Approach to Cover the Interoperability Criterion in EIS: Application to Storage Bid-requests in the Big Data of the BPIS

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Keywords: Enterprise Information System, Bid Process Information System, Interoperability, BPEL-WS, SOA, Big Data.

Abstract: Enterprise Information System (EIS) must cover the interoperability criterion between its business and technical infrastructures. Nevertheless, the "vertical fit" problems, which has deduced from the business infrastructure handicap the exploitation of this criterion. To overcome this failure, we propose in this paper our solutions to reduce the gap between business and technical infrastructures of an EIS. Particularly, we describe our approach in three main phases: Business, Middle and Technical views, in order to cover the interoperability criterion between these infrastructures. We apply our contributions to storage bid-requests in the Big Data of the Bid Process Information System (BPIS).

1 INTRODUCTION

Nowadays, the exploitation of new information and communications' technologies become increasingly a necessary condition for the evolution of any enterprise. It influences at the nature of its collaboration with its customers, its partners and its subcontractors as part of their project achievements. The competitiveness of each enterprise depends on: its degree of integrity respecting the Business Processes that it covers; its degree of interoperability with its customers, partners and suppliers that it coordinates; and its flexibility in relation to its power to adapt skills and resources to support market requirements (Zahaf, 2017 b).

The development of any enterprise depends on the quality of its Enterprise Information System (EIS) that it manipulates. Thus, the implementation of an EIS is a delicate step to achieve, since its conception until its exploitation and evolution (Zahaf, 2017 a). The urbanization approach (Fournier-Morel et al, 2008) (Bertin, 2014) implements this EIS according two infrastructures. Note that Each infrastructure incorpotates two levels. The business infrastructure which is the phase relating to the design of the EIS, covers "Business view" and "Functional view". The "Business view" represents the modelling of the business processes used by the enterprise. The "Functional view" represents the functions and flows information's towards business processes regardless of the technologies used.

The technical infrastructure which is the phase relating to the design of the EIS, covers "Application view" and "Physical view". The "Application view" represents the applications used to support functions and flows, and to equip the processes. The "Physical view" represents the material infrastructure.

Nevertheless, the Urbanization approach has to deal with "three fit" problems (Zahaf, 2014). The "vertical fit" represents the gap between business and technical infrastructures. The "horizontal fit" translates the deficiencies of identifying software's that cover the EIS at its business level (induced by the "vertical fit" problems). In addition, this fit translates the intra-applicative communications problems. The "transversal fit" interprets the inter-applicative communications problems. Such problems handicap the exploitation of the integrity, interoperability and flexibility criteria's (Zahaf, 2014). In this paper, we are interested to resolve the "vertical fit" problems of the EIS. Thus, we describe our solutions to ensure the interoperability criterion, which represent intra-enterprise and inter-enterprises communications.

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Fatnassi, K., Zahaf, S. and Gargouri, F.
Approach to Cover the Interoperability Criterion in EIS: Application to Storage Bid-requests in the Big Data of the BPIS.
DOI: 10.5220/0009563600820088
In *Proceedings of the 17th International Joint Conference on e-Business and Telecommunications (ICETE 2020) - Volume 3: ICE-B*, pages 82-88
ISBN: 978-989-758-447-3

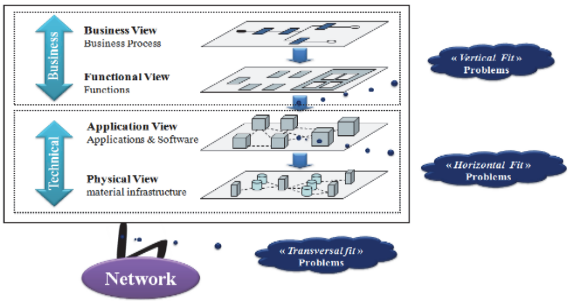

Figure 1: Enterprise Information System reference model: "three fit" problems (Zahaf, 2014).

Our approach in EIS is defining into three main phases: Business, Middle and Technical views. We apply our contributions to storage bid-requests in the Big Data of the Bid Process Information System (BPIS).

This work is organizing as follows. The second section describes our EIS approach to treat interoperability criterion. The third section represents the specification of our approach in the context of the BPIS. The fourth section shows the application of our contributions to storage bid-requests in the Big Data of the BPIS. We end this work by the conclusion and with the prospects of our future works.

2 OUR APPROACH TO EXPLICIT THE EIS INTEROPERABILITY

In order to cover "vertical fit" problems effects, we propose an approach to guarantee the interoperability criterion between business and technical infrastructures of an EIS. Figure 2 shows our approach to cover this criterion.

Our solution has based on modelling business processes using BPMN (OMG, 2011) and executing these processes using BPEL-WS (OMG, 2007). Indeed, we rely on the work of (Zahaf, 2017 a) which showed that BPMN and BPEL are the most suitable languages to define and even to implement business processes. In fact, each enterprise has its own strategy to exploit its processes flows. The BPEL standardizes the definition format of business processes flows. This language guarantees the interoperability criterion inside and between enterprises by using Web Services (BPEL-WS). Indeed, BPEL permits to orchestrate interactions between Web Services using XML documents. However, BPEL was criticizing by the difficulty to implement in the "application view" business functions defined at the business infrastructure. This premise increases the gap between business and technical levels, and enhances "vertical fit" problems effects. In order to deal with this failure, we integrate SOA approach to define functions as services in the "functional view". This solution facilitates the alignment and coherence between business and technical infrastructures of an EIS "*SOA participates in the resolution of "vertical fit" problems*" (Zahaf, 2014). SOAP technology that exploits SOA approach, permits to implement WS. It allows the transmission of data between remote applications while ensuring their security. However, this transmission was characterizing by the heaviness of the XML documents exchanged by the SOAP services (Papazoglou, 2018). In order to cope with this limitation, we propose to integrate REST-WS technology with the JSON format that ensures faster transmission than XML (Castillo, 2011).

Furthermore, we treat our interoperability propositions between the two infrastructures of the EIS. In fact, we use the Big data (Fermigier, 2012) technologies to exploit the "application view" and we show that our communication interface's permits to ensure data availability for a large volume and variety of data (structured or unstructured). We prove that our contributions permit to resolve "vertical fit" and "horizontal fit" problems.

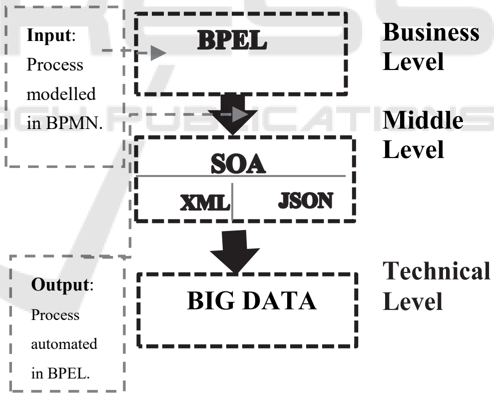

Figure 2: Our approach in Enterprise Information System to treat the interoperability problems.

We propose to implement our approach in three main phases (Figure 3):

- **Business Level:** we apply the BPEL language to automate and implement the business process. Note that the input of this phase is the process modeled with BPMN language.
- **Middle Level:** we use in the frontend: HTTP (Pasternak, 2016), Typescript (Bierman, 2014), HTML and CSS (Frain, 2012). In the Backend, we use SOAP/XML as a "repository". The

rapidity of transmissions was ensuring by the conversion from XML to JSON format in the Controller.

- **Technical Level:** we utilize MongoDB and Hadoop technologies to exploit the Big Data approach: (1) Hadoop is an open source platform, which use to store and process the huge volume of data; (2) MongoDB is a document-oriented database characterized by the notion of replication: the data is on multiple servers, leading to greater fault tolerance (Fermigier, 2012).

Figure 3 shows our implementation in EIS to guarantee the interoperability criterion.

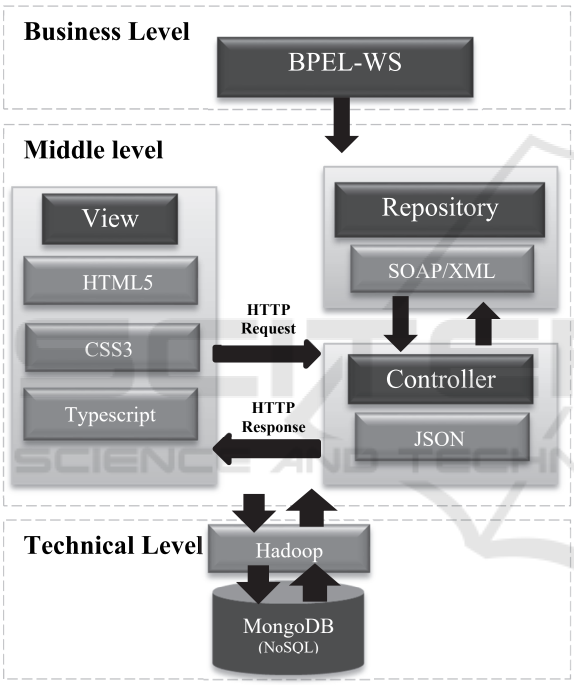

Figure 3: Implementation of the Interoperability in EIS.

In the next section, we apply our contributions to explicit the interoperability criterion in the context of the Bid Process Information System or BPIS (Zahaf, 2017 a).

3 SPECIFICATION OF THE BPIS INTEROPERABILITY

The owner emits a specific offer in order to acquire a product. After a certain delay, he receives proposals from different contributors, which submit their techno-economic expertise. The bid process studied the product design activity by optimizing factors of production (cost, price, quality of services and risks). It is a key business process, which influences the enterprise's survival and strategic orientations (Zahaf, 2017 a). The Bid Process Information System or BPIS that supports the bid process must support the interoperability (Zahaf, 2014). In fact, this criterion guarantees communications between enterprises involved to contribute together in the construction of the techno-economic proposal that materializes the bid proposition.

In the following, we propose to apply our approach, which ensures the interoperability in the functional scope of the BPIS. Concretely, we exploit our three phases in the context of the BPIS.

3.1 Business Level of the BPIS

We rely on the work of (Zahaf, 2017 a) which described the "bid process" modelling using BPMN. The proposed modelling covers three main processes: "assessment the eligibility of the bid", "elaboration of the bid proposition", and "closure of the bid process". Particularly, we are interested at the phase, which treats design activity of the product: "elaboration of the bid proposition".

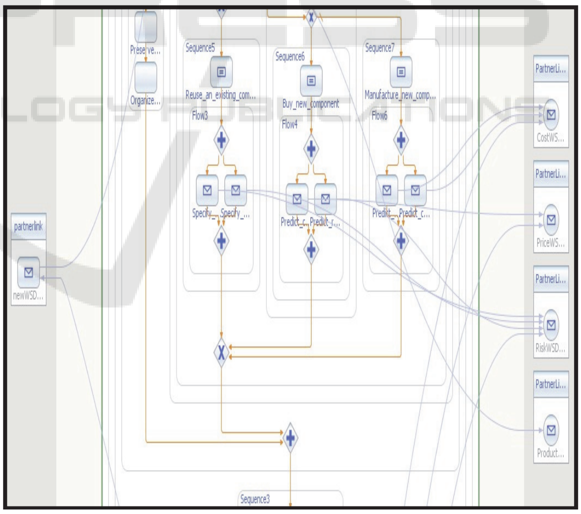

Figure 4: Extract of our implementation that covers the techno-economic Bid proposition with BPEL.

We extend the work of (Zahaf, 2017 a) by implementing the techno-economic bid proposition with BPEL. Figure 4 shows an extract of our implementation.

During The construction of the technical solution, the manufacturing tree permits to specify products to manufacture and others to purchase. Figure 5 describes

```
<invoke name="Select_technical_component" partnerLink="PartnerLink3" operation="ProductWSDL1Operation" xmlns:tns="http://j2ee.netbeans.org/wsdl/BpelModule1/ProductWSDL1" portType="tns: ProductWSDL1PortType" inputVariable="ProductWSDL1OperationIn" outputVariable="ProductWSDL1OperationOut"/>
        <if>
          <condition> ns1:doXslTransform(stub(), stub(), stub(), stub(), $ProductWSDL1OperationOut.part3) </condition>
          <sequence name="Sequence5" xmlns:tns="http://j2ee.netbeans.org/wsdl/BpelModule1/RiskWSDL1">
            <assign name="Reuse_an_existing_component">
              <copy>
                <from> concat('hello', $ProductWSDL1OperationIn.part3) </from>
                <to variable="ProductWSDL1OperationOut"/>
              </copy>
            </assign>
              <flow name="Flow3">
                <invoke name="Specify_risks_related_use_component" partnerLink="PartnerLink5" operation="RiskWSDL1Operation" xmlns:tns="http://j2ee.netbeans.org/wsdl/BpelModule1/RiskWSDL1" portType="tns:RiskWSDL1PortType" inputVariable="RiskWSDL1OperationIn" outputVariable="RiskWSDL1OperationOut"/>
                  <invoke name="Specify_component_risk" partnerLink="PartnerLink5" operation="RiskWSDL1Operation" xmlns:tns="http://j2ee.netbeans.org/wsdl/BpelModule1/RiskWSDL1" portType="tns:RiskWSDL1PortType" inputVariable="RiskWSDL1OperationIn1" outputVariable="RiskWSDL1OperationOut1"/>
              </flow></sequence>
          <elseif>
    <sequence name="Sequence6">
              <assign name="Buy_new_component">
                <copy>
                  <from variable="ProductWSDL1OperationIn" part="part3"/>
                  <to variable="ProductWSDL1OperationOut" part="part3"/>
                </copy>
                </assign>
                <flow name="Flow5">
           <invoke name="Predict_component_price" partnerLink="PartnerLink6" operation="PriceWSDL1Operation" xmlns:tns="http://j2ee.netbeans.org/wsdl/BpelModule1/PriceWSDL1" portType="tns:PriceWSDL1PortType" inputVariable="PriceWSDL1OperationIn" outputVariable="PriceWSDL1OperationOut"/>
```

Figure 5: Fragment of code in BPEL that represents the selection type of product.

an extract of the fragment of code in BPEL that represents the selection type of product required to build the technical solution. It shows the different alternatives described by “control flows” to reuse an existing product, purchase product or manufacture product.

The construction of the technical solution ends up with incorporating the financial-proposal. It includes the cost of the technical-proposal and an interval that specifies the future price of the manufactured product on the market. In addition, a study that assesses risks related to the creation of the technical-proposal, permit to support each contributor for its decision at the end of this phase: to readjust the proposal, either to finalize and transmit it to the owner or to abandon the process (Zahaf, 2017 a).

3.2 Middle Level of the BPIS

BPEL was criticizing by the difficulty to implement in the “application view”, services defined in the “functional view”.

In order to deal with this failure, we integrate SOAP-WS to solve the interoperability gap between the business and the technical levels of the BPIS. Figure 6 shows an extract of the conversion from BPEL to SOAP/XML.

It is true that SOAP permits the transmission of data while ensuring their security. However, this transmission was characterizing by the heaviness of the XML documents exchanged by the services. In order to deal with this failure, we use SOAP/XML as a "repository" and we convert XML to JSON format in the Controller. Figure 7 shows a fragment of code Java EE that convert XML to JSON of User Model.

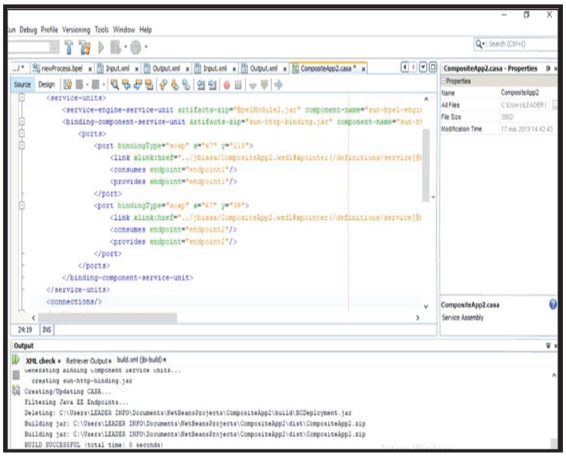

Figure 6: Extract of the conversion of the BPEL techno-economic Bid proposition to SOAP/XML Web Services.

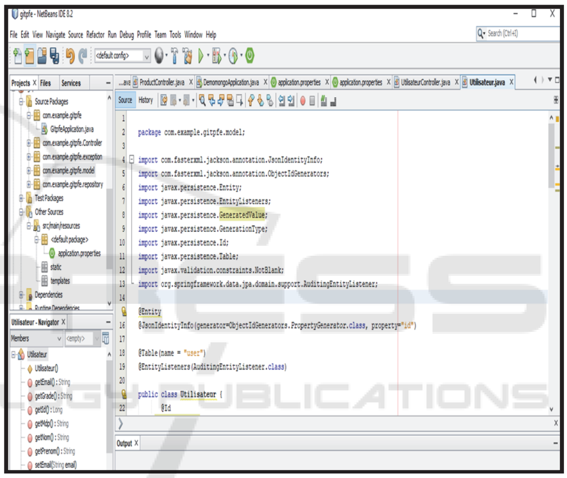

Figure 7: Fragment code Java EE that convert XML to JSON of User Model.

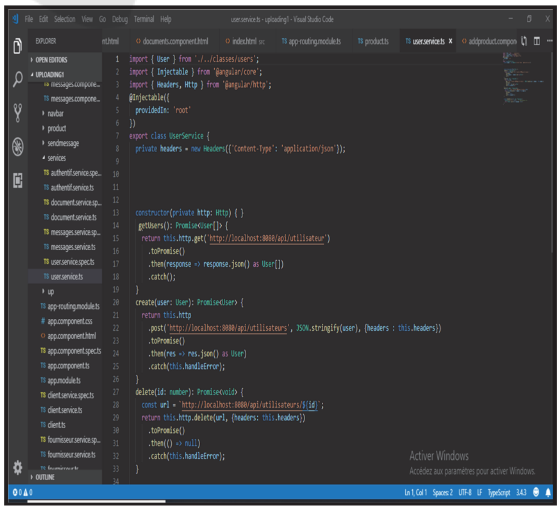

Figure 8: Fragment code JSON in angular 7 of User Web Services.

The conversion of XML document to a JSON enables to exchange data's between Web Services. Figure 8 shows a fragment of JSON code writing with angular 7 that describes the response of the WS of user by HTTP.

In fact, HTTP verbs to these actions: GET (to read information), CREATE (to create information), PUT (to update information) and DELETE (to delete information).

3.3 Technical Level of the BPIS

We propose to exploit our contributions, to evaluate the response time of request that permits to insert documents describing the characteristics of manufactured products (code, cost, price, risks, label, quantity, etc.), in the non-relational Database, that's why we propose to integrate Big Data approach (Fermigier, 2012) at this level.

In fact, the need on real time response is very important for any enterprise, which evolves in a market characterized by stiff competition, especially, in the context to contribute on the bid proposition. The Big Data approach is characterizing by:

- **Volume:** permits to treat a huge amount of data, which produces at every instant and stores in database.
- **Velocity:** permits to optimize the frequency on which data exchanges, between the client and the server.
- **Variety:** represents an amount of variety of dataset with different forms (texts, documents, images, sound, videos etc.), or different types of data that can be structured (data is represented with predefined format for example: image video, etc.) or not structured (data is represented without predefined format for example: text).

Big Data support technologies and tools to treat different problems: store, treat and access the big volume of data; an important variety of data type; and especially the access of data with a faster speed to reach. These technologies are: (1) non-relational database (NoSQL) and (2) Hadoop (High-availability Distributed Object-Oriented Platform) (Piazza, 2013).

A distributed non-relational database offers a huge volume of data with fast random access. It allows the fault tolerance in the case of a big volume of stocked data. For example, we use MongoDB, which is oriented distributed document database and an open source Big Data framework. We choose MongoDB because it bases on the principle of master-slave, and it has the capacity to store an important volume of unlimited data. Its principle is characterizes by the notion of replication in such a way data is on multiple servers, which leading to having the fault tolerance. Furthermore, the division and the duplication of documents realize as the most requested documents be in the same server. MongoDB database is exploiting by two fundamental components of Hadoop: (i) HDFS: Storage component, (ii) MapReduce: Treatment component. In fact, Hadoop is an open source apache framework written in java. It supports a huge volume of data approximately pet octets of data.

4 STORAGE OF BID-REQUESTS IN THE BPIS BIG DATA

We propose to evaluate the response time that represents the duration of execution between the moment of sending a message and the moment of the reception of results of the request.

In our approach, we are interested especially to accomplish an experimental study of response time with non-relational database « MongoDB » and « Hadoop » (Big Data).

We chose to test the response time of Web Service while using Big Data. Besides, we measure the response time for example: the response time of the bid of manufactured product by 100 millisecond (ms).

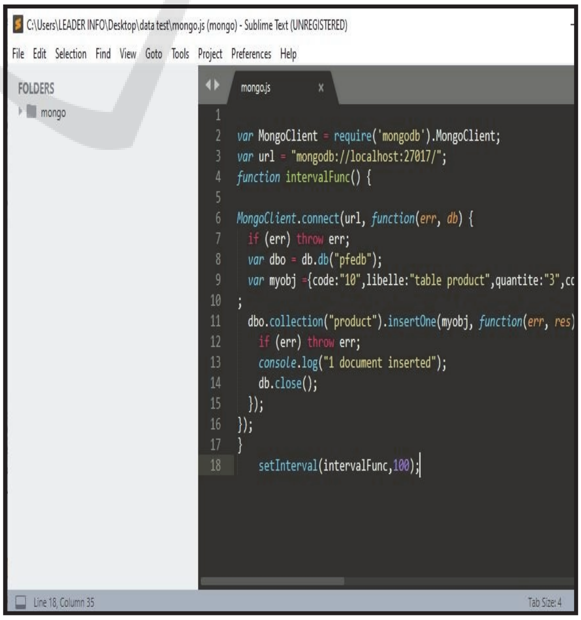

Figure 9: Fragment of function *intervallFunc()* for products design during a period of 100 ms with Big Data.

Figure 9, Figure 10, Figure 11 and Figure 12 present the obtained results by testing the response time of Big Data.

Figure 9 depicts JavaScript code of the *intervallFunc()* function. It represents the number of the inserted documents into a relational database Big Data, during a period of 100ms. We add, also, properties (code, cost, price risks, label, and quantity) which is relative for each inserted product.

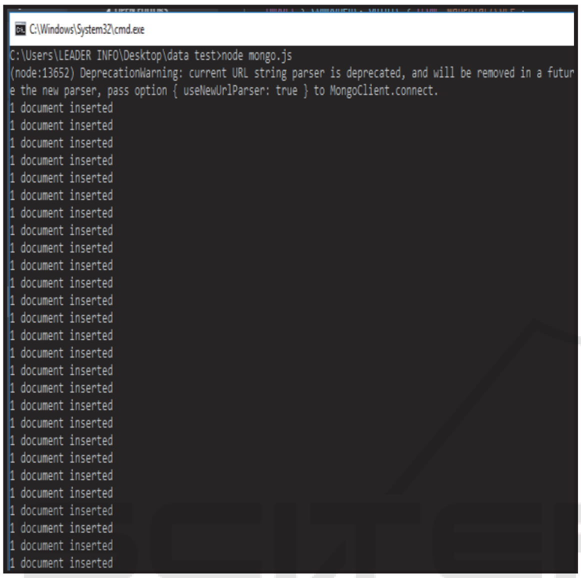

Figure 10: Extract the compilation of MongoDB database that store a dataset of product.

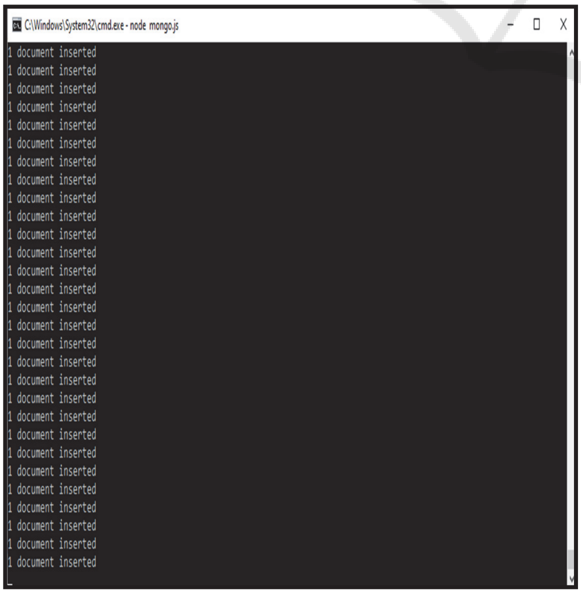

Figure 11: Extract of MongoDB database that store a dataset of product in the progress of compilation.

After the compilation of the *intervallFun()* function, Figure 10 and Figure 11 demonstrate that Big Data approach is more optimal for the storage a huge volume of datasets: more than (+232.7 k) during a period of 100 ms for *inserted documents*.

We notice that the response time of Big Data permits to store more than thousands of *inserted documents* during 100 ms. We deduce that the response time of Big Data is one of the most efficient database systems that it aims to ensure a faster speed, and to store a large variety, huge volume and high velocity of data sets.

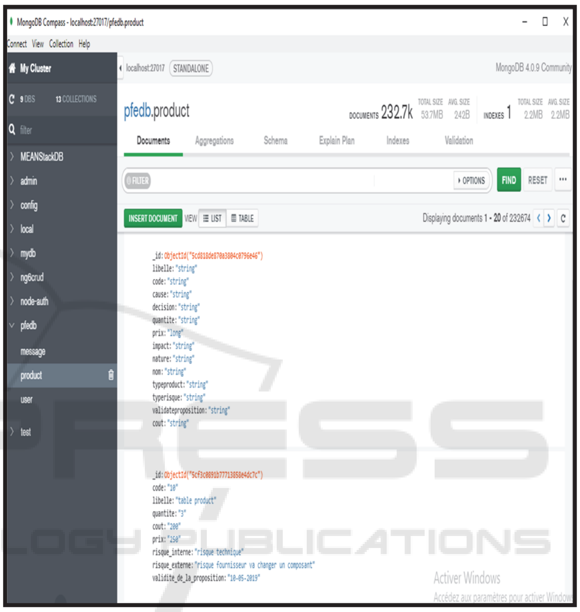

Figure 12: The inserted document of Big Data (MongoDB and Hadoop) in progress of the compilation.

Figure 12 shows an extract of MongoDB database that store user, product and message datasets, required to definite the techno-economic bid proposition.

5 CONCLUSIONS

In this paper, we have proposed our contributions to ensure the interoperability criterion in the Enterprise Information System (EIS), which is the executing support of business processes. Concretely, we have defined an approach defining into three main phases.

In the “Business View”, we have proposed to treat this criterion by modelling business processes using BPMN and executing them using BPEL language. The proposed solution permits to guarantee interoperability in the business infrastructure of the EIS.

In the “Middle View”, we have proposed to integrate SOA approach to define functions as services in the “functional view” of the EIS. In fact, BPEL was criticizing by the difficulty to implement in the “application view” business functions defined at the business infrastructure. In fact, the SOAP allows the transmission of data between remote applications. However, this transmission was characterizing by the heaviness of the XML documents exchanged by the SOAP services. To overcome this limitation, we have proposed to integrate JSON messages for the data transmissions between Web Services (WS). The proposed solution permits to cover “vertical fit” problems effects between business and technical infrastructure of the EIS.

In the “Technical views”, we have relied on the Big Data technologies in the “application view” of the EIS (MongoBD and Hadoop). In fact, our main objective consist to check communications validities between business and technical infrastructures of the EIS. Moreover, we needed to store a large volume and variety of data.

We have applied our contributions to evaluate the response time of request that permits to store documents describing the characteristics of manufactured products (code, cost, price, risks, label, quantity, etc.) in the context to contribute on the bid proposition.

In our future work, we propose to treat the interoperability between applications that covers the technical infrastructure of the EIS. Our perspectives consist to deal with “horizontal fit” and “transversal fit” problems.

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