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Research paper

Performance analysis model for service supply chains : case of the retirement supply chain

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Abstract

A service supply chain (SSC) is a supply network that transfers resources into services with or without physical products, to satisfy customer needs. So it's evident that without offering the right service at the right time to the right person, the service is incomplete, inconsistent and ineffective. In the same context, the retirement field faces the challenge of offering the correct pension to the right pensioner the first month of his retirement. This paper approaches this challenge from a SSC perspective as a case study for dealing with continuity in service supply chain. It uses a methodology that combine Analysis-Specification-Design-Implementation (ASDI), Office Support Systems Analysis and Design (OSSAD), Business Process Management (BPM), and Supply Chain Operations Reference (SCOR). It analyzes and models the Moroccan retirement SSC, simulates the behavior of "the management of civil pension rights" process, and proposes a set of Key Performance Indicators (KPI) to evaluate the continuity in the service supply chain. Hence, this work provides guidance on the performance analysis of a SSC.

Keywords: *Service Supply Chain; Modelling; Simulation; ASDI; OSSAD; BPM; SCOR; KPIS.*

1. Introduction

In recent years, the world economy has grown increasingly service oriented. In a supply chain system, by definition, there must be a product that is created by the points of origin and delivered at the points of consumption. We talk about a SSC when this product is not a tangible physical product, and in the domain of service supply chain, two types of supply chain systems arise, namely the Service Only Supply Chains (SOSCs) and the Product Service Supply Chains (PSSCs). SOSCs are supply chain systems in which the "products" are pure services and physical products do not play a role. For example, in many well-established service industries such as psychology advice, healthcare body checking, retirement field, financial consultancy. Unlike SOSCs, many supply chains manage physical products together with significant service considerations. Thus, there are both "services" and "physical products" in PSSCs. For example, PSSCs are found in restaurant and food retail supply chains, product design and retailing supply chains, and logistics service providers [1]. In this work the SOSC is analyzed, considering the case study of the Moroccan retirement scheme.

Retirement in Morocco is provided by five general schemes. A compulsory one, for employees in the private sector, and which is managed by the National Social Security Fund (NSSF). A compulsory scheme for the incumbents employers of the state (civilian and military) represented by the Moroccan Pension Fund (MPF). The Collective Retirement Allowance Scheme (CRAS), which is compulsory for the staff of public establishments and temporary employees of local authorities. As well as a voluntary supplementary scheme for private sector employees managed by the Moroccan Inter-professional Fund of Retirement (MIFR). In addition, there are two internal funds, the National Office of Water and Electricity (ONEE), the water and electricity distribution Boards and the Bank Al-Maghrib. These funds are managed differently and their method of pension calculation is not the same.

In this work, the studied organism is the MPF. This fund manages the civil pensions scheme, the military pensions scheme, the supplementary pension scheme ATTAKMILI, and the non-contributory pension schemes. When treating the civil retirement scheme, the processing steps differ according to the budget type of the affiliate administration. Therefore, a distinction between "the general budget" and "the autonomous budget" is made. Actually, when one refers to the general budget of the State, reference is made to what would constitute nearly 85% of the budget law and which traces the needs of all the ministries and institutions of the country. On the other hand, as for public establishments for inter-municipal co-operation, they have a so-called autonomous budget, which is voted by the bodies responsible for the establishment, as is the case for the local authorities. In this work, the focus is on the civil retirement scheme and especially the general budget.

Among the challenges the retirement scheme faces on one hand there is the need to make this system last longer. Whiting this framework, in Morocco a reform was adopted at the end of 2016, which concerned only the civil retirement scheme. This reform has mainly affected three points: the contribution to the scheme, the retirement age, and the calculation of the pension. Another one that will aim at a merger between the different funds can follow it. The other main challenge is the difficulty of managing the continuity between the salary and the retirement pension, which means the difficulty of offering this service (the retirement pension) to the customer (the pensioner) at the right time (first month of his retirement). In this work, this challenge is approached from a service supply chain side, as an example of continuity issues in SSC, and which provide us an overall analysis of this system, and consequently enable us to put strategies to address the root causes of this problem.

The remainder of this paper is organized as follows. Section 2 gives an overall overview about researches related to the SSC systems, to

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the supply chain modelling and simulation approaches, and to our case study: the retirement field. Then follows Section 3, which explains the methodology used in this work to evaluate the performance of the studied service supply chain. The different models and the simulation are presented in Section 4. Finally, Section 5 is a conclusion with synthesis of the achieved work and future research directions.

2. Literature review

2.1. Service supply chain

With the growing importance of the service sector in economies, the notion of SSC has obtained a more prominent role in contemporary operations management, as more and more traditionally product based companies like IBM, Cisco and Pitney Bowes garner increasing proportions of their revenues from services [2]. And, in light of the increasing attention on SSC by both practitioners and academics, [3] defines the Supply Chain as "the flow of goods and services that involves raw materials supply and storage, the process and the work for final goods from point of origin to point of consumption", and [4] defines it as "a series of activities composed by a particular company and all other companies interact directly or indirectly, through its suppliers and customers, upstream and downstream, for the effective consumption of products and/or services by end users", while [5] defines the SSC as "a structured set of competencies that constitute proactive, relational, coordinative people and technology dimensions desired to deliver specific service offerings". On one hand, some researches are rather interested in the difference between the traditional supply chain and the SSC, for [6] the difference is due to the special IHIP characteristics of services (intangibility, heterogeneity, inseparability, and perishability) that must be considered, while [7] specifies that the SSC differs from the traditional supply chain in two aspects, the first one is the fact that the supplier's capacity is fixed for service firms (e.g. in airlines and hotels) while in the traditional supply chains the supplier can produce her products; the second difference is that there is no operation cost in SSC while the operation cost cannot be ignored in the traditional supply chains. On the other hand, a various studies focused on evaluating the SSC performance, among which the work of [8] that developed a measure of sustainable service supply chain management (SSSCM) performance by focusing in the nature of network hierarchical relations with qualitative and quantitative scales, the authors developed a hierarchical network for SSSCM in a closed-loop hierarchical structure, they also indicated the practical implementation and enhances management effectiveness for SSSCM. Reference [9] proposed a grey based hybrid framework for evaluating the environmental performance of service supply chains, by integrating grey based method with ELECTRE and VIKOR approaches. To understand the effectiveness of criteria and method to evaluate environmental performance of service supply chains in a developing country context, the authors carried out two case studies. In the same context [10] developed a framework of service supply chain performance measurement, by stressing a methodology based on the extent fuzzy analytic hierarchy process. The emphasis is on performance measures dealing with service supply chain processes such as demand management, customer relationship management, supplier relationship management, capacity and resource management, service performance, information and technology management and service supply chain finance. The developed framework of service supply chain performance measurement is applied to the hotel supply chain. Reference [11], focuses on the assessment of performance in the light of the presumed perception of all actors of the studied supply chain, in this case it's the hospital (the actors are : patients, medical staff and managers). Authors use the AHP (Analytic Hierarchy Process) method to choose the most appropriate design of healthcare supply chain in a case study based on three decision criteria: costs, accessibility to health products and quality. Last but not least, [12] examined the supply chain's performance under different coordination strategies involving risk and information sharing between the application service provider and the application infrastructure provider. The authors found several key managerial insights from their model. Most importantly, they found an effective decentralized mechanism to achieve the goal of maximizing the overall supply chain performance. In the literature, research has covered several fields, in the automobile industry [13] studied on the capability coordination of automobile logistics SSC under buyback contract. For automobile logistics service integrator and functional logistics service provider, they decide the optimal logistics capability order quantities separately based on their maximum profits. When both the order quantities are equivalent, the automobile logistics SSC reaches an optimal coordination state. Then the numerical simulation verifies the correctness of the model. Other works addressed the configuration of the after-sales supply chain, among which can be mentioned [14] that analysed three configuration choices: the degree of vertical integration, the degree of centralization, and the decoupling of activities. The authors performed an exploratory case study over seven companies belonging to durable consumer goods industries. The results show that configuration choices vary, suggesting that no ''one best way'' exists, but they are rather influenced by drivers, including the attractiveness of the after-sales business, the strategic priorities, the characteristics of the physical product and the services offered, and the configuration of the manufacturing and distribution supply chain. And even the call center field was not spared; Reference [15] constructed a theoretical model to study the competition of call centers in the call center service supply chain. In their study the authors created a single index that aggregates several contract parameters. The index can be used to segment the call center market as well as to estimate the contract prices at equilibrium. The results can help the call centers to locate and focus on their market niches. Clients can use the results to estimate the cost of their contracts and negotiate with the call centers for better deals. The results can also be used to explain the observed reshoring phenomenon in recent years from the perspective of operations management. In the field of energy, [16] examined empirically and theoretically the distinctiveness of the supply chain configurations in the energy efficiency retrofitting services sector (EERS). Three ideal types of supply chain configurations were identified based on the size and scope of the energy efficiency retrofitting project. The authors have also explored the influence of these configurations on the performance of the supply chains. In the same field, [17] presented a review of UK past and present policies, produces a timeline of impacts retrofit policy has had upon the EERS sector within the UK. In evaluating these policies, attention is clearly required in viewing how differing policy tools interact with and impact supply chains and end users from differing angles. Adopting this standpoint could enable a smooth customer journey to increase energy efficiency and enable a heightened level of awareness.

2.2. Modelling and simulation techniques in supply chain

Discrete event system modelling, including supply chain is for the scientific community a primary concern; in fact the modelling is an activity of the brain [18], the authors of [19] defines the meta-models, frameworks and methods in this spirit. Many other studies confirm the huge number of the supply chain modelling methods, according to [20] two modelling paradigms exists: centralized and distributed, while the authors of [21] divided the modelling approaches into: modelling type (mathematical, simulation, multi-agent) and modelling settings (linear, integer, dynamic, stochastic problem settings). In the same framework, the authors of [22] used bibliometric and network analysis tools to analyse quantitative supply chain risk management literature and to identify emerging trends of this research area, in their work they cite a review of the quantitative and analytical models for managing supply chain risks. Other research works reveal the different roles of supply chain modelling, for [23] the main one is to make the supply chain sufficiently understandable to ensure product quality, while [24] highlighted the ability of the modelling methods to describe the real world phenomena. In the same context, [25] highlight the lack of integration of

supply chain systems with enterprise systems as a cause of disruptions of the supply chains, and then the authors confirm that the modelling is important when designing supply chain systems. Various works took advantage of the describing ability of the supply chain modelling in diverse areas, in [26], [27] and [18] the authors modelled the Moroccan supply chain of electricity, in [28] and [29] the authors used a modelling approach to describe the pharmaceutical supply chain within Moroccan hospitals, [30] makes clear the different processes of the retirement supply chain in Morocco, and [31] uses multi-agent approach to model an enterprise business environment. Another important role of supply chain modelling is the supply chain simulation which is a scientific method by which users employ a model to observe the operation of an entire supply chain and conduct ''what-if'' analysis for multiple scenarios [32]. Modelling and simulation in supply chain has been widely applied in recent years, especially to real-world supply chain applications, and they are useful to represent the reality of supply chains, generating alternative solutions that improve supply chain performance [33]. Actually, prediction, performance, entertainment, training, education, confirmation and discovery, are purposes for which simulation can be applied. Reference [34], added that the simulation models are often used when certain characteristics of the supply chain cannot easily be modelled with analytical models or when stochastic variables are to be incorporated. And in addition to considering the various sources of variability and uncertainty that affect the supply chain performance, the simulation modelling also take into account individual behaviours and heterogeneities as well as interactions between the entities [35]. And as long as simulation is suited for studies where time- dependent relations are analysed, [36] specified that the main reasons to use discrete event simulation for system analysis in supply chain management are the possibility to include dynamics and the simplicity of modelling. Finally, simulation allows researchers to study processes in ways nature prohibits, given that it can be run many times with the values of the model parameters modified in each run and changes observed in outputs [37]. Reference [38] specifies that simulation methods form two large classes: the methods of the formalized systems representation; methods directed to the activation of the intuition and the experts' knowledge application. The literature is rich of works that addresses the simulation approaches, among which [39] presented a simulation model characterizing the complex dynamic behaviour of procurement system that takes into account the coupling with production planning, in the context of stochastic demand and delivery lead-time. And in [40], the authors developed a generic discrete event simulator, which can be used as a support for simulation of both centralized and decentralized control system. Moreover, the authors of [41], developed an injection moulding decision system with efficient parameters, by means of both simulation and mathematical models. Furthermore in the financial sector, [42] focuses on a simulation model for dichotomous approach between governance and the management of the operational level activities.

2.3. Retirement field

In the last decades, more and more researchers, focus in the retirement field. Among these researches, [43] developed an integrative model to understand how pension scheme structure and pension scheme communication impact pension participation and contribution rates at organizational level. Other researchers have focused in the retirement security of citizens in advanced age, as [44] who deals with the possibility of covering all inhabitants in a region; it describes the possibilities of the regional pension and analyses it by the real conditions in the Czech Republic. The result of this work were the defining of the conditions for the public pension fund to function, where the second pillar pension scheme seems optimal, in addition to a specific solution that contains an actuarial model of the functioning of the regional pension fund. And in order to analyse the relationship between financial optimism and non-participation in pension schemes, the authors of [45] explains that financial optimism reduces the probability of employees joining employer run pension schemes and also the probability of the self-employed subscribing to private pension plans. Their research suggests that both employed and self-employed individuals who are financially optimistic could face the very negative consequences of pension shortfall and low pensions income when they retire. Whereas the authors of [46] studied a generalized multi-period mean–variance portfolio selection problem within the game theoretic framework for a defined-contribution pension scheme member. Reference [47] interested in the effect of the new rural pension scheme on the labour supply behaviour of the elderly, the authors used pooled data from two waves of the China Health and Retirement Longitudinal Study and an analytical framework of combination of regression discontinuity design and difference in difference method, they found no evidence that pension receipt from the new rural pension scheme program does significantly induce the elderly to withdraw from the labour market. Moreover, in exploring the migration from defined benefit to defined contribution pension schemes, the authors of [48] focused on this change interface with accounting, and they used a critical perspective to reflect on this interface including how the change is accounted for in corporate reporting narrative. And in order to analysis the relationship between the level of a return guarantee in an equity-linked pension scheme, and the proportion of an investor's contribution needed to finance this guarantee, the authors of [49] have considered three types of schemes : investment guarantee, contribution guarantee and surplus participation. They find a negative (and for two contract specifications concave) relationship between the participation in the surplus return of the investment strategy and the guarantee level in terms of a minimum rate of return. Furthermore, the introduction of the possibility of early termination of the contract (e.g. due to the death of the investor) has no qualitative and very little quantitative impact on this relationship and as a last example of researches related to this field, [50] presented the first study that quantified the redistributive effects of a rule change by a real world scheme (the Universities Superannuation Scheme, USS) where the sponsor underwrites the pension promise. They find that the pre-October 2011 scheme was not viable in the end, while the post-October 2011 scheme is probably viable in the end, but faces medium term problems.

In these different works, and in order to deal with different problematics, the pension scheme is modelled in an actuarial mathematical way, whereas this paper considers the service supply chain side of the retirement field, and using a methodology that combined different methods, this service supply chain is modelled and analysed.

3. Research method

A modelling methodology is a set of methods, tools, approaches and concepts allowing the modelling of a system. In fact, on one hand the objectives that can be assigned to a model are firstly its explanation capacity, description or understanding (e.g. model for interpreting observed behaviors or share a universe of discourse) and his ability to guide action (design, simulation, monitoring / control, etc.) [28]. On the other hand, the strength of a modelling methodology lies in its ability to combine approaches, tools or methods of different origins and organizing their arrangement in a very specific purpose [28]. As part of our purpose to analyze and evaluate the retirement supply chain, six modelling methodologies are identified to answer our analysis and specification issues:

- TOronto Virtual Enterprise (TOVE) was proposed by the University of Toronto is an ontological framework for enterprise integration based on and suited for enterprise modelling. It contains a limited number of concepts/terms that are used in enterprise modelling; it provides rigorously defined semantics and uses formal languages to represent ontologies [51].
- GRAI Integrated Methodology (GRAI-GIM), the work on it started in the 1970s at the GRAI Laboratory of the University of Bordeaux. The objectives at that time were to model a production management system in order to be able to define precisely the specifications needed to choose a software package

for a Computer Aided Production Management (CAPM) system. The domain of GRAI-GIM is to support the designer of a Computer-integrated manufacturing system (CIM system) to help him elaborate the model of an Integrated Manufacturing System in order to deduce the specifications of that CIM system [52].

- Computer-Integrated Manufacturing Open System Architecture (CIMOSA) has been developed as an early Enterprise Architecture Framework (EAF) at a time when the focus was on Computer-Integrated Manufacturing. However, the CIMOSA event-driven process-based concepts can be applied to any type of enterprise and in any environment (centralised or distributed). It has the potential to support information exchange in inter-organizational environments [53].
- Purdue Enterprise Reference Architecture (PERA) is a model of the Purdue Methodology. This methodology is the process of carrying out the development and operation of any enterprise. It is a picture of the structure of the steps involved in the methodology or process and of their interrelationships as these occur in that process. As such, PERA is architecture and because of its truly generic nature, it is, in fact, enterprise reference architecture [54].
- Generalized Enterprise Reference Architecture and Methodology (GERAM), is developed by the IFIP-IFAC Task Force , and adopted as an Appendix of ISO15704:2000 and it is the result of the pursuit of a universal set of requirements which would provide a uniform approach in the assessment, classification, comparison and use of various enterprise architecture frameworks. Thus, by generalizing the contributions of various existing and emerging enterprise architecture frameworks, GERAM aims to define a complete collection of tools, methods and models to be employed by an enterprise engineering and integration effort [55].
- ASDI is used for the design and the implementation of modelling, simulation and piloting software environments dedicated to a domain (class of systems). The analysis and specification phases allow us to obtain the generic modelling of a domain, and the design and implementation phases allow us to create a library of reusable software components of this domain [56].

Thus, these methodologies explain how to combine methods, approaches and tools to produce a system model. However, in relation to our evaluation problem of the retirement supply chain, the ASDI is chosen as long as this methodology has a decision-making aspect. In the first step "Analysis", it is a question of defining the objectives assigned to the system, and defining how the mission will be carried out, whom or what will be involved and how resources should be organized to effectively carry out this mission. In this step the OSSAD method is chosen, which can be described in a simplified way as answers to four successive questions “how to represent the objectives of the organization?”, “how to represent the distribution of human resources to achieve these objectives?”, “how to represent the circulation of information to achieve these objectives?” and “how to describe precisely all the means (human and material), as well as the progress of the procedures to achieve these objectives?”. To each of these questions, OSSAD proposes answers through the elaboration of graphic representations, or models. In the second step “Specification”, the conceptual model reflecting the existing system in implemented. In the literature, there is an array of tools and methods of modelling that are easy to manipulate, among which Business Process Model and Notation (BPMN) is chosen, which has been widely used for business process specifications. The third step “Design” represents the simulation phase in which the dynamic specifications specified in the "Specification" step is exploited. At this stage the simulation of the BMPN model is done using Bonita BPM. The last step “Implementation” the system of control by indicators is implemented, by the establishment of the dashboard. At this step, we are inspired by the KPIs provided by the Supply Chain Operations Reference SCOR, which has already been used for the modelling of this same supply chain in [30]. Figure 1 sums up the different methods used according to the ASDI methodology, in order to evaluate the performance of the Moroccan supply chain of retirement pension.

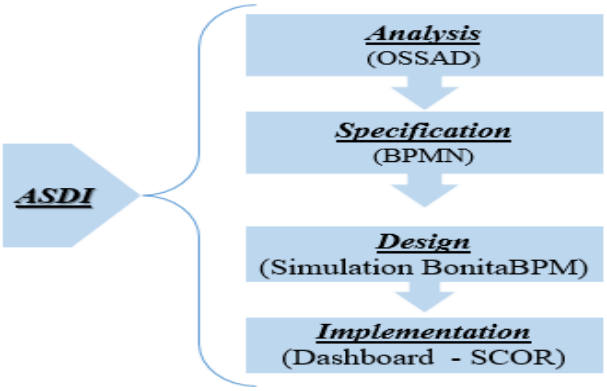


Fig. 1: ASDI Methodology.

4. Modelling and simulation

4.1. Analysis

In a general way, the most common modelling methods are either using a data structuration or process automation, and then the organizational aspects are usually slipshod. While the methods which are work organization rather than data organization and treatment automation are really few (OSSAD, UML, SADT/IDEF0, etc.), we find OSSAD which is primarily concerned with the organizational functioning. It’s used to express different goals of an organization and to represent them as functions; it also describes human means and technological resources of the organization [57]. This method aim is to conduct changes and to take advantages of reorganization opportunity offered by new technology. Computer science and office automation are considered as tools which assist the individual task [58]. OSSAD proposes two levels of modelling: abstract and descriptive.

4.1.1. The abstract model

The abstract model shows the strategic goals of an organization in terms of functions and information packets that circulate between these functions. Functions can be decomposed into cascading subfunctions, as many as necessary to describe a given organization [59]. The organization studied is MPF, it consists of four poles: ‘Operations’, ‘Support’, ‘Organization and Information System’ and ‘Portfolio Management’. The responsible pole for the processing of retirement folders is ‘the Operations Pole’ and precisely its division ‘the Division of Concession of Civil Pensions’. Apart from this division, the pole consists of three other divisions, ‘Military Pensions Concession Division’, ‘Control and Payment Division’ and ‘Customer Relations Division’. The following figure (Figure 2) shows the different functions of the division of concession of civil pensions, through the abstract model done using the software ‘Workey Designer’. For the management of the civil retirement scheme and especially the general budget, three services of this division come into play: ‘Career tracking of Civilian State Personnel Service’, ‘Contribution tracking Service’, and ‘Main Pensions Concession Service’. Together they manage the tracking of the affiliate’s career, its contribution, the folder liquidation and its concession. The figure also shows that in order to achieve its objective - which is treating all the folders received by the office order, and delivering them on time to the control and payment division, with the minimum of rejection - the division interacts with other external actors, namely: ‘the office order’, ‘the affiliate’s administration’, ‘the customer relationship division’ and ‘the control and payment division’.

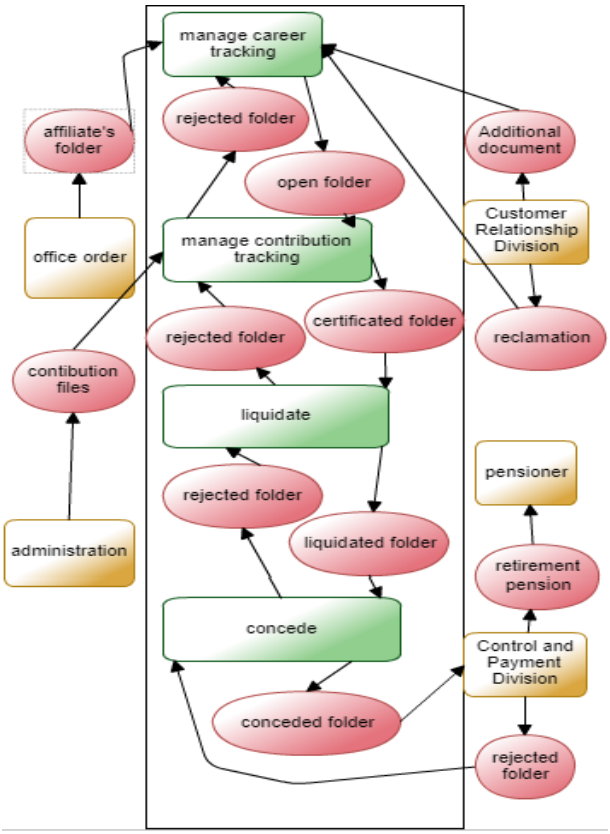


Fig. 2: OSSAD - The Abstract Model.

4.1.2. The descriptive model

The descriptive model represents human means and technological resources used within an organization. These are defined in terms of procedures and operations, as well as in terms of roles, resources and tools [59]. So, if the last level gives us a clear idea about the studied organism's objective, this one answers the questions how does MPF ensure the concession of rights constituted in accordance with the law and regulations, within the agreed time limits while guaranteeing the accuracy of the amounts? In addition, who participates in each activity? To provide a synthetic view of the distribution of responsibilities for an activity, OSSAD proposes the activities-roles matrix shown in our case by Figure 3, Figure 4 presents the different activities.

Activités/Rôles	The courier office	The affiliation office	The contribution office	The liquidato	The verifie
Receiving Mail	☑	☐	☐	☐	☐
Sorting mail	☑	☐	☐	☐	☐
Assignment of mail	☑	☐	☐	☐	☐
Certification of Identity Data	☐	☑	☐	☐	☐
Career Certification	☐	☑	☐	☐	☐
Edition of the certification sheet	☐	☑	☐	☐	☐
Data entry of declared contributions	☐	☐	☑	☐	☐
Reconciliation of contributions due to contributions paid	☐	☐	☑	☐	☐
Contribution Certification	☐	☐	☑	☐	☐
Folder verification	☐	☐	☑	☑	☑
Verification of certified data	☐	☐	☐	☑	☐
Verification of legal conditions	☐	☐	☐	☑	☐
Calculation of pension	☐	☐	☐	☑	☐
Edition of the liquidation sheet	☐	☐	☐	☑	☐
Folder Concession	☐	☐	☐	☐	☑
Edition of the concession decision	☐	☐	☐	☐	☑

Fig. 3: OSSAD - the Descriptive Model: Activities-Roles Matrix.

Activités/Rôles
Receiving Mail
Sorting mail
Assignment of mail
Certification of Identity Data
Career Certification
Edition of the certification sheet
Data entry of declared contributions
Reconciliation of contributions due to contributions paid
Contribution Certification
Folder verification
Verification of certified data
Verification of legal conditions
Calculation of pension
Edition of the liquidation sheet
Folder Concession
Edition of the concession decision

Fig. 4: The Activities of the Activities-Roles Matrix.

According to our activities-roles matrix, we conclude that the four functions represented in the abstract model are composed of sixteen activities done by five participants. These activities are : receiving mail, sorting mail, assignment of mail, certification of identity data, career certification, edition of the certification sheet, data entry of declared contributions, reconciliation of contributions due to contributions paid, contribution certification, folder verification, verification of certified data, verification of legal conditions, calculation of pension, edition of the liquidation sheet, folder concession and finally the edition of the concession decision. The participants are respectively: the courier officer, the affiliation officer, the contribution officer, the liquidator, and the verifier.

4.2. Specification

In the first phase of this modelling methodology we have seen the objective assigned to the system, and defined how the retirement folder treatment is carried out, and the resources involved in this mission. In this phase we detail the behavioral model of the system using the BPMN with the software BonitaBPM. According to figure 5, we can see that 'the management of civil pension rights' process is composed of six lanes: "head of career tracking service", "Dispatching", "Affiliation", "Contribution", "Liquidation", and "Concession". The process is initiated by the start event "receive folders", and it ends by the execution of one of the three end events: "folder sent to the organization", "Non-compliant folder", or "conceded folder". Once the folders are received from the different affiliate's administrations, the head of career service assign these folders to the affiliation officers, and then he designates a monitoring agent who will be responsible for the follow-up of the processing of folders, he starts by dispatching the folders to the assigned officers. The affiliation officer studies the folder, if the folder is not complete (all papers are received) he rejects it, if not he validates it, and then he certifies the affiliation data before printing the certification sheet. And then he sends the certified folder with its certification

sheet to the concerned contribution officer and a copy of it to the monitoring agent. Once the contribution officer receives the folder, he verifies the affiliation certification, if it is valid, he certifies the contribution, if not he rejects the certification. The liquidator studies the certified folder (affiliation and contribution), if it is not valid he reject the folder. If a folder is

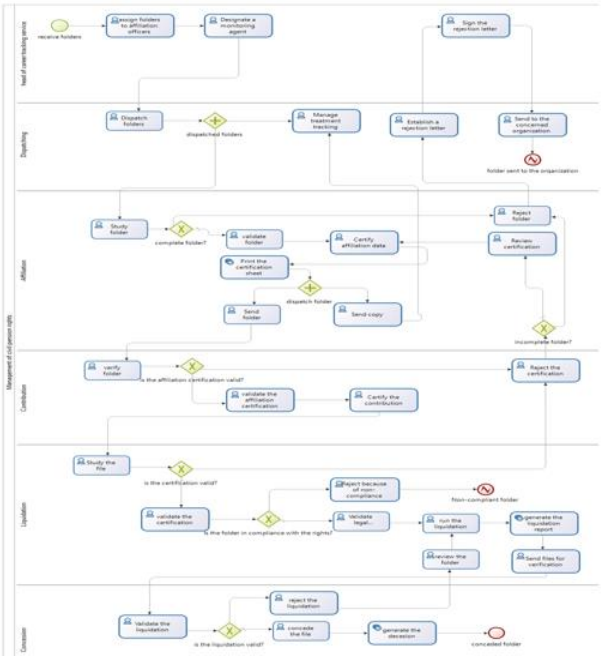


Fig. 5: The BPMN Model of 'the Management of Civil Pension Rights' Processes.

Rejected before the certification and / or before the liquidation, the monitoring agent establishes a rejection letter that describes the rejection causes; this letter is signed by the head of career service before being send to the concerned organization. For each rejected folder, once it is sent to the organization, the management of civil pension rights ends by executing the error end event "folder sent to the organization". For the valid certified folder, the liquidator verifies the compliance with the rights, if this compliance is not valid he rejects the folder, in this case the management of civil pension rights ends by executing the error end event "Non-compliant folder". For the folders with valid rights compliance, the liquidator validates the legal conditions, and then he runs the liquidation via the system (which will calculate the pension amount and generate a pension number) before printing the liquidation report, then he sends the folder for verification to the verifier. In case the verifier rejects the liquidation, the liquidator reviews the folder and repeats the verifier validates the liquidation operation until it. Once the verifier validates the liquidation, he concedes the folder (which will generate a decision number) and finally generates the decision. In this case the management of civil pension rights ends by executing the end event "conceded folder"

4.3. Design

The simulation in Bonita Open Solution is used to evaluate the way a Process runs under different resource availabilities and different load profiles. When a Simulation is run, a specified number of iterations over a specified period of time are run either with simulated data or with assigned probabilities, and the cumulated result of all iterations is shown in a report. To use the simulation function on a process, we first define simulation parameters, and then we define simulation resources and load profiles. In this work the load profile we use is composed of the start date 01-06-2018 at 08:30 am, the end date 31-12-2018 at 04:30 and 100 instances. The objective is to simulate the case of an affiliate who is going to retire in the end of the year 2018, giving that the affiliate's administration have to send his file six months before his retirement, we choose the start date on June 2018. It is considered that a folder is received late if the reception date is greater than the retirement date minus 3 months, in our case, a folder is late if it is received after September 30, 2018. A received folder may be complete or incomplete (lack of a document), and during its processing, a folder may not be subject to a revision, or it may be subject to more than one revision. In this study we choose five as a maximum possible number of revisions. So to characterize a folder, we create the business object 'dossierState' (LONG bonitaBPMid; DATE receptionDate; BOOLEAN complete; INTAGER revisionNbr ;) as shown in our bom.xml presented in Figure 6.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<businessObjectModel>
    <businessObjects>
        <businessObject qualifiedName="bizdata.dossierState">
            <description>The received retirement folder for an affiliate.</description>
            <fields>
                <field type="LONG" length="255" name="bonitaBPMid" nullable="false" collection="false"/>
                <field type="DATE" length="255" name="receptionDate" nullable="true" collection="false"/>
                <field type="BOOLEAN" length="255" name="complete" nullable="true" collection="false"/>
                <field type="INTEGER" length="255" name="revisionNbr" nullable="true" collection="false"/>
            </fields>
            <uniqueConstraints/>
            <queries/>
            <indexes/>
        </businessObject>
    </businessObjects>
</businessObjectModel>
```

Fig. 5: The Business Object 'Dossier state.

In addition, to specify the scenario to simulate, we created the form shown in Figure 7, with which we feed our objects before launching the simulation.

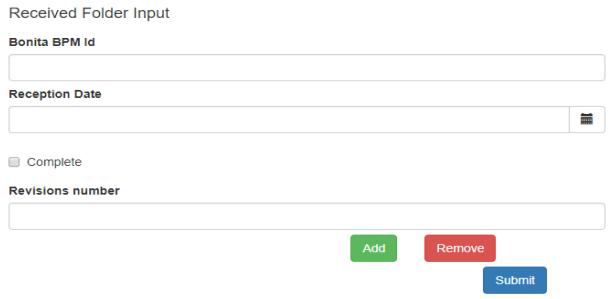


Fig. 6: The Form Dossier State.

Six scenarios are considered, as shown in Table 1. In keeping with our profile, we considered a date that meets the deadlines, and one that represents a late reception, we also considered whether the file is complete or not, and the case of a treatment without revision and the other with maximum number of revisions.

Table 1: The Simulation Scenarios

Scenario	Reception date	Complete	Revision number
Scenario 1	01/06/2018	yes	0
Scenario 2	01/06/2018	yes	5
Scenario 3	01/06/2018	No	-
Scenario 4	01/11/2018	yes	0
Scenario 5	01/11/2018	yes	5
Scenario 6	01/11/2018	No	-

The simulation is based on a reception of 1000 folders (the average number of received folders in 6 months). The reception respects the period of our simulation profile. The following table presents the minimum, the average and the maximum execution time (by hours) of the main activities of our process, and which are: Certify affiliation, Certify contribution, Run the liquidation, Review the folder, Concede the file. (Sc: Scenario, Mi: minimum, A: average, Ma: maximum).

Table 2: The Execution Time by Activity

	Certify affiliation data			Certify the contribution			Run the liquidation			Review the folder			concede the file		
	Mi	A	Ma	Mi	A	Ma	Mi	A	Ma	Mi	A	Ma	Mi	Av	Ma
Sc 1	293,667	250	450	722.083	1239	1499	314.5	539	630	0	0	0	165.1	201	320
Sc 2	293,667	250	450	722.083	1239	1499	375.8	596	697.12	38.5	93	185.88	199.12	241.4	385
Sc 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sc 4	293,667	250	450	722.083	1239	1499	314.5	539	630	0	0	0	165.12	201	320
Sc 5	293,667	250	450	722.083	1239	1499	375.8	596	697.12	38.5	93	185.88	199.12	241.4	385
Sc 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

According to this simulation, we conclude that:

- The reception date does not affect the duration of processing, but a folder received late, given the duration of the processing, may be paid late (reception on 01/11/2018 in a lot of 1000 folders: 3000 hours on average).
- The scenarios that take more time are 2 and 5, and therefore the revision impact the duration of processing, knowing that 5 was considered as the maximum number of revisions.
- When an incomplete folder is received, the activities presented in the table are not executed, and therefore an incomplete folder is not conceded.

Based on these results, we note that the two parameters to be considered in the development of our dashboard are "incomplete folder reception" and "folder revision".

4.4. Implementation

For every person managing a process, indicators are an indispensable tool for decision-making. It is just inconceivable to properly manage a process without measuring its performance; monitoring its performance and comparing performance against target. In this context and in order to measuring the performance of the management of civil pension rights process the metrics provided by SCOR are used. SCOR is a reference model. The purpose of a process reference model, or business process framework, is to describe the process architecture in a way that makes sense to key business partners. Architecture here means the way processes interact, how they perform, how they are configured and the requirements (skills) on staff operating the process. The SCOR reference model consists of four major sections: performance (standard metrics to describe process performance and define strategic goals), processes (standard descriptions of management processes and process relationships), practices (management practices that produce significant better process performance) and people (standard definitions for skills required to perform supply chain processes) [60]. In this work we focus on its performance section. The performance section of SCOR consists of two types of elements: the performance attributes and the metrics. A performance attribute is a grouping of metrics used to express a strategy. An attribute itself cannot be measured; it is used to set strategic direction. Metrics measure the ability of a supply chain to achieve these strategic attributes. SCOR offers five performance attributes: reliability, responsiveness, agility, costs and asset management efficiency. As a part of our goal to evaluate the continuity between the salary and the pension, we are interested in the responsiveness attributes which means in a general way the speed at which tasks are performed, the speed at which a supply chain provides products or services to the customer. The SCOR key performance indicator for responsiveness is 'Order Fulfillment Cycle Time'. It represents the time passed between the moment a customer places the order (in our case: the moment of receiving a folder) to the moment the order is fulfilled (in our case: the moment the folder is conceded). To calculate the 'Order Fulfillment Cycle Time' SCOR specifies: [Sum Actual Cycle Times for All Orders Delivered] / [Total Number of Orders Delivered] [60].

Based on this indicator, and given the context of our case study, the indicator that corresponds functionally to the 'Order Fulfillment Cycle Time' is:

- 'Rate of pensions conceded before the 25th of the first month of retirement' and which can be calculated for each trimester as follow: [the number of folders conceded before the 25th of the first month of retirement since the beginning of the period] [the total number of folders received before the end of the period], for example, for the A trimester 'January , February , March' the indicator will be [the number of folders conceded before the 25th of the first month of retirement since the 1st January] / [the total number of folders received before the 31th March].

In addition, based on the simulation results we propose:

- Late folders rates' and which can be calculated for each trimester as follow: [Number of folders received after retirement] / [the total number of folders received before the end of the period].
- Revised folders rates' and which can be calculated for each trimester as follow: [Number of revised folders] / [the total number of folders received before the end of the period].

In addition, to recapitulate Table 3 presents the dashboard that sum up these indicators.

Table 3: The Dashboard

The indicator source	The indicator title	The calculation formula	The indicator type	The calculation periodicity
SCOR	Rate of pensions conceded before the 25th of the first month of retirement	[the number of folders conceded before the 25th of the first month of retirement since the beginning of the period] / [the total number of folders received before the end of the period]	Steering indicator	A trimester
Simulation	Late folders rates	[Number of folders received after retirement] / [the total number of folders received before the end of the period]	Performance indicator	A trimester
	Revised folders rates	[Number of revised folders] / [the total number of folders received before the end of the period]	Performance indicator	A trimester

5. Conclusion

The work presented in this paper is an evaluation study of a SSC, which models and simulates the behavior of the management of civil pension rights process, and proposes a set of KPI to manage this process; this is done with a proposed methodology that combines ASDI - OSSAD – BPM – SCOR. This methodology can be used to evaluate other SSCs.

Therefore, this paper includes a literature study of the three fields 'Service supply chain", "Modeling and simulation in supply chain" and 'Retirement filed". It also presents a set of modeling methodology used in research works, followed by an explanation of the used one, which is ASDI. For the functional aspect of the studied SSC, we used the abstract and descriptive models of OSSAD method. Then BPM is used for the specification by modeling the studied process with BPMN via BONITA BPM and simulating its behavior with the same tool. On the basis of the result of the simulation, two

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performance indicators were taken into consideration, and based on the metrics presented by SCOR we defined a pilot indicator.
As a perspective, we can rely on this work to develop a dashboard that traces the delay in a service supply chain regardless of the case study and valid for any type of service.

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