Available online at www.ijournalse.org

Emerging Science Journal

(ISSN: 2610-9182)

Vol. 8, No. 4, August, 2024

Adopting ISO 20022: Opportunities, Challenges, and Success Factors for Corporations in Payment Processing

João Constantino [1, 2], Henrique São Mamede [1, 2*], Miguel Mira da Silva [3]

[1] *Department of Science and Technology, Universidade Aberta, Lisbon, Portugal.*

[2] *Institute for Systems and Computer Engineering, Technology and Science (INESC TEC), Porto, Portugal.*

[3] *Instituto Superior Técnico, Avenida Rovisco Pais, CP 1049-001, Lisbon, Portugal.*

Abstract

This research explores the adoption of ISO 20022, a standard that corporations can leverage to instruct payments to their partner financial institutions. Due to the complexity and case-specific variables involved, the adoption process may be complex and require significant effort from financial institutions and customers over an extended period. This research analyzes the opportunities and challenges for corporate users posed by ISO 20022 and identifies the success factors that must be considered during the adoption process. The research key findings indicate that an implementation approach incorporating flexibility, custom extensions, the use of a markup language for creating and managing messages, pilot testing, and user feedback can be an effective adoption model for ISO 20022. Design Science Research Methodology is employed in designing, building, and evaluating a solution proposal to develop a structured, customized, and flexible solution complying with the ever-changing requirements and landscape. This research contributes to the payment processing field by providing a comprehensive adoption model for ISO 20022 that considers critical factors and challenges. The proposed customized and flexible solution can assist corporations in successfully adopting ISO 20022 and contribute to creating a common language and model for payment data worldwide. The initiative's success depends on the effective adoption by all players, including corporations.

Keywords:
ISO 20022;
Electronic Payment;
Cross Border Payments;
Treasury Management.

Article History:

Received:	28	March	2024
Revised:	17	June	2024
Accepted:	27	June	2024
Published:	01	August	2024

1- Introduction

The landscape of payment systems is undergoing significant transformation, driven by technological advancements and evolving regulatory frameworks. In recent years, the adoption of ISO 20022, an international standard for financial messaging, has emerged as a pivotal development in the realm of corporate payments. ISO 20022 offers a standardized format for the exchange of financial messages, facilitating interoperability, efficiency, and enhanced data-rich transactions [1].

The adoption of ISO 20022 by corporations holds immense implications for payment processing, treasury management, and overall financial operations. By embracing this standard, businesses can streamline their payment workflows, improve straight-through processing rates, and achieve greater visibility and control over their cash flows [2]. Moreover, ISO 20022 enables corporations to leverage structured data formats, facilitating seamless integration with enterprise resource planning (ERP) systems and other financial applications [3]. This integration enhances data quality, reduces manual intervention, and enables advanced analytics and reporting capabilities [4].

* **CONTACT**: jose.mamede@uab.pt

DOI: http://dx.doi.org/10.28991/ESJ-2024-08-04-010

ISO 20022 is a global and open standard for payment messaging that aims to create a common language and model for payment data globally [5]. It comprises a repository of messages and rules for exchanging electronic instructions between financial institutions and between corporations and financial institutions. It was first introduced in 2004 to provide the financial services industry with a common platform for developing messages using a central dictionary and design rules [6]. It describes a common platform for the development of messages using three functionalities [7]:

- A modeling methodology to capture in a syntax-independent way financial business area, business transactions, and associated message flows;
- A central dictionary of business items used in financial communications;
- A set of XML and ASN.1 design rules is preferred to convert the message models into XML or ASN.1 schemas whenever using the ISO 20022 XML or ASN.1-based syntax.

The most relevant development to date is the Single Euro Payments Area (SEPA), and thanks to this initiative, it is now possible to initiate and process euro payments (credit transfers and direct debits) within the European Union and several non-EU countries efficiently, quickly, and with fewer costs. Theoretically, it is as easy to make a euro payment to another SEPA-zone country as it is to make a domestic payment [8]. This was achieved through a phased implementation completed in 2014 for the Eurozone and 2016 for the non-eurozone SEPA countries [9, 10].

The initiative to roll out cross-border payments globally leveraging ISO 20022 is ongoing and has already achieved relevant milestones. The goal is for the initiative to be completed in November 2025, and by then, most financial institutions will be communicating through a single language. This comes in response to new market demands for which the legacy standards proved inefficient to address, such as increased automation and cost efficiencies, volume and quality of data, lack of interoperability, enhanced market integration, Know-Your-Customer (KYC) requirements, and real-time services. The common denominator for all these improvement programs is the need for a global migration to ISO 20022, widely recognized as the standard for the future [11, 12].

Despite the potential benefits, the adoption of ISO 20022 poses challenges for corporations, including implementation costs, data migration complexities, and interoperability issues with legacy systems [13]. Therefore, understanding the factors influencing corporate adoption and the strategies for successful implementation is essential for organizations navigating the transition to ISO 20022.

A range of studies have explored the adoption of various financial standards and their impact on corporate performance. Banerjee [14] and Chepakov [15] both highlight the benefits of ISO 20022, with Banerjee specifically noting its potential to increase net income and assets. Banerjee refers to the fact that ISO 20022 can impact the profitability of an organization in the long term and significantly increase the net income and assets for financial institutions more than the costs associated with the migration process, ensuring long-term profitability. Chepakov emphasizes the importance of implementing a unified standard of electronic messages in financial transactions, discusses the main problems associated with ISO 20022 implementation, and provides potential approaches for domestic implementation by the Bank of Russia.

Chakroun et al. [16] and Giner Inchausti et al. [17] provide further evidence of the positive impact of standard adoption on financial performance, with Chakroun emphasizing the role of good corporate governance. Ambarchian [18] discuss the adoption of other financial standards, noting the challenges of transitioning to accrual accounting in the public sector and Wachira highlighting the influence of transparency and environmental sensitivity on the adoption of sustainability reporting guidelines. Kevorkova et al. [19] and Quagli et al. [20] both focus on the management of payments and the adoption of new accounting standards, with Kevorkova emphasizing the need for effective payment management in corporate systems and Quagli identifying firm-level factors that influence the quality of disclosure on the expected impact of new standards.

The adoption of ISO 20022 for payments is a significant trend in the financial industry, with studies showing its potential to increase long-term profitability [14].

However, compared to the interbank space, there needs to be more attention paid to what this migration means for payment users, particularly the cash management processes of corporations and large organizations [21], especially when migrating from legacy and proprietary bank messaging and communication standards. Given the ongoing worldwide adoption of financial institutions, corporations are also affected by the changes in the inter-banking market [22–25]. This context has been observed in working environments where setting up a payment infrastructure on a global scale becomes a daunting task. The motivation for this research comes from this observation, and its main objective is to better prepare corporations on their road to adopting the standard. The problem identified arises from the need for corporations to pay more attention to the impact of adopting new bank messaging and communication standards, particularly when transitioning from legacy and proprietary standards. Complying with the standard's requirements brings new challenges that must be acknowledged, assessed, and acted upon. The motivation for this study is to enable adoption by minimizing operational burdens and facilitating a smooth and sustainable transition to ISO 20022. This can be achieved by bridging gaps that organizations may encounter while adopting ISO 20022.

Building on the shortcomings, this study focuses on the following research question: Is it possible to create a model that enables organizations to adhere to the standard ISO 20022 effectively in a sustainable and scalable way?

A theoretical understanding is established and resort to Design Science Research Methodology to develop an adoption model of ISO 20022 that corporations can reference. Next, the study's results are discussed, including the solution's effectiveness and its possible contribution to the global payments field of study.

This article presents the following structure. It starts with a brief Introduction (Chapter 1), giving context and presenting the research problem. It advances to the research background (Chapter 2). In Chapter 3, the research methodology is described. Chapter 4 details the Proposal Design and Development, and its application is described in Chapter 5 (Demonstration). It follows with an Evaluation of the results (Chapter 6) and concludes in Chapter 7.

2- Research Background

This chapter presents a theoretical background on the topics related to adopting ISO 20022 for payments.

2-1- Opportunities

Opportunities for promoting efficiencies are widely referred to in the literature. This broad term can be broken into smaller pieces, such as greater straight-through-processing, speedier reconciliation, use of e-invoicing, real-time tracking of payment across multiple banks and payment systems, and less manual work.

Straight-through processing benefits all parties involved in the payment chain and can be defined as a fully automated workflow execution. Initiators will have a better experience and acknowledge the reduced complexity of payment execution [26].

Improved reconciliation and e-invoicing are also potential opportunities for corporations. ISO 20022 Extended Remittance Information in a structured format will provide complete and granular information about transactions (documents, lines, among others), thus ensuring more potential for automatic reconciliation [26]. Electronic invoices (e-invoices) are sent to the payer of the invoice and automatically complete the details for the payment and creditor reference [27], reducing manual work and data entry errors and simultaneously easing the reconciliation process.

It also allows payments to be tracked through SWIFT's Global Payments Innovation (GPI) initiative. The service advertises the potential to reduce payment inquiry costs by up to 50% [28].

It is interdependent with the 'improved efficiency and cost reduction opportunity' related to the possibility of leveraging richer, more structured data and complying with requirements. Kwok states that more regulatory challenges are now felt than at any other point in history, particularly in fraud prevention and anti-money laundering [29]. Banks are required to report large amounts of crucial data to the authorities. Any counter-terrorism financing, embargo, sanction checks, and know-your-customer (KYC) function should be identifiable in any payment or transaction. ISO 20022 allows a more transparent, enriched payment message to be used, and by taking advantage of this, corporations may avoid inquiries from the banks, additional manual work, and delays in processing payments.

According to Virtanen, operational risks arise from technological incompatibilities, which would be limited by adopting a single standard [30]. Large & Large [31] reinforces this idea and states that corporate treasurers seek fully integrated automated systems and services. These would give them complete visibility and control of their cash and risk exposures.

One not-often-mentioned opportunity for corporations is the possibility of rationalizing bank account use. Wandhöfer [32] and Virtanen [30] agree on the argument that ISO 20022 and its ability to facilitate cross-border payments will allow a more effective and manageable centralization of payment processing. For SEPA, making payments and processing receipts in one country or bank account is possible. This would save time and money and enable liquidity management to be consolidated.

2-2- Challenges

From the analysis, one topic is discussed across most of the literature: the coexistence of multiple standards and the fragmentation of the payments market landscape. A phased rollout of ISO 20022 means that only some actors will embrace the standard simultaneously, and at any given moment, different banks will be at different degrees of preparedness. And so, will corporations.

Fragmentation in the payment flow means no harmonized experience exists across the multiple 'legs' of the payment processing flow from the initiator through banks, intermediaries, and correspondents.

Lindsay notes that different standards can vary widely in functionality, notably in their capacity to carry remittance information [33]. The adoption of ISO 20022 allows enriched and structured data to be sent down the entire payment

chain, taking advantage of a consistent data dictionary. Retzer [34] asserts that if this consistency is not observed somewhere along the chain, it can impact performance, reliability, and compliance. The same author expands his view on the subject and highlights uncertainty as the leading cause for the coexistence of standards [34]. The title can, however, be misleading as the opportunities the author refers to are primarily for software providers and consultancy firms rather than for the corporate user.

Another frequently observed challenge is related to the continuous evolution of ISO 20022. Wandhöfer [32], in the context of SEPA, adds that rulebook changes and updates are applied as part of release cycles where many improvements and enrichments to the original basic versions of the rulebooks are being made. This means that corporations must regularly adapt to the changes and comply with the new versions, which inevitably involves effort and requires resources.

Also, the need to overhaul the IT architecture is frequently raised. As per Jaiswal & Mishra [35], new standards and a new syntax (XML) may require current technology infrastructures to be upgraded or migrated to one able to produce and handle the required outputs. This can potentially translate into organizations implementing system changes to handle the new requirements associated with the adoption. Such systems can be, for instance, Enterprise Resource Planning (ERP) or other back-office solutions [30].

Being a data-rich and structured format, organizations will require improved data management processes and procedures. Poser [36] states that increased regulatory requirements in compliance, fraud prevention, and anti-money laundering drive the need for comprehensive and structured data. However, to allow a more transparent, enriched payment message to be used, entities need to improve their data management processes for capturing, organizing, and maintaining new data and curating the existing data. Mäenpää [37] refers to the XML schema, a file the XML message can be validated against. It stresses that its purpose is to define the structure, content, and semantics within the XML document. The schema does not provide the exact rules on what information needs to be provided, but instead, it defines how to provide the data, the format, the allowed length, and several other rules. Therefore, significant flexibility is allowed for the same message, and the same data set can be represented in many different ways, ending up with a unique combination of data elements.

Virtanen [30] asserts that issues within the implementation of ISO 20022 have been especially relevant for the customer-to-bank and bank-to-customer communication spaces. Implementing the standard consistently and harmonizing it has been problematic for SEPA and globally. The same author addresses the topic of ambiguity and the difficulty in achieving consistency and harmonization by providing examples of the European Payments Council implementation guidelines for SEPA and the problems and challenges felt on a more global scale. The Common Global Initiative (CGI) was established by SWIFT, where several central banks and a community of corporations created a working group to address the mentioned issues by publishing standard implementation guidelines.

Mäenpää [37] defines the hypothesis that improving how information is presented in implementation guides provided by banks would positively impact the number of resources needed for the customers to successfully implement a system generating payment messages. Even if the standard is well structured, it cannot work as intended if the guidelines are ambiguous and implementers struggle to understand the content.

2-3- Success factors

Any transformational project involves multiple stakeholders, and the road to adopting ISO 20022 is no exception. As such, according to the perspective of various authors, the alignment between stakeholders is fundamental for a successful project [38-40]. Kwok [29] highlights the role of senior management in providing the necessary support during the adoption process. Resources and budgets must be allocated, and other ongoing or future projects may need to be reprioritized. This strongly relates to another success factor related to planning and goal setting. The same author states that a clear time frame must be established for achieving the goals and the approach for the migration: big bang or phased (like-for-like).

Wandhöfer [32] observes the phenomenon from a different perspective and considers the corporation as a stakeholder, a part of a larger community of users. Given the challenges related to flexibility and ambiguity in the context of SEPA, the author expresses the importance of the corporate community in emphasizing its wish that consistent use of ISO 20022 should be achieved over time. It should be ensured that their voices are heard in the appropriate forums to shape the standard's evolution.

Any complex project requires availability and knowledgeable resources. Cojocaru & Cojocaru [41] observe this need and state the importance of the banks educating their corporate customer base to facilitate the adoption. Poser [36] places himself in the role of an organization undertaking the adoption of the standard and reflects on the difficulty of securing enough resources and ones with the required skill set to perform the changes. The author also suggests that any gaps could be filled by external partners specialized in the subject.

Provided that ISO 20022 can incorporate more data in its messages and structure it logically, more attention needs to be given to data management in organizations. Corporates may find that their master data needs to be enriched and/or

undergo a cleaning process to comply with new or specific requirements by different banks and from several geographies. Wandhöfer provides a concrete example: the Finnish tax authority requires that additional information be populated when issuing payments to the tax agency. Without these data, the Finnish tax authority would have difficulty reconciling the payment/payer, leading to delays and potential penalties [32].

Wandhöfer [32] and Mäenpää [37] disagree, however, on one of the approaches for creating the messages. While the latter advocates that overpopulating or including redundancies would not be the best practice to follow as it would increase complexity and maintenance, the first asserts that the defined rules should be consistently applied and become more comprehensive than the minimum baseline of mandatory fields. The level of information in the payment message is critical for corporations, and this can only be delivered if all entities in the payment chain can support the data set, therefore the argument to overpopulate.

2-4- Opportunities for Corporations

The adoption of ISO 20022 presents several key opportunities for corporate users. Banerjee (2020) highlights its potential to significantly increase net income and assets, while Babić [42] emphasizes its role in quality management and customer satisfaction. Babić noted the importance of implementing ISO standards to enhance management systems and ensure customer satisfaction through continuous improvement. Horry et al. [43] and Nascimento et al. [44] both underscore the benefits of ISO standards in enhancing corporate image, environmental performance, and operational efficiency. Horry emphasized benefits like enhancing corporate and public image, improving environmental performance, and ensuring regulation compliance. Nascimento remarked that the use of standards benefits professionals by decreasing implementation time, ensuring quality, and highlighting complexity within organizational environments. Martins et al. [45] identify determinants of ISO adoption, including top management support, perceived benefits, and competitive pressure. Barata & Cunha [46] and Tidd [47] further explore the potential for synergies between ISO 20022 and other management systems, such as information systems and innovation management. In particular, Tidd emphasizes the context-sensitive nature of effective leadership in innovation, the importance of key individuals beyond leadership, and the influence of organizational motivations and goals on the type and degree of innovation required.

2-5- Discussion

Processing an electronic payment is a complex process. The payment needs to navigate different payment infrastructures to complete the transaction. Each payment infrastructure has its rules and requirements, and declarations must be fulfilled and validated at each checkpoint before the process is allowed to progress to the next phase. Also, the payment system may need to transfer funds to a different payment network to complete the transaction. This transfer can often result in delays or fees. Furthermore, each payment network also requires its own documentation and verification processes. This can result in inquiries, delays, or additional fees.

The SEPA initiative, a result of the cooperation between the European Central Bank (ECB) and the European Commission (EC), laid the tracks that allowed payments to travel seamlessly from one country to another by harmonizing and simplifying the communication between all the involved parties and establishing its interbank network infrastructures. This is similar to how the freight train can travel from one country to another through a network of standardized track gauges without transferring goods to other trains and carrying one simplified and accepted model for the customs declaration [48].

The implementation of ISO 20022 at a global scale is underway. Similarly to SEPA, the initiative aims to harmonize the creation and processing of messages between all the involved parties as they progress through the different interbank systems. However, unlike SEPA, several payment infrastructures still need to be crossed, and specific requirements may be presented at each checkpoint. This means that a payment initiation message (named "pain.001" as per ISO 20022) to be issued must be rich and tailored to the specific requirements of every leg of the payment, such as the rules specific to banks and payment systems. Unlike SEPA, this payment initiation message is in the "pain.001" format; despite having seen its format standardized, its use has not been simplified.

The fragmentation and mixed use of payment messaging standards is a significant friction in cross-border payments [49, 50]. Payment systems worldwide are increasingly adopting ISO 20022 as a common messaging standard, an opportunity to promote greater interoperability in cross-border payments. However, while this trend may point to the potential for enhanced cross-border payments, variability in how ISO 20022 is deployed across the globe could undercut some of its benefits. For example, many of the inefficiencies with cross-border payments faced by the financial industry and its customers are caused by misaligned message flows and inconsistent data usage along the end-to-end payment chain. Thus, while ISO 20022 provides a joint base for more interoperable exchange of cross-border payment messages, how the standard is used in practice can vary considerably, meaning that friction in the processing of cross-border payments could continue to persist even as ISO 20022 is adopted [51].

In addition, each adopting organization will feel its specific problems and challenges. Low-quality master data is a common issue faced by many organizations, and the success of a strategic initiative can inevitably be compromised if

the problem exists and is not addressed. It can arise from various factors, including human error, lack of data governance, and poor data quality management and quality practices over the years. The need for richer data is disruptive, forcing organizations to review their procedures and work on enriching data according to new requirements. For bank and branch details, complete and comprehensive databases are available on the market, offering querying, integration, and validation services. Such databases and integrations may significantly assist in ensuring that quality data is fed into the payment execution process.

The enrichment of the payment instruction is not related only to static data. In recent years, the purpose of payment has become an increasingly important piece of information requested to be included in payment initiation instructions. This ensures that transactions are correctly categorized and reported for regulatory and tax purposes. In most cases, a textual description of the purpose of payment satisfies the requirements. However, many countries provide and require specific codes or descriptions with different levels of detail and granularity, ultimately leading to challenges in maintaining payment transaction-related data. An automated derivation mechanism with the possibility of manual overrides is the ideal solution for this problem.

An intermediary bank is a financial institution acting as a middleman between the initiator's and recipient's banks in a payment transaction [52]. Intermediary banks are often used for cross-border payments or when the two banks involved in the transaction do not have a direct relationship. A few variations can be used, depending on the specific requirements of the banks involved and the payment system being used. For instance, full or partial intermediary bank details include the bank's name, address, SWIFT/BIC code, and an account number or IBAN. However, when pre-established intermediary relationships exist with specific intermediary banks for certain types of payments, the payment instruction needs to derive and incorporate this data. For instance, this is the case of CHIPS [53].

On the operational side, it is generally only possible to thoroughly test any solution after operating in a live environment. "Penny testing", a strategy where a minimal payment is sent through the payment system, can be helpful in some cases. However, it is only sometimes reliable for testing real-life scenarios, as it only tests a small fraction of the payment process and does not necessarily reflect the complexity and variability of actual payment transactions. Banks can validate the structure of the payment messages and perform data quality-related checks but cannot fully simulate end-to-end flows. An entire process would involve third parties, such as intermediaries and beneficiary banks, processing data through several payment processing, clearing and settlement systems and receiving feedback and electronic bank statements. This means that a test payment instruction may successfully pass the quality checks promoted by the payment initiator's bank. However, the same instruction may not result in successful payments in a live environment.

Commercial Enterprise Resource Planning (ERP) products, Treasury Management Systems (TMS), and other back-office solutions are essential tools for many corporations, providing a comprehensive range of functions, including financial and treasury management [54]. However, such systems may have limitations in supporting the adoption of ISO 20022 payment initiation messages. Vendors often provide inflexible solutions for creating and managing payment initiation instructions. They need to catch up with the evolution of the standard or the rapidly changing market and its new initiatives. Fully supporting the standard would mean the creation of many different variations of the initiation messages, adding to the effort of adoption and maintenance, which might become a heavy burden for corporations operating in a complex context.

Despite the importance of addressing the challenges of transitioning to ISO 20022, there needs to be more literature providing specific solutions or detailed guidelines from both technical and non-technical perspectives. As a result, corporations may inadvertently make incorrect assumptions, harbor unrealistic expectations, and consequently make potentially costly mistakes during the adoption process. Therefore, a comprehensive investigation must be conducted to address this research gap, which involves developing a solution and all the necessary components to adopt the standard effectively.

Overcoming the challenges involves thorough preparation and planning. Assessing the change's scale and complexity is crucial to correctly determining the resources required for the project. Engaging the banks, opening direct communication channels, and assigning close points of contact are highly recommended activities to be executed before the formal initiation of the project. Equally important is collecting the organization's current pain points regarding issuing electronic payments, as they are likely to persist even after the adoption unless investigated and adequately addressed.

3- Research Methodology

This research utilizes the Design Science Research Methodology (DSRM) to create an adoption model for ISO 20022 by corporations for payments. The reason behind the choice of this methodology was mainly driven by the need to solve a real problem rather than simply filling in a lack of knowledge or attempting to explain a phenomenon. It is a methodology concerned with creating an artifact, its pragmatic validity, and its orientation to achieving a set goal. The foreseen steps of the methodology are illustrated in Figure 1.

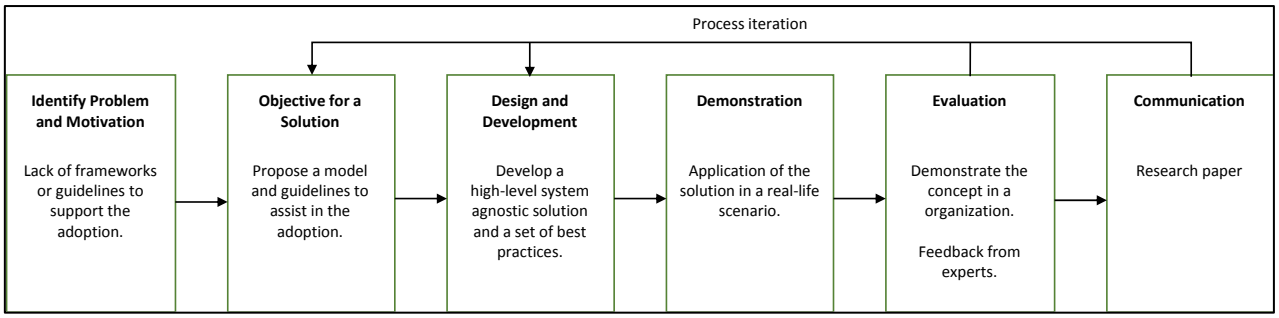

Figure 1. The steps of DSRM (adapted from Peffers et al. [55])

Adopting this approach ensures that our research maintains both practical relevance and scientific rigor [56].

A six-step process was applied, as presented in Figure 1:

- Step 1. Identify Problem and Motivation: Identification and statement of the research problem and the relevance of a solution for it, as described by chapters 1 and 2;
- Step 2. Objectives for a Solution: Conclude by reasoning the solution objectives for the previously defined problem, as described in Chapter 4;
- Step 3. Design and Development: Identification of the methods, models, and concepts for the development of the solution, as described in Chapter 4;
- Step 4. Demonstration: practical application of the developed solution into solving a particular case of the problem, as presented in Chapter 5;
- Step 5. Evaluation: observation and measurement of the quality of the developed artifact as a solution for the problem, as described in Chapter 6;
- Step 6. Communication: communication of the problem and its relevance, the artifact, and its importance and utility, which is accomplished by the publication of this article.

It is an iterative methodology, as the latter two steps (evaluation and communication) feedback into the second and third steps (objective for a solution and design and development) constantly redefine the problem and knowledge base, which are incorporated again into the research process.

4- Proposal Design and Development

In this chapter, the research objectives and the proposal are described. Considering DSRM, it corresponds to Steps 2 and 3, as presented in Chapter 3.

4-1- Research Proposal

Corporations are exposed to several challenges in regaining the potential benefits from the adoption. Mastering such a complex migration relies on the definition of an appropriate strategy [11, 29, 57], one that reduces operational burdens and creates a seamless, sustainable, and non-disruptive transition.

As acknowledged, limited information is available regarding the success factors for the adoption, compromising the attainment of the potential benefits and amplifying the challenges felt to achieve the said benefits. This obstacle has been identified as a research gap.

The research proposal consists of developing a model that enables organizations to adhere to the standard effectively in a sustainable and scalable way. The model consists of general guidelines and the development of a technical solution that can be used as a reference according to the needs of any organization wishing to adhere to ISO 20022.

The main objective of this study is to facilitate the adoption of ISO 20022 for payments by corporate users and provide a model of adoption that can be used as a reference by any other corporate wishing to adhere to the standard.

Financial institutions and software providers can also take advantage of this study to gain better visibility, understand the upstream challenges and limitations their corporate customers face, and factor this knowledge in when developing their solutions.

The objects to be developed all relate to creating the payment initiation instruction (the final output according to the ISO 20022 pain.001.001.03 format) and the supporting functionality to achieve that final output successfully. These objects have dependencies, meaning that the success of implementing one object relies heavily on the successful implementation of the previous object in the chain of dependencies.

The three proposed technical objects can be categorized as:

- Custom Forms: To enrich payment-related data and provide additional logic and flexibility;
- XML Master File schema: a set of instructions and rules required for the creation of a structured XML file containing relevant data and elements to be included in the payment instruction (including the enriched data from the Custom Forms artifact);
- XSLT Transformation Template: a set of rules to be applied to the XML Master File output, which results in the creation of the ISO 20022 pain.001.001.03 instruction.

4-2- Description

After acknowledging the theoretical background, understanding the corporation's context, and familiarizing oneself with the problem and objectives, the next step is to design and develop a solution. This exercise will focus on designing a high-level, system-agnostic solution that addresses the required flexibility and ever-evolving nature of ISO 20022 payment initiation formats. It is also essential to produce several different variations of the same instruction. It is crucial for the solution's success that it is made in an easy way to tailor, test, and deploy.

As for the tools to use for the development, meeting the goals can be achieved by adopting low-code or flexible development technologies, data representation, manipulation, and transformation syntaxes, or a combination of these methods. Depending on the complexity of the rules involved, developing a set of extensions may be required to address specific problems.

Markup languages such as XSLT (XML Stylesheet Transformations) [58], Thymeleaf (*https://www.thymeleaf.org/*), Velocity (*https://velocity.apache.org/*), Freemarker (*https://freemarker.apache.org/*) or Handlebars (*https://handlebarsjs.com/*) allow dynamic content creation by combining templates with data models to generate an output. A well-structured and fully standardized dataset can be easily converted into the desired format by applying transformation templates. Different technologies provide different capabilities, but all are designed to be simple and flexible, with features like macro definitions and specification of functions, conditional statements, loops and iterations, and filters that allow developers to create complex templates and rules without advanced coding requirements and skills. These also enable immediate testing as it can be done offline, holding a sample file and the template to be applied against it.

A simplified schematic depicting the process of extracting, transforming, validating, and transmitting a payment instruction can be found in Figure 2.

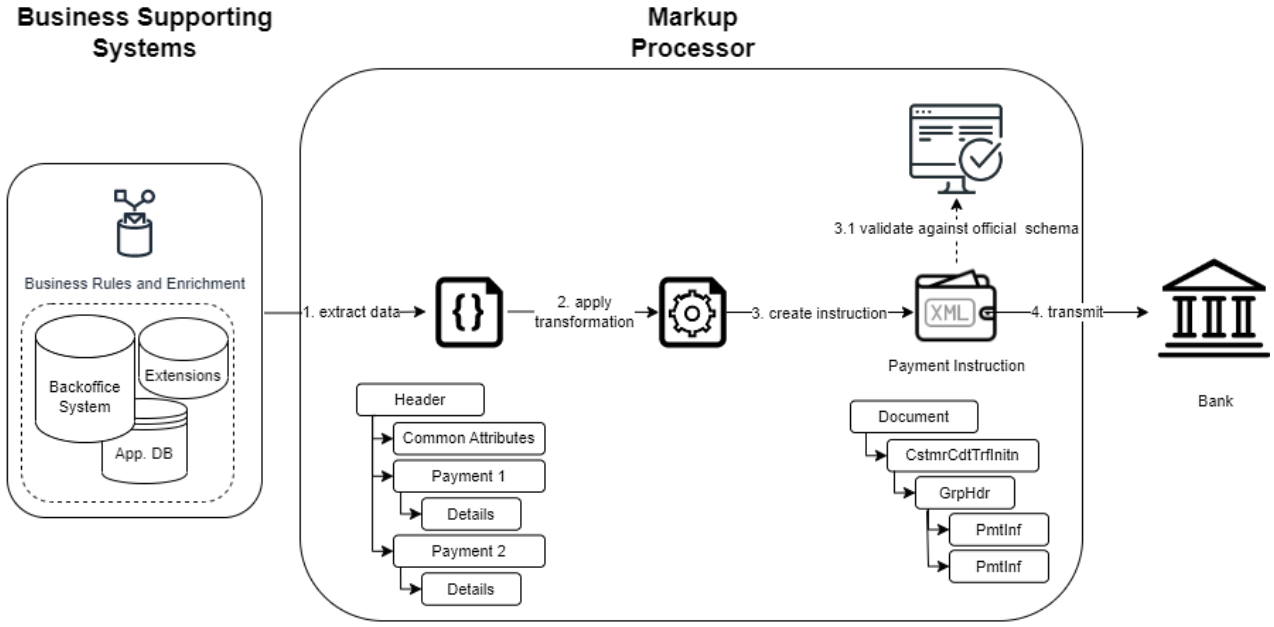

Figure 2. Schematic of the entire extraction, transformation, validation and transmission flow

The data source for the payment instructions lies entirely within the business support systems (ERP or back-office systems) and additional databases and extensions. The flow initiates with the data extraction process from these systems into a format ready to be consumed by the markup and transformation language of choice. During the data extraction process, a set of business rules needs to be applied to translate the data from the source system into a more meaningful and human-readable format, typically XML or JSON, depending on the technology to be used. Both data files have a hierarchical structure, which means that data is organized to reflect relationships between the data elements.

The structure is not relational, meaning it is not comprised of multiple tables linked by sets of primary/foreign keys. Instead, it is very much focused on the 'payment' object, and for each instance, all the relevant details are referenced hierarchically under that branch. For instance, each payment should contain not only the basic details (date, currency, amount) but also complete details about the payee (name, bank account details, address) and transactions being settled (numbers, type, amounts, purpose).

Once the data is extracted using a processor service, a custom-made template is applied to the data extraction. This template contains all the necessary rules to convert the initial extract into the final ISO 20022 XML payment initiation format. The suggested tools and technologies allow, for instance, the conversion of JSON into XML, thus complying with the final and expected output of a "pain.001" message. Any logic that was not considered part of the data extraction process (business rules) can now be applied, and this may be particularly useful when dealing with slight variations in the format imposed by the banks or markets in which they operate. Examples of possible uses are covering particular requirements related to using an IBAN or a bank account number (when both are provided), deriving a purpose of payment code, or even deciding when to use or not use an intermediary bank. Examples of possible uses for such rules are countless.

The creation of the pain.001 XML file is achieved by applying an XSLT Template to the XML Master file. This template contains all the rules to be applied to the XML Master file to produce the pain.001 instruction. Contrary to the process that generates the XML Master file, the XSLT template's structure, rules, and conditions are accessible and transparent, even to individuals lacking technical development skills. It allows changes to be performed, scenarios to be manually created and tested offline, and its structure and output to be validated quickly and resorting only to offline desktop applications.

Two possibilities for the technology to adopt were on the table: XSLT and Freemarker Template Language16, both able to effectively create XML payment instructions and rich in functions and functionality that could be used to perform the transformations. Due to several factors, XSLT was ultimately chosen as the technology to adopt as its syntax was considered more uncomplicated to understand and code in. It integrated directly with the XML Master file through XPath17 (a syntax able to point to specific tags and sub-tags of an XML structure), and the availability of free and lightweight desktop applications that allow the easy modification of the templates and testing them offline for various scenarios.

An example of a simplified transformation of the XML Master can be observed in Figure 3, detailing the creation of the header elements of the payment instruction in the XSLT file. The syntax to identify the source data is XPath.

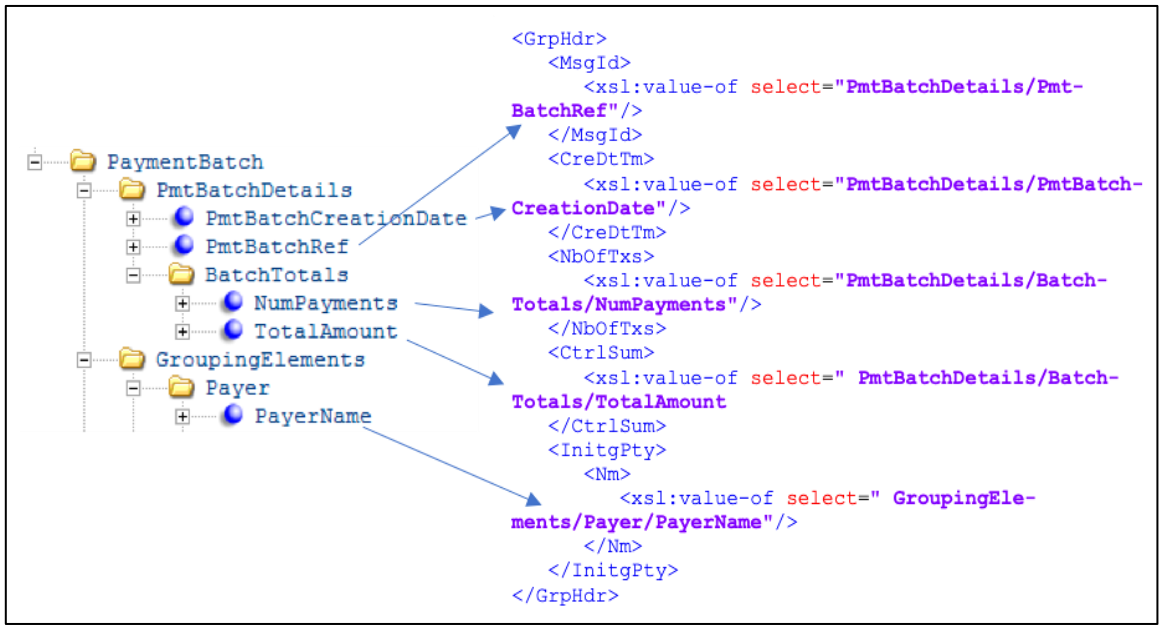

Figure 3. Mapping between XML Master (left) and payment instruction (right)

Not only does XSLT allow the possibility of mapping the contents of the XML Master file in the XSLT template, but it also enables the following:

- The ability to use functions to convert text strings or numbers or apply other types of transformations (for instance, concatenate strings or truncate a text string to a defined number of characters);
- Define conditions to create and/or populate tags;
- Create groups and loop within the contents of each group.

Limitations do, however, apply to the use of XSLT as a technology. As the XML Processor service can only interpret XSLT syntax up to version 1.1, the development was constrained to the available functionality and functions in that version. Nevertheless, these were considered sufficient to proceed with the development, as workarounds were found for every challenge that was encountered. An example of such a limitation and the adopted workaround was the impossibility of resorting to the 'replace' function, which replaces a sequence of characters defined inside a string that matches an expression. Instead, the 'translate' function available in v1.1 achieved a similar result but using a slightly more elaborate syntax.

As the payment instruction in XML format must obey an officially published schema [59], the final output can constantly be tested against it and provide a mechanism for the early detection of potential errors in the structure of the payment instruction. One single violation makes the entire instruction invalid. Therefore, verifying its validity before transmitting it for further processing is always recommended – this proactive approach may save time and effort.

5- Demonstration

In the context of DSRM, it is essential to demonstrate that the artifact works in practice and solves the identified business problems while identifying any unintended effects that may emerge in the interaction with other organizational elements [60]. This can be achieved through various strategies, such as prototyping, experimentation, simulation, case studies, proof of concept, or other appropriate activities [55]. To carry out this step successfully, it is essential to have a thorough understanding of how to use the artifact to address the problem.

A prototype is an early sample, model, or release of a product built to test a concept or process, and it is generally used to evaluate a new design to enhance precision by system analysts and users [61]. By having a functional prototype available for demonstration and a Quality Assurance infrastructure ready (a recent copy of the entire Production environment), it could demonstrate countless scenarios, including the ones identified as pain points by the organization. Not only allowed to fully reproduce and address known issues, but also allowed to simulate the execution of many scenarios easily and quickly.

The development of the model took place in a professional environment. A project was undertaken to assist an organization in adopting ISO 20022 and enable it to effectively manage its disbursement process through the electronic transfer of funds to its payees around the globe.

The organization, driven by the quest for modernization, sustainability, and efficiency, has, throughout the years, embarked on the road to digitization. Several initiatives have already been undertaken, which have led to the consolidation of processes and workflows. Such initiatives include implementing robust back-office software and other business support systems solutions. Despite all the efforts, the organization still feels severe pain points in its payment-related operation. It wishes to take the current infrastructure and processes to the next level, be fully compliant in the future, and take advantage of the potential benefits introduced by ISO 20022.

A fully functional prototype has been developed, enabling the demonstration of business scenarios including, but not limited to, the ones identified as pain points for the organization. It makes it possible to observe and measure how well the artifact supports the solution to the problems by comparing the objectives to the actual observed results from using the artifact. Table 1 consolidates the input and output of six different business scenarios, representing a reasonable array of possible situations for demonstration. Many other scenarios can be and were demonstrated. However, due to the high volume of possible inputs, these scenarios are not included in this article, only a summary of those considered to be the most relevant and representative of the challenges. Table 1 summarizes the test scenarios and indicates what elements to pay attention to when evaluating the contents of the payment instructions. Offline tests can be performed by combining the XML Master samples provided for each scenario with the single XSLT transformation template developed for this project, resulting in a payment instruction.

Table 1. Sample scenarios considered for demonstration

Bank Acct.	Profile	Remit	Total	Breakdown	To Observe
Bank A - EU	SEPA	Unstr.	550 EUR	Pmt. 1: 300.00 (100.00+200.00) Pmt. 2: 250.00 (300.00-50.00)	- Compliance with SEPA rules - Unstructured remittance message (multiple payments and documents) - Batch Booking (grouping rules)
Bank B – UK	SEPA	Struct.	550 EUR	Pmt. 1: 300.00 (100.00+200.00) Pmt. 2: 250.00 (300.00-50.00)	- Compliance with SEPA rules - Structured remittance message (multiple payments and documents) - Batch Booking (grouping rules)
Bank C – CA	Global	Unstr.	7000 CAD	Pmt. 1: 5000.00 (3000.00+2000.00) Pmt. 2: 2000.00	- Proprietary local instrument code - Routing details

Bank C – JP	Global	Unstr.	9000 JPY	Pmt. 1: 7000 JPY Pmt. 2: 2000 JPY	- Proprietary local instrument code - Routing details - Inclusion of alternate bank account name (in Katakana) - Bank branch address removal - Bank account type
Bank A - EU	Global	Unstr.	6000 -	Pmt. 1: 2000.00 AUD Pmt. 2: 2000.00 GBP Pmt. 3: 1000.00 EUR Pmt. 4: 1000.00 EUR	- Concatenation of beneficiary bank name and address - Concatenation of routing numbers with bank account numbers - Rules for populating the Bank Account tag for countries like Côte D'Ivoire - IBAN usage rules for Azerbaijan (an IBAN country) - Purpose of Payment
Bank B - NY	Global	Unstr.	4000 USD	Pmt. 1: 1000.00 Pmt. 2: 1000.00 Pmt. 3: 2000.00	- Domestic ACH payment (ABA routing code) - Cross-border with an intermediary (CHIPS Participant) - Cross-border without an intermediary (urgent payment) - Payees contact details - Purpose of payment

The scenarios include examples for all banks and bank accounts in scope, with variations in each format. For all situations, compliance with the published pain.001 XML schemas was observed, and visual inspections of the structure and relevant elements of the files produced were performed, with particular attention given to problematic scenarios. Despite the known limitations, sample files were sent to banks to validate the structure and identify possible violations of the rulesets required by the initiator banks. Visual inspection of the elements of the output of each scenario was equally performed in search of possible issues and inconsistencies.

As such, the creation of remittance messages (the composition of structured or unstructured, multiple occurrences of unstructured), the way payments were broken down by document payable, the identification of the POP, Intermediary Bank, and the usage of the IBAN, among other rules, were all demonstrated during this phase.

6- Evaluation

Pries-Heje et al. [62] propose the evaluation strategy of choice. The author's formulation of a framework for DSR evaluation considers two main dimensions:

- Its environment: whether the evaluation is performed in a real-life setting (naturalistic) or involving simulation or experimentation (artificial);
- The timing: whether the evaluation is performed before (ex-ante) or after (ex-post) the development of the artifact.

Considering the context and the criteria set proposed by the framework, the relevant quadrants for evaluating the artifact are Naturalistic and Artificial/Post, as illustrated by Figure 4.

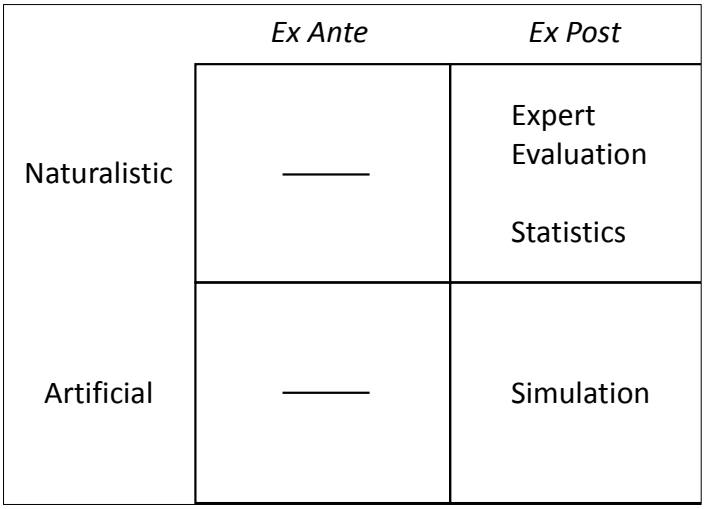

Figure 4. Approach to the evaluation of the artefact (adapted from Pries-Heje et al. [62])

For the demonstration purpose, a fully functional prototype was developed, as described in Chapter 5, and used it first for simulations with real-world scenarios and data.

Two different approaches were used to evaluate the artifacts that were produced. Firstly, two focus groups were consulted through structured surveys 18 weeks past the go-live of the solution used for demonstration, allowing time for it to mature and for the consulted experts to develop their feelings and opinions. Secondly, the collection and compilation of statistics created a picture of the evolution of the effectiveness of the artifact by consolidating years of data related to the use of the legacy solutions and providing side-by-side comparisons for the first 20 weeks following the adoption of the standard by the organization.

6-1- Focus Group Evaluation

This survey targeted two focus groups:

- Treasury Specialists (3 individuals): the group of users responsible for executing the fund's disbursement process for the entire organization, including all the communication with financial institutions (rejections, fees, and inquiries) or the bank statement reconciliation process. In addition, its composition has been stable throughout the years, and, as such, this focus group is deeply aware of how successful the execution of this business flow might be when comparing different solutions;
- IT Developer and Support Specialists (5 individuals)—the group responsible for implementing and supporting the technical solutions related to the finance functional domain (including the payment execution process). Similarly, to the previous group, its composition has not suffered any recent change, which enables them to compare implemented solutions throughout time. The profiles are mixed, as four individuals are purely technical resources, and one is a functional IT resource acting as a bridge between the end users and the IT Helpdesk service.

The focus groups were realized on the 18th week following the beginning of the coexistence period and the 12th week from the official go-live date (and deployment of the 6th version of the product). This is to allow enough time for the solution to stabilize and for the involved parties to form an opinion about the success of the implementation.

The surveys were built differently for each focus group but had much in common. Both include six questions to be evaluated using a 5-point Likert scale and the possibility of adding comments (see Table 2). A set of questions allowing free text was also included, similar in both groups except for one question centered around the adequate choice of technology (made available only to the IT Developers and Support Specialists).

Table 2. Focus Group 'Treasury Specialists' – Questions

#	Question	Answer Type
Q1	In comparison to the maintenance of legacy formats, and on a scale of 1 (much worse) to 5 (much better), how do you evaluate the ISO 20022 solution in the following aspects:	-
Q1.1	Easiness to perform any change to the templates	1 - 5
Q1.2	Effort involved in testing and deploying a change	1 - 5
Q1.3	Involvement of business users in the definition of rules and in testing the solution	1 - 5
Q1.4	Perception of complexity associated with performing rollouts to other banks?	1 - 5
Q1.5	Overall, regarding added value and success, how do you compare the new against the legacy solution?	1 - 5
Q1.6	In terms of overall effort in supporting the solution, how do you compare against legacy?	1 - 5
Q2	Comments regarding the previous set of questions	Open
Q3	How do you see the implemented ISO 20022 solution as being scalable and sustainable? Why?	Open
Q4	Do you see any room for improvement to the ISO 20022 solution? Provide details	Open

The set of questions for the group 'IT Developer and Support' are presented in Table 3.

The goal of the focus groups was to evaluate the overall success of the adoption in several dimensions. Not only was the overall success queried, but also the feeling related to sustainability, complexity, and effort required to maintain the solution, its scalability, and the room for improvements.

The outcome revealed that, in general, satisfaction with the ISO 20022 solution is very high in comparison to the legacy formats. All the respondents from both focus groups, except for one person, showed evident satisfaction with all the dimensions mentioned above in the analysis. The analysis on the first set of 6 questions (through a Likert scale), presented in Table 4, shows just that, considering that the range of possible values goes from 1 (much worse) to 5 (much better).

Table 3. Focus Group 'IT Developer and Support' - Questions.

#	Question	Answer Type
Q1	In comparison to the maintenance of legacy formats, and on a scale of 1 (much worse) to 5 (much better), how do you evaluate the ISO 20022 solution in the following aspects:	-
Q1.1	Easiness to perform any change to the templates	1 - 5
Q1.2	Effort involved in testing and deploying a change	1 - 5
Q1.3	Involvement of business users in the definition of rules and in testing the solution	1 - 5
Q1.4	Perception of complexity associated with performing rollouts to other banks?	1 - 5
Q1.5	Overall, regarding added value and success, how do you compare the new against the legacy solution?	1 - 5
Q1.6	In terms of overall effort in supporting the solution, how do you compare against legacy?	1 - 5
Q2	Comments regarding the previous set of questions	Open
Q3	Did you find the choice of technologies adequate? If not, provide details	Open
Q4	How do you see the implemented ISO 20022 solution as being scalable and sustainable? Why?	Open
Q5	Do you see any room for improvement to the ISO 20022 solution? Provide details	Open

Table 4. Focus groups consolidated results

#	Consolidated Result
Q1	-
Q1.1	4
Q1.2	5
Q1.3	5
Q1.4	4
Q1.5	5
Q1.6	5

6-2- Results Discussion

On the comments that were requested, the response was enthusiastic. Comments such as "The ISO pain.001.001.03 is much easier to modify" or "Significant improvement! (the ISO 20022 format) has many differences and exceptions, but that is manageable" were received by the IT Developer and Support staff. Encouraging comments were also received from the Treasury staff, such as "Overall, the solution is much better compared to the previous. (...) We do not use workarounds anymore" and "The process is now much smoother, and I can clearly say that we have fewer rejections (maybe 80% less), and the number of inquiries and the time we spend on them decreased to less than 10% of what it used to be".

Most IT Developers and Support staff also replied positively concerning the choice of technology, accounting for 4 out of 5 positive evaluations. One respondent added, "It makes the transformation very simple, and we can test immediately". Equally positive was the perception related to the sustainability and scalability of the solution, with one respondent answering, "It is sustainable. (...) We have significantly fewer incidents now. (...) The introduction to new bank accounts must be simplified.". Everyone agrees that users, in general, are now much more involved because they can understand the applied rules.

This solution has generated a very positive first impression. It allows it to end with situations of struggling with multiple issues, from managing multiple (and very diverse) formats, limitations with character sets, urgently required changes, and updates to master data with the only purpose of working around issues, to name a few. Now everything seems to be fitting all together, with a clear strategy defined and elements like the quality of master data not forgotten. Everyone agrees that the number of open incidents drops dramatically, allowing a more minor effort to support the payment process. Users are now aware of the rules applied and can even create test cases and try the solution. This is a major shift; an ISO 20022 adoption initiative means significant improvement. Organizations inevitably adopt the pain001 format in the next few years, but it is better to start by having a template that can be reused, not requiring to start from scratch. Also, having the definition of the steps that should be executed and the instructions for getting details from the banks makes everything much easier to deal with.

Abandoning the MT101, UN, and US ACH formats could have been done earlier since everyone feels that they are sources of problems and issues. After ISO 20022 adoption, the process became much smoother, with fewer rejections

(some participants referred 80% less), and the amount of inquiries and the time spent on them decreased to less than 10% of what it used to be. It also means no more issues with invalid characters, and the bank reconciliation of SEPA payment batches is improved.

However, one IT Developer/Support staff wanted more from the outcome of the adoption, responding very negatively to almost every question. This respondent argued that "the new solution is more complex to manage. There is no need to have an intermediate step between the extraction of data and its transformation" and that the choice of XSLT as the technology "(...) is inadequate. (...) It is overkill". It also questions the sustainability of the solution and its ability to scale, manifesting the desire to "go back to the old (but much more effective) solution". Given the clear contrast between the responses of this particular person and the remaining people who participated in the survey, this result may be considered an outlier.

A clear pattern was identified regarding the perception of items that could be improved. The IT Developer and Support group highlighted the need to improve the XML Schema, which was described as "confusing". They stated that "the rules are not clear. (validation fails), but according to the solution architect, that is acceptable.". The Treasury focus group, however, listed a set of possible improvements that cannot be linked in any way to ISO 20022 (define payment approval workflows, for instance) or are impossible to address, like the impossibility of performing end-to-end testing with banks.

The results are very positive. Not only was the adoption carried out by the organization successful, but it also addressed a series of pain points, allowed quick remediation of issues, and laid the foundation for facilitated rollouts and the addition of new functionality. The fact that the artifact was deployed in a "real-life" environment in a complex payment landscape and with a successful outcome grants it validity and utility from the perspective of DSRM.

7- Conclusion

Adopting ISO 20022 presents several challenges that organizations must overcome to ensure a successful transition. Thorough preparation, including business analysis, identification of scenarios, assessing the scale and complexity of the change, proper planning, and engaging banks, are critical tasks to observe. Additionally, organizations must be prepared for ever-evolving payment initiation formats and unexpected changes. Adopting flexible development tools, data representation, and transformation syntaxes like markup languages can help create dynamic content and generate output. By taking a strategic and proactive approach to these challenges, organizations can successfully navigate the adoption of ISO 20022 and realize its benefits.

The main contribution of this research is bridging the identified research gap: the lack of literature on solutions or guidelines to address the challenges organizations face when adopting ISO 20022.

Not every organization faces the same challenges, but this research has contributed to implementing a flexible, sustainable, and scalable model, and the model can serve as a reference to any other organization in the adoption process. By illustrating the methodology with an organization's adoption of ISO 20022, this research makes it possible for potential other candidates to replicate the processes herein.

It is also an aim to trigger further research in this field by allowing other researchers to take on the outcome of this master's thesis and extend the knowledge base on this topic.

Ultimately, since it is possible that the community of corporations does not have its voice heard adequately within the governing body of the standard, this document could, in theory, provide the perspective of a corporation to the same governing body and, possibly, influence future decisions, especially those related to efforts of further harmonizing the instructions.

7-1- Limitations

Several challenges were felt during the different phases of the work, the most remarkable one being the impossibility of performing end-to-end testing without being in a "live" environment. In addition, given the extremely high number of possible combinations of data elements, it is virtually impossible to test every possible scenario. These facts contribute to an increase in the perceived risk related to the adoption, as financial data of this type is sensitive, and any potential errors are not easily recoverable. Nevertheless, risk needs to be mitigated, in this case, for instance, by gradually increasing the amount and volume of payments to be processed and thoroughly verifying the outcome of the cash flows.

It was also observed that following the go-live, several changes had to be performed on the XSLT transformation template as the financial institutions failed to provide accurate instructions for creating messages. In addition, exceptions had to be considered, which were not documented and only verified once payments were executed in a live environment.

During the Evaluation stage of the DSR, it was, unfortunately, impossible to collect reliable statistics on rejected payments for the legacy formats. The organization needed to record such details consistently. Therefore, comparing the

figures between legacy formats and ISO 20022 was impossible. This was mitigated by surveying the involved user community and inviting it to provide feedback.

Despite the organization's substantial investment, positive attitude, and availability of resources to undertake the ISO 20022 adoption project, it was baselined on a highly ambitious schedule. Therefore, investing as much effort in particular objects as they deserved was impossible, and their outcomes cannot be considered optimal. Some limitations were only observed in the later stages of the development cycles, when dependencies were already observable, and remediation would mean significant additional effort. However, none of these limitations had any significant negative impact on the main output, the creation of the payment instruction; therefore, no intervention was considered required. This can be done later when resources are available for object remediation and integrated testing.

Such cases are:

- The XML Master file schema has room for improvement in terms of the validations it can perform – more tags can have validations built for them and even make use of 'and'/'or' logical operators, which was not explored;
- The structure of the XML Master can also be improved – it was noted that address structures were shared between several elements, which compromises the ability to create more granular validations for its sub-tags in its corresponding schema;
- Some aspects of the structure of the XML Master were not mapped through business rules and were simply left as part of the structure but as placeholders and reserved for future use.

7-2- Future Work

Adopting ISO 20022 for payments opens doors to organizations aiming to automate their business processes and promote efficiencies. Its data-rich formats and structured nature allow data to be more easily consumed by other services, opening possibilities in executing the related business process.

Two of these possibilities are now being evaluated to be worked on shortly:

- Automating the confirmation of payments by integrating the ISO 20022 pain.002 format and:
  - For successfully executed payments, automatically issue payment confirmation documents to the beneficiaries;
  - For rejected payments, automatically initiate workflows for the resolution of issues (for instance, if the reason for rejection is a closed beneficiary bank account, the workflow should be initiated, and the master data management team needs to be assigned an issue resolution task);
- Enable the automatic creation and reconciliation of customer payments using customer or transaction references made available in the cart.053 bank statement format.

8- Declarations

8-1- Author Contributions

Conceptualization, J.C., H.M., and M.S.; methodology, H.M. and M.S.; software, J.C.; validation, J.C., H.M., and M.S.; formal analysis, J.C.; investigation, J.C.; resources, H.M. and M.S.; data curation, J.C.; writing—original draft preparation, J.C and H.M.; writing—review and editing, H.M. and M.S.; visualization, J.C. and H.M.; supervision, H.M. and M.S.; project administration, H.M. and M.S.; funding acquisition, H.M. All authors have read and agreed to the published version of the manuscript.

8-2- Data Availability Statement

Data sharing is not applicable to this article.

8-3- Funding

This work is financed by National Funds through the Portuguese funding agency, FCT - Fundação para a Ciência e a Tecnologia, within project UIDP/50014/2020. doi:10.54499/UIDP/50014/2020.

8-4- Acknowledgements

The authors want to acknowledge the support provided by INESC TEC – Institute for Systems and Computer Engineering, Technology and Science during this research, making it possible.

8-5- Institutional Review Board Statement

Not applicable.

8-6- Informed Consent Statement

Not applicable.

8-7- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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