounting information are data falsification, accounting policy and information systems. The quality of data contained in accounting information systems has a significant impact on internal and external compliance [9]. According to [6] the detection of accounting errors cannot depend on chance or accidental discovery.

The average number of accounting errors is higher in weak internal control systems than in strong systems [10]. An equally important and effective tool to prevent errors and fraud is internal control [8, 9].

The study of [11] evaluated the impact of information technology (IT) deficiencies on financial reporting and the findings suggest that companies with IT control deficiencies report more internal control (IC) deficiencies. The adoption of effective IT controls, provides important benefits to the entire company or organization [4].

Anderson and Lanen highlight how the introduction of EDI affects the relationship between complexity and performance [12]. They concluded that EDI technology has improved the performance of administrative work and that error feedback has implications for the design and implementation of new accounting information systems.

Common errors associated with the issue of invoices result from poor records or inaccuracies in information systems (IS). The use of new technologies and the improvement of information systems, in particular the automation of the internal control system [4], is a factor that can contribute to the prevention, detection and consequent reduction of accounting errors.

2.2 Limitations on the digital system

In the study of [13], it is suggested that most companies agree with the statement that electronic invoicing reduces costs, saves time, increases storage efficiency and allows better control of their processes. But more than half of the companies do not agree with the statements that it is more secure and causes fewer errors [14] identify some of the main problems during digitisation in the procurement process, although they also point out positive aspects.

In [15], the research combines empirical and conceptual qualitative approaches in order to propose a new maturity model that supports the implementation of electronic invoicing processes. Although one would expect that for example EDI would increase productivity by transferring data entry tasks at the customer originating from suppliers, suppliers only remain "interested" because of the business relationship [12]. The identified limitations arise from how to treat digital documents, ensuring maximum automation without errors. It is therefore relevant to evaluate how to optimize the implementation of electronic invoices, for example, as mentioned in [15]. If, on one hand, the use of digital documents can contribute to some automation, on the other hand, it is not easy to ensure quality and total accuracy when integrating them into accounting systems [14].

2.3 Detection of errors and automatic error correction

Repetitive and monotonous tasks are still a relevant part of accounting work. According to [17] due to the lack of standardization, the task of classification of invoicing entries for accounting purposes has not yet become fully automatic, proposing a platform, designed to adequately address this issue by adaptive meta-learning.

In [18] a machine learning based method is proposed for the detection of abnormal behavior in electronic invoicing system to detect abnormal data from the vast number of electronic invoices. A pointed aspect addressed in machine learning models, is the problem of anomaly detection in accounting entries that represents a critical challenge for accountants and auditors [16].

A common factor in any of the machine learning models is the need for historical data taken from invoices [16, 17, 18], which tend to be easier to take from structured files such as electronic invoices ("XML invoices" as mentioned by [16]), and the accuracy of the models will tend to benefit from the quality of the data.

It is concluded here that accounting errors and their control and detection come from the quality of internal control as emphasized for example in [8, 10, 11]. There is an interconnection between internal control and IT control [11]. Although in the area of information systems no literature clearly referring to the automatic detection of accounting errors has been identified, the reference to the relevance of the problem of detection of anomalies in accounting originating from wrong business transactions is emphasized. It should also be noted that in machine learning models the data source is relevant, so that sometimes it involves some work to adapt and format the data to be worked with (the so-called pre-processing), in order to obtain "clean" or quality data, as observed in particular in the models of [16, 17].

The need for error regularization is something focused on the literature indicated on accounting errors, given the implications on the quality of information. However, regarding to information systems, no adequate literature was found to answer this part of the issue of automatic error correction.

3 Methodology

The research methodology followed was the Design Science Research (DSR) which is embodied in the creation of artifacts, in this case in the area of information systems [19].

The objective was to create an artefact in the area of information systems, in this case, a conceptual model of an automated internal control system for supplier’s electronic invoices that seeks to understand and answer the problem of how the digital system can reduce errors in the registration of digital invoices.

DSR is an applicable possibility in the research area of accounting information systems according to [20], where in part the proposed artifact is.
Considering the model of the DSR process proposed by Peffers [22], in six activities/steps applied in our work we can describe it as follows:

Step 1, problem identification and motivation, as a result of the literature review described in section 2, concluded as follows: no reference models were found in the researched literature on how the digital system can reduce errors in the registration of electronic invoices.

Step 2, the study of the solution's objectives, in which possible solutions are sought to solve the problem, either as a result of the initial literature review or the literature framing the concepts - see section 2 and 4;

Step 3, development of conceptual model proposal, in order to solve the problem - see section 5;

Step 4, demonstration, by building a simulation artefact of the proposed conceptual model - see section 6;

Step 5, evaluation, in which we seek to observe and measure how the artifact corresponds to solving the problem - see section 6;

Step 6, communication, corresponds to the conclusions expressed in the dissertation document and in this document.

4 Concepts of internal control and IT applicable in information systems

Following the conclusions drawn from the initial literature review researched, some points to be taken into account in the search for bases to frame the solution to answer the question of how the digital system can reduce errors in the registration of digital invoices were identified. Once the goal was identified and in order to search for bases for the solution, it was sought to identify literature that would frame some concepts and relevant factors to be taken into account to develop the conceptual model proposal.

4.1 Accounting information systems and internal control

An accounting information system needs internal controls and is relevant to the internal controls themselves. According to [22] it is relevant to achieving internal control objectives: designing effective control systems that take a proactive approach and, introducing controls into a system at the early design stage than adding them after the fact.

Internal controls can be classified into three relevant functions [23], preferably any internal control system should have a combination of these three types: preventive, detective and corrective.

The main IT-related controls are typically defined at two levels as mentioned in [22, 23, 24]: general controls and application controls.

It was concluded that one of the relevant risks identified is related to processing integrity, and the controls to be implemented should be proactive, inserted in an early design phase, ensuring the prevention and detection of errors, being framed at the level of the so-called application controls.

4.2 Processing integrity checks and their monitoring

The controls aimed at processing integrity can be briefly described as: input controls, processing controls, and output controls [22, 23].

Input controls are intended to prevent or detect the entry of any inaccurate, incomplete or invalid data in order to avoid incorrect output [22, 23]. There are several possible input checks, which will be usable according to the source and the intended objectives in order to avoid errors. Many input checks also serve as processing checks.

According to [23] during the ongoing operation, management should receive regular reports on the performance of the computer system. These records make it possible to find patterns of errors and take action to correct erroneous procedures or the application software itself.

Many automated control monitoring tools function as controls and simultaneously provide monitoring information about the continued operations of other controls [24].

Thus, it is concluded that processing integrity is ensured by rules of various types, which can be used in data entry and/or in processing. Besides control activities, monitoring is relevant. During ongoing operation managers should thus receive regular reports to monitor the performance of the computer system and simultaneously monitor internal controls.

4.3 Electronic invoices and integration into information systems

The European definition given by Directive 2014/55/EU is that an electronic invoice (e-invoice) is an invoice issued, transmitted and received in a structured data format allowing its automatic and electronic processing by machine. They do not include a visual presentation of the invoice. The purpose in automation is not to display a visual presentation, except in irregular cases [25].

To enhance the use of electronic invoices, if issuing and receiving entities implement quality control rules based on the same standard and semantic model, they may ensure that their documents are not rejected during their validation (by machine) in the receiver [26].

The pre-entry check is an essentially technical "quality" assessment of the data structure, which, although it enhances subsequent machine procedures, does not by itself guarantee full invoice conformity, since it aims in particular at validating the form but not the substance of the invoice. Substance validity refers to the correspondence of the invoice to a valid commercial transaction, i.e. at business level.

5 Development of a Conceptual Model proposal

In order to seek, in the context of information systems, to identify ways to enhance the use of electronic invoices, in an automated way, reducing errors, particularly with accounting impact, we formed an informative base in the literature that allowed us to contextualize an idea of how the digital system can reduce errors in the registration of such invoices. The type of rules that can be applied, and how they can be adapted in the implementation of an artifact embodied in a conceptual model of an automated internal control system for supplier’s electronic invoices of goods and services, and thus make an exploratory study for this purpose.

5.1 Contextual framework

In order to integrate a digital invoice into an information system automatically, it must first be machine-readable. There is
therefore a need to be able to extract structured data from the invoice. In this context, an electronic invoice (which by its nature consists of structured data, for example based on XML-type markup languages) could be a mean to serve such a purpose.

In the model recommended in the Portuguese example of the Electronic Invoice in the Portuguese Public Administration (hereinafter referred to as FE-AP), the CIUS-PT (Core Invoice Usage Specification – Portugal), particular emphasis is placed on the pre-processing phase of an electronic invoice, a technical validation made by a machine concerning file format aspects.

For business purposes, and subsequently for accounting processes, validation of the form alone will not be sufficient, but there is a need to also validate, in a more in-depth manner, the substance of the form, i.e. to validate that the invoice refers to a valid commercial transaction.

Business validation traditionally relies on a manual data matching check, however, considering the structure of the information inherent to electronic invoices, it is possible that business validation can also be performed by machine.

We started from the contextual premise that the quality control of the structure, according to syntactic validation rules (structure according to a schema) and semantic and functional (format and type of data in the fields), was performed. We focus then on the model in the internal control phase (business validation with technical resources) advocated here, which aims to expand the context of functional/business rules, and which seeks to translate into the scheme described in Figure 1.

5.2 Context of general requirements

Based on the observation of a traditional purchasing process, we can see that for the authorisation (validation) of an invoice for payment, the information base is the reconciliation of information from the purchase order (order) and the receipt record.

The basic idea was to transpose the objectives and elements of the traditional control processes of a supplier invoice, supported by paper or equivalent, replacing the manual with the machine using automated controls.

In the model we sought to extend, in a digital environment, the elements controlled on a supplier electronic invoice, in an automated way, in order to reduce human intervention at this stage, assuming the existence of informational elements generated in other processes (e.g. purchase orders, delivery confirmation records, accounting), which allow reducing the need for manual checks, and serving the purpose of validating the content of the invoice.

For the purposes, there are two fundamental requirements to take into account: 1- The invoice must reference at least the unique identification of the purchase order (the internal number assigned by the customer); and, 2- The invoice must reference the customer's product identification code.

The model of application requirements to be developed is contextualized as represented in figure 2. It thus implies having the following characteristics: a data model, the application of verification rules, reportable in views and reports, supported on an appropriate interface.

![Figure 2 - Diagram of specific application requirements to be developed](image)

5.3 Internal control process proposed

The process, as generally contextualized in figure 3, fits the validation phase in the business scope. This is a validation to be done by machine through the verification of compliance with predetermined rules, allowing the maximum automation of internal control, reducing human intervention in the decision process to a minimum, although this may be necessary when the type of verification should allow it (particularly because the level of abstraction of the decision is complex and reserved for human decision). From the automatic validation process of the internal control rules, 3 possibilities may result: 1-Validate - all rules were passed, with no errors detected; 2-Reject - some essential decision rules were not passed; 3-Alert - some more subjective decision rules were not passed, and may be rejected or validated for the subsequent process after human decision analysis. If duly validated, the invoice will be ready to be processed for accounting purposes.

![Figure 3 - Diagram of the business validation process of electronic invoice](image)

5.4 Data model

For automated verification to be possible, it will be necessary to take into account, in addition to elements contained in the content of the invoice itself, other information elements originating in other business processes, such as: purchase/order orders, receipt...
and inventories, accounting, supplier management (which will be present, for example, within an ERP).

For the purpose of studying the control model, it was decided to consider only some fields provided for in the EN 16931-1 Standard, as listed in the CIUS-PT model, namely those that will be representative elements of the essentials of an invoice and, as such, should be compulsorily present for the recommended control, and will constitute a good basis for demonstrating the model's potential.

For the purposes of this work, and given the exploratory nature of the study, it was sought to focus on the definition of only a set of representative and heterogeneous fields, and thus with the potential to cover various exemplary situations of controls and rules to be implemented, in conjunction with the information entities mentioned.

Having identified the attributes of the invoice for the purpose of studying a control model, in a total of 22 fields, we have assigned our own terminological definition (reference name) and a coding for the study to the identifying sequence of each field of the EN-16391-1 standard (the coding follows a sequential numbering preceded by the identification reference of the attribute to the model - AM).

Note that the data model focuses on the electronic invoice data model, so, depending on the control need of each field, the data to be obtained from the indicated informational entities must be adequate for that purpose.

5.5 Model use cases and definition of monitoring views and reports

In general terms, the risks associated with the treatment of supplier invoices cannot be totally dissociated from the purchasing and procurement processes. The verification of risks associated to those processes can be translated into automated use cases. Thus, and for the purpose of use cases, we must take into account automated use cases, i.e., the verification situations performed by a machine for business validation purposes, which will be better translated into the automatic validation rules.

In addition to automated use cases, there will be a need for follow-up and monitoring so that accounting officers and managers can check errors and anomalies detected and other indicators useful for accounting follow-up and management.

These human users should thus be able to consult the status of invoices and errors identified by the execution of control rules so the system should provide: 1- A main panel (dashboard type) of entry with general indicators and routing buttons for views and reports; 2- Display panel of the electronic invoice in human readable mode with signalling of fields with errors identified by the control rules; 3- Panels with the possibility of checking diverse information in the form of reports and views, in particular of errors flagged by the control rules; 4- Contain panel where the final decision can be promoted by human on situations with errors to analyze (i.e., the error situations of invoices not automatically rejected).

5.6 Automated internal control rules model

In order to be possible the preventive control of errors in the acceptance of electronic invoices, it will be necessary to adopt mechanisms that minimize business risks. Within the scope of information systems, there are several possibilities of applicable types of application control.

The control types need to be translated into validation rules in order to address the risks of validating the invoice for business purposes as described above. The control model is based on automatatable use cases for checking invoice data.

The rules can be very variable, depending on the field and the type of control idealized. In our study, we surveyed some that were identified as possible and representative of the intended demonstration, although there are probably others possible.

The modelling of the rules is based on the invoice data model and the proposed referencing. Then for each field, given the intended automated control use case and subsequent validation rule, the identification of the origin of the informational elements to take into account, the error messages for each rule for reporting and visualization purposes, and the identification of the intended decision level for automation.

A model referencing framework with the following characteristics is proposed for the construction and referencing rules to be applied:

1- rule reference identification resulting from the concatenation of the rule type (business: RN) with the reference identification of the invoice field and a sequential number of rules per field. Specifically: if for example for the field ID_numberFT, which is coded with code AM-01, we have more than one rule, the sequential identification will be: RN_AM-01_1, RN_AM-01_2, ... and so on, successively.

2- description of the business validation rules (automated use case), in which, the intended verification is expressed textually;

3- matrix of identification of the origin of informational elements to be used in the validation rule, which shall be composed of a subdivision by informational entities, as many as necessary, being that, in the idealization of this model, the need for at least the informational entities identified in point 5.4 is considered (Invoice, Supplier, Purchase Order, Delivery Confirmation, Product, Accounting);

4- text description of the error message for each rule to be included in the human-readable reports and views;

5- decision matrix identification in case of non-validation of the rule, which, given its substance and desired level may, according to the process described in section 5.3, be a rejection or an alert for human analysis and decision.

Considering the described structure and some rules identified as representative of the type of control possible to introduce per field of the invoice, figure 4 contextualizes the framework model of the referencing internal control rules for supplier’s electronic invoices, exemplifying for the case of a field, the one referring to the document number (ID_numerofT which corresponds to the reference identification in the model "AM-01"): 
It is also relevant to indicate that most rules have a direct logical component, for example when only validating that the field is filled out as expected. Others are a little more demanding, comparing and crossing data on the invoice with other data related to other information sources. Other rules, although logical, have a more subjective component, as in the case of situations in which a certain number of days or a certain percentage of deviation is compared, in these cases, the parameters indicated may be adjusted according to the specific circumstances, objectives and control needs.

6 Demonstration and evaluation

After the study of the exploratory model described in the previous chapter, it is important to understand whether it is effective for the purposes of the intended control problem, which was done by building an exemplifying prototype, semi-functional, to test the validity of the whole conceptual model: from the idea of process, through the data model, the rules model and the use model (reports and visualizations). Finally, the overall assessment of the adequacy of the model for the purposes of the intended objectives was performed.

6.1 Demonstration with the construction of a semi-functional prototype in power BI

In order to demonstrate the conceptual model advocated, a simulation artefact was built. For this purpose, the Microsoft Power-BI tool was used. It is a Business Intelligence Self Service software characterized by enabling a simple and intuitive use of business analysis, which allows the preparation of data and the creation of reports and interactive visualizations. It was chosen for its versatility to test data models, visualisations and even rules (as shown) in an integrated manner, and thus was considered relatively suitable for testing the idea of the proposed model.

The prototype developed is essentially semi-functional, since it does not allow the actual processing of electronic invoices, but simulates some of the environment in which such invoices may be processed. The goal was to experiment with different aspects of the model, serving as a basis for demonstration and evaluation. It is therefore important to summarize the demonstration of the various aspects of the exploratory conceptual model proposed in section 5 transposed to the prototype:

- Data Model

Based on the general domain model referred to in 5.4, it was transposed to a data model to be treated in power BI through data tables in Excel files (this option was followed to make it easier to structure and study the data model, however, it is possible to consider others).

- Rules

For demonstration purposes and the application of control rules, a table was added to the data model in power BI regarding the identification of these rules, according to the codification proposed in section 5.6, as well as the corresponding decision matrix and respective messages in case of error (automatic non-validation).

Following the separation indicated in point 5.6 between rules for general fields and rules for invoice line fields, two other tables have also been added for the purposes of constructing and applying control functions based on the DAX language used in power-BI.

- Views and reports

With the purpose of analyzing the relational potential of the data model in conjunction with the testing of the rules and simultaneously simulating the interface in terms of reports and visualizations, several dashboards were built following the provisions of section 5.5, as shown in figures 5 and 6, which reflect images of the dashboards already with data elements loaded for testing as described below (simulation tests of the model).

![Figure 5 - Initial electronic invoice internal control monitoring panel](image)

![Figure 6 - Viewer panel of individual analysis of a purchase e-invoice](image)
dynamics of the information relationship. By making adjustments to the introduced data, it was possible to understand the dynamics and adjustment needs in the model itself, on the way to a more solid solution proposal.

After this iterative design cycle, having built a model with the respective rules (namely those indicated in section 5.6), and with the model and prototype in an advanced stage, more real elements were tested, using SAF-T files from a company. Since it was not possible to have access to electronic purchase invoices, it was decided to use the SAF-T file, as it presents structured elements in XML, namely sales invoices, thus allowing some data transposition. Thus, given that the invoicing elements in SAF-T refer to sales, they were transposed to the model as if they were purchases, the customer table was transposed as if they were suppliers, order confirmations were transposed as purchase orders and transport notes were transposed as delivery confirmations. In the accounting records, debits and credits were reversed in order to reflect customer accounts as if they were suppliers. The uploaded invoice data period is from January to April 2021, for 362 invoice documents issued.

When loading the invoicing documents, cancelled invoices and credit notes were not removed, thus allowing the evaluation of situations of invoices issued in substitution, with references possibly to the same purchase orders and documents that should not be validated (yet) in this model (in this case credit notes), and thus allowing the simulation of situations that the rules should signal. Three tests were made based on the same data source, with some different characteristics, as described below, resulting in different results that should be taken into account in the final assessment.

Simulation test - scenario 1
The first test was performed based on the initial transposition of data without checking potential errors that could exist in the creation of the SAF-T file itself, and the validation reported the result described in figure 7 (graphic image taken from the initial monitoring panel of the prototype as shown in figure 5). Of the 362 invoices analysed, only 93 (25.69%) were fully validated, 113 (31.22%) rejected, and 156 (43.09%) with signalling errors for human analysis.

Simulation test - scenario 2
Given in particular the high number of rejected invoices in the scenario 1 test, the reason for that was analyzed and it was verified that the main cause was the inexistence of references to purchase orders in some of the invoice lines (in a total of 103 invoices). This error ended up conferring some randomness of errors to be detected by the model. After correcting the missing purchase order references in some invoices (79 in total), a new test was made scenario 2, with the results described in figure 8. Of the 362 invoices analysed, 126 (34.81%) were fully validated, 33 (9.12%) rejected, and 203 (56.08%) with signalling errors for human analysis.

Simulation test - scenario 3
Considering the results of the simulation tests of scenario 2, in particular the high number of invoices to be analysed, the reason for this was studied and it was found that it was due to the application of two rules in particular. Since they were rules with potentially adjustable analysis parameters according to the desired control level, adjustments were made and the results described in figure 9 were obtained. Of the 362 invoices analysed, 222 (61.33%) were fully validated, 33 (9.12%) rejected, and 107 (29.56%) with signalling errors for human analysis.

6.2 Evaluation of results and concept
The results described reflect the use of 42 rules, 15 relating to application to general invoice elements and 27 relating to lines. After demonstrating the final version of the artefact, embodied in the conceptual model described in chapter 5, through the prototype developed for model demonstration, using simulation tests, described at the end of the previous section, it is important to understand whether the exploratory conceptual model advocated meets the proposed goals or not. Based on the data loaded for simulation and testing purposes, it was possible to evaluate the dynamics of the model in the various aspects, data model, rules, visualizations and reports.
Obviously, the statistical results indicated also reflect the quality of the data used in the test, as described and evidenced in the 3 test scenarios presented. However, they allow us to conclude that the level of analysis and detection of errors in 362 invoices, also consisting of 2790 invoiced product lines, multiplied by the rules in question, totaled 80,760 checking operations. This number of operations leads to the conclusion that it is difficult to be performed by humans. Human analysis tends to be less comprehensive and sometimes tends to simplify some verification procedures, and is also prone to natural failures that tend to lead to errors, which should be reduced.

In order to describe the overall assessment of the model based on the results of the demonstration performed with the prototype and simulation tests, we will therefore summarize the conclusions concerning the main components of the model:
- Process - the simulation results allow precisely this potential for preventive error discovery, so the process in general terms can be considered valid;
- Data model - the demonstrated allows to realise the possibility, from a base of some main elements generally present in any invoice, to be validly possible to consider the use of electronic invoice in order to enhance automation in information systems;
- Control rules - the model contemplates several types of rules, only technical validation, mixed validation (technical and business) and purely business validation. What is important to underline is that control rules, besides technical mechanisms, should take into account internal control rules used in business validation. A synergy results from this combination. On one hand, management objectives are achieved with regard to controls and, on the other hand, the quality of the information content processed by information systems is improved. However, the application of rules based on parameterisable metrics must be used with extra care, since the variables derive from the context in which they are applied (for example, depending on relevant variations in product prices, the acceptable percentage difference may be variable) as evidenced in test scenario 3 versus test scenario 2;
- Viewers and reports - the dashboards demonstrate the great versatility possible, given the data and model presented, allowing the human reading of an electronic invoice, as well as perceiving the type of errors. A very comprehensive search and filtering is possible, allowing a focused and informed analysis for human decision.

In addition to the assessment carried out as described, an evaluation was also sought, particularly of the concept, based on another instrument, in this case in the form of a focus-group interview with three people responsible for the company that provided the data used in the simulation tests described, namely the CEO, the certified accountant and the employee responsible for validating suppliers' invoices.

As a result of the evaluations it was concluded that the artifact meets the objective of business validation of electronic invoices, having the potential to prevent subsequent errors. The implementation of rules with technical resources for business validation is a valid control mechanism. It is possible to design automatisms based on electronic invoice and the combination with other elements of the information systems, provided that some essential criteria that allow the interaction of information are met.

It is possible with the proposed structure to track and monitor the controls carried out with visualizations and reports and thus prevent errors, improve data quality of other procedural aspects and the very use of information systems. However, the applicability of the rules, particularly the more subjective ones arising from parameterisable metrics, will have to be assessed according to the reality and context to be inserted.

The evaluation, particularly as a result of the focus group, showed that the model motivated interest among participants. If at first they found it difficult to implement, based on the documentary reality they face daily (badly filled supplier invoices), after discussing and better understanding the idea, and considering the more widespread use of electronic invoices and changes in processes, it will eventually be possible to apply it to their reality in the future, but not in the short term. It was concluded that the general evaluation was positive.

6 Conclusions

This chapter presents some final considerations on the development of the dissertation. The main conclusions, the observed limitations and suggestions for future work are described.

7.1 Summary of the work carried out

This paper presents the formalization and exemplification of the application of a conceptual model of an automated internal control system for supplier’s electronic invoices, thus seeking to contribute to the study of automated mechanisms to reduce errors in accounting information systems and, simultaneously, to improve the quality of historical data required for the application and study of processes such as machine learning.

The final evaluation allows concluding that the proposed conceptual model, based on electronic invoices and structured data model, offers an effective basis for automated controls inserted in a process as recommended. It was possible to verify that the rules indicated are logical and feasible, allowing a significant coverage in number, quality and speed, compared to what would be possible by manual processes. Even in situations where less restrictive validations were chosen, because they are more subjective (sometimes based on parameters that must be adequate to the real business context in which they are intended to be applied), in addition to being alerts, they allow the human decision maker to access information for quick and structured analysis, through reports and visualizations that are potentially very variable and with significant search and filtering options,
enhancing the timely discovery of anomalies, improving the quality of the records and information available in the IS. However, it was also possible to verify that there are limitations for an implementation in a real scenario to be possible, starting with the observation that even in a relatively simple model as the one proposed, based on some fields generally present in any invoice, there are organizational elements that if they are not present, make the proposed process less feasible. Starting with the buyer's organizational model, based on the triangle purchase order, purchase confirmation and invoice, and on the supplier's side, the need to ensure the identification of the client's purchase order and the use of compatible product identification codes in order to be recognized between the two parts of the business. Lastly, the model is based on identifying the supplier in particular by means of the tax number, combined with the country code, which is valid when the suppliers are national, from the European area and from other countries that use a similar identification protocol, but will not be the same when the supplier is from a country where there is no requirement for a tax identification number.

The final conclusion is that information systems will be as effective and efficient as the better they handle and deal with the information they process. The reduction of errors, through rules that prevent undue records, or the improvement of processes that lead to improved quality of information, are therefore relevant to the quality of information systems. The use of electronic invoices from suppliers for automatic integration in the IS, combined with technical control processes, namely those resulting from internal controls with validation objectives, can help to make information systems (namely for accounting purposes) more efficient, as they enhance the quality of the data they process.

7.2 Limitations of the work
As a first limitation in the development of this dissertation is the difficulty of identifying the best way to study the model advocated, the process ended up becoming longer, having taken the various versions over time.

Another limitation felt, was the lack of technical knowledge that would allow the construction of a prototype on a platform eventually more appropriate. The use of power BI software was a resource felt as potentially possible to use for the intended demonstration, but which was a challenge, because it was essentially studied and mastered at the same time of the need for the dissertation.

Electronic invoices are not yet widely used between companies, so it was not possible to access invoice data in this support issued by suppliers in a business context, requiring the use of the aforementioned SAF-T files.

7.3 Future work
No work in the area of knowledge can be considered completely finished. The presented work is just a small piece in this search and sharing of knowledge. It is hoped that this research work does not end here, being able to be used and improved in other variables, particularly in the area of information systems where it belongs. Thus, in order to contribute to the development of the theme of electronic invoice processing with the information systems, it is suggested the development of future researches in the following aspects:

- Study of validation of the model in contexts of different organizations and professionals;
- Integration of the recommended model with a comprehensive electronic invoice processing system;
- Consider other aspects and concepts of rules in the validation of electronic invoices;
- How to validate other type of situations of purchases of goods or services than just the type considered, i.e., purchase situations outside the pattern described in the model;
- Integration of the recommended model with machine learning processes in the processing of electronic invoices.

REFERENCES


