# A proposal for a software tool to perform business process smart assessment in enterprises

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# A Proposal for a Software Tool to Perform Business Process Smart Assessment in Enterprises

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**Abstract:** The challenges faced by enterprises in a daily basis, foster them to implement improvement initiatives to be able to address them. As a first step towards the implementation of those initiatives, there is a need to perform assessments to understand the As-Is state of the enterprise considering different aspects such as maturity, agility, performance, or readiness towards digitisation. However, assessments are expensive in terms of time and resources. Specifically when considering qualitative appraisals, such as maturity or capability assessments, since they often demand the participation of one or more human assessors to review documents, perform interviews, etc. Therefore, means to automate or semi-automate the assessment process are essential, since they could reduce the effort to perform it. In this sense, this work introduces a software tool to support assessments in enterprises using text data as assessment evidence. The tool is developed following a conceptual framework named Smart Assessment Framework, which introduces a metamodel with abstract components to be instantiated for the development of systems dedicated to organisational assessments. The elements defined by the framework are grounded on the capabilities of smart systems. The application domain of the tool is focused on Process Capability assessment, in compliance with the ISO/IEC 33020:2015 international standard. The tool uses a Natural Language Processing method to process the assessment evidence and an Ontology as Knowledge Base to support the calculation of capability levels and to provide improvement recommendations.

*Keywords:* Computer software; Artificial intelligence; Machine learning; Knowledge-based systems; Efficient evaluation; Assessment

## 1. INTRODUCTION

Enterprises are continually in motion (Proper, 2013) to improve their operations, comply with regulations, adopt new technologies with effectiveness and efficiency, or optimise their costs. This implies some changes, thus the need to understand the As-Is situation so as to recognise the strengths, weaknesses and gaps of the enterprise to be able to draw the To-Be state and reach it. This will allow to identify and understand ends, means, scope, and candidate changes (Rouse, 2009). In this sense, enterprise assessments allow to obtain such understanding through a series of steps comprising assessment planning, data collection and validation, results determination, and results presentation (ISO/IEC 33002). Assessments are considered as the first step towards improvement in enterprises (Tarhan and Giray, 2017).

Throughout the years, there has been a growing interest to address different challenges that rise when performing assessments in organisations (Abdimomunova and Valerdi, 2010). In this sense, the most recent approaches are focused on the development of tools for automating the assessment activities. This is due to factors such as the transition towards digitalisation in enterprises (Rojko, 2017; Uhlemann et al., 2017), which results in more data that can be automatically analysed by dedicated systems; the ease of use of frameworks to develop both Front-End and Back-End applications with efficiency in terms of time and resources; or the rapid development and adoption of Artificial Intelligence (AI) methods (Ehrlinger and Wöß, 2016) that allow to improve the treatment of enterprise data. Regardless the motivating elements that foster enterprises, universities, and research institutes to pursuit the development of tools to support automated or semi-automated assessments, the main objective in most cases is the reduction of the need for human intervention during the assessment.

Considering qualitative appraisals, such as maturity or capability assessment, most tools are focused on the use of post-processed data as evidence, such as numerical questionnaire responses or ratings that were previously defined by assessment experts, without considering the use of raw data such as text descriptions of the assessed entity. Moreover, they are often developed without following a framework to guide the design of architecture of the system from a conceptual perspective. This work aims at tackling these issues by proposing a tool for assessment, focused on Process Capability assessment, that uses raw text data as assessment evidence. The tool is developed following a conceptual framework devised to guide the development of smarter assessment approaches: the Smart Assessment Framework (SAF) (Romero et al., 2020a).

This paper is organised as follows. Section 2 describes the related work and research challenges that drive our work. Section 3 presents the research method followed to develop the tool. Section 4 describes the main layers of the SAF used in this work. The architecture of the system is described in Section 5. The validation of the tool based on performing a real assessment is presented in Section 6. Finally, Section 7 presents the conclusions of the work and enumerates future research perspectives.

## 2. RELATED WORK

This section provides an overview of approaches introduced in the scientific literature to improve the assessment process through automation methods. We identify two main trends: papers that are focused on automating the results calculation phase of the assessment, and those that aim at automating the full process without requiring any form of human intervention.

In the first group, the work by (Lok and Walker, 1997), for instance, proposed a software tool that provides means to store assessment models in a database to keep organised all the data from the assessment. The work by Wen et al. (2008), proposed the use of a knowledge-based decision support system for measuring enterprise performance with the objective to perform results determination automatically. The system uses a set inference rules within a knowledge base, and it also considers weights provided by managers with respect to the performance metrics that are used for the assessment. The paper by Cater-Steel et al. (2016), on the other hand, introduced a paper for IT Service Management process assessment. The tool allows to collect data through online surveys and the results are provided to the user automatically through the analysis of the gathered data. The work by Adali et al. (2017) introduced a software tool for Agility assessment based on guiding the assessment through an exemplar assessment process that includes the definitions and guidance to conduct assessments. The tool follows a specific reference model to measure agility named AgilityMod (Ozcan-Top and Demirörs, 2015). On the other hand, the work by Barafort et al. (2018) describes a Software as a Service tool and the process followed to develop it. The tool was devised to aid assessors that rely on the TIPA framework (Barafort et al., 2014), which is a framework comprising a set of methods and tools to perform business process assessment. Finally, (Leal et al., 2020) presented a system devised to perform interoperability assessment through the use of an ontology to serve as a knowledge base.

Regarding tools devised to perform fully automated assessments, the software tool introduced by Krivograd et al. (2014) allows to perform maturity assessment using a generic data model that supports the use of different maturity models to perform business process assessment. The system is connected to a Business Process Management system that allows the extraction of the information required for the assessment. Moreover, it provides a function able to recommend possible improvements based on the problems that were identified. The approach by Grambow et al. (2013) proposes a similar method for Software Engineering Process assessment. However, the tool is able to sense changes of event logs in real time and it applies process mining techniques (Van Der Aalst, 2011) to provide results. The tool also allows the users to manually introduce assessment evidence.

Considering the works presented before, we have identified a lack of works focused on the processing of different types of raw unstructured data that can be generated in enterprises on a daily basis. Specifically, text data is a common resource that is often ignored in this context. This type of data can be found in documents, process descriptions, regulations, among others. Therefore, given this limitation, this work focuses on devising a software tool able to use raw text as assessment evidence and process it to provide the assessment results. On the other hand, most works present artefacts that are focused on solving specific problems without following dedicated and pre-defined generic frameworks or sets of formal guidelines. In this sense, the tool introduced in this work is defined following a conceptual framework named Smart Assessment Framework and its development is framed in the context of the Design Science Research methodology.

## 3. RESEARCH METHODOLOGY

We follow the Design Science Research (DSR) method (Von Alan et al., 2004) in this work. DSR aims at improving an environment through the incremental development of artefacts following a specific design cycle. The cycle is based on the feedback of the environment, scientific theories, experience and expertise of experts, and meta-artefacts within a knowledge base. We specifically consider the three-cycle view of DSR (Hevner, 2007) to guide the development of the proposed tool, which is considered as an artefact to improve the environment in which stakeholders that take part of an enterprise assessment operate. The main source of knowledge used in this work is the Smart Assessment Framework, a conceptual framework that has been devised in a previous work (Romero et al., 2020a) to guide the development of smarter assessment approaches based on the integration of capabilities from smart systems (Romero et al., 2020b) to perform assessments.

In the **Rigour Cycle**, we take as main source of knowledge the Smart Assessment Framework, since it provides the grounds for the development of artefacts such as the one presented in this work. Moreover, knowledge regarding technical aspects is also considered, including documentation of development frameworks, as well as papers, documents and books explaining the implementation and use of ontologies and neural networks architectures.

In the **Relevance Cycle**, we consider as requirement for the artefact that it must be compliant with the concepts and relationships defined in the SAF. Moreover, the validation of the assessment experts is another relevant condition. The main idea behind both requirements is that their fulfilment will lead to an artefact able to address the defined problem so as to ultimately serve as an improvement driver for the environment.

The activities of the **Design Cycle** include the design, development and evaluation of the tool, following in an iterative cycle. The first two tasks are performed by the authors, whilst the evaluations of the tool are done through meetings with specialists in the field of assessment, specifically within the domain of Business Process Capability assessment. In addition to the meetings with experts, the evaluation of the artefact is also based on verifying if the architecture of the system is robust in terms of compliance with the main concepts from the source of knowledge.

## 4. SMART ASSESSMENT FRAMEWORK

The Smart Assessment Framework is a conceptual framework devised to serve as base for the development and implementation of assessment methods that have the support of systems with smart capabilities such as reasoning, learning, and data perception. The metamodel of SAF, defined using the ArchiMate language (Band et al., 2016), presents three main layers to be considered for smart assessments: Management Goals, in which the motivational aspects of the assessment are defined; the Assessment Process, which shows the elements of the assessment from the business perspective; and the Application Services, which presents the components and services that must be used to perform assessment, from a software engineering point of view. In this work, we focus on the Application Services layer of SAF, since we are focused on the development of a software tool. The elements of this layer are shown in Figure 1.

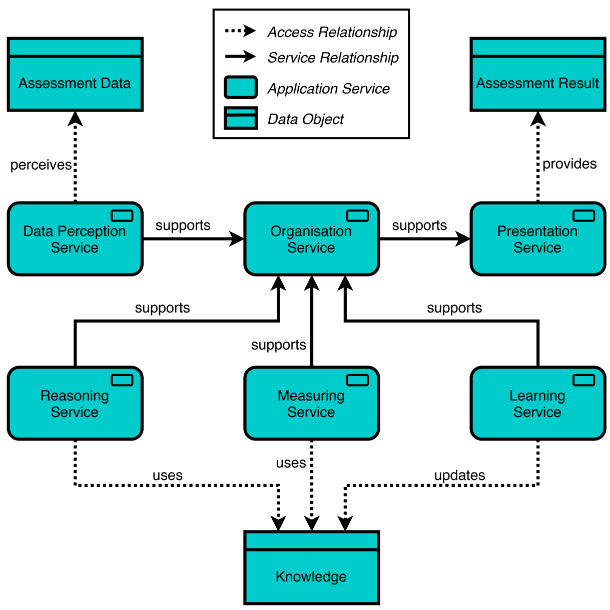


Fig. 1. Elements of the Application Services layer proposed in the SAF.

SAF proposes the development of systems that provide three main services in its Application Services Layer, and these services are performed by a certain dedicated component. The first service, **Data Perception** is performed by a Perception Manager component. Its main objective is to sense or receive input data to be used for the assessment, pre-process the data and provide it to the Organiser component. The Perception Manager could sense data as well using sensors, or provide the proper interface for humans to interact with. The **Organisation Service** is the core of the Application Services layer of SAF, it is performed by an Organiser component, which receives the pre-processed assessment data from the Data Perception Service and distributes it to three components depending on the needs: Reasoner, Measurer, and Learner. The Reasoner provides the Reasoning Service, and it uses Knowledge to infer new information regarding the Assessed Entity. The Measurer uses pre-programmed measurement mechanisms that are defined by the Assessment Model or Framework to calculate and provide assessment results. The Measurer could also aggregate results, if required. The Learner provides the Learning Service based on updating the existing Knowledge, which is considered as another element of SAF that can be in the form of data organised in a database, ontologies, or pre-trained Machine Learning models. Finally, the **Presentation Service** receives the results of the assessment provided by the Organisation Service and generates a structured view of those results to the stakeholders.

In this work, we use the components, services and relationships of SAF as guide to develop the software tool. Concretely, we instantiate elements of SAF defined in its Application Services layer to develop components that are interconnected to perform automatic and semi-automatic assessment of enterprise entities. The following section presents the instantiated elements in detail. For more information about the SAF we encourage the reader to refer to the original paper (Romero et al., 2020a).

## 5. THE SOFTWARE TOOL

The architecture of the software tool introduced in this work is presented in Figure 2. It shows the three main services defined by the SAF: Data Perception, Presentation and Organisation. It includes the Knowledge element as well. In this section, we present details regarding the architecture of the system considering how each service is provided and the methods and technologies that are used.

The Data Perception and Presentation services are both provided through the Front-End part of the tool. In this sense, the input Assessment Data is provided by human assessors directly to the software and the Assessment Results are also given by the tool through a visual interface that can also allow to download them. The version of the tool described in this work provides support for the input of text evidence and it provides the Assessment Result in two formats: text and ontology. The Front-End part of the application has been developed using the React framework (Fedosejev, 2015), which is an open source JavaScript library for building user interfaces. React was developed by Facebook and it was released in 2013. In addition to React, we use other JavaScript libraries to support it such as React Redux [1], or React Redux Thunk [2].

The Organisation service is provided by a Back-End application that acts as a server using the Python Flask library [3]. The application receives POST requests [4] from

[1] react-redux.js.org
[2] github.com/reduxjs/redux-thunk
[3] flask.palletsprojects.com
[4] w3.org/Protocols/rfc2616/rfc2616-sec9

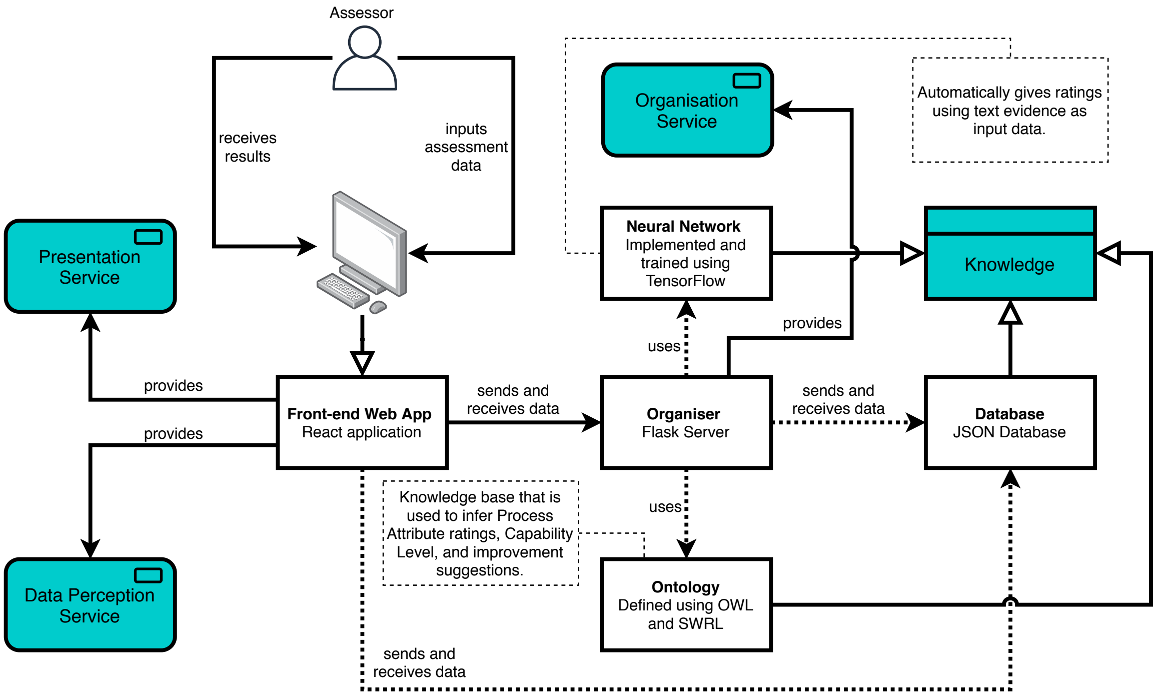


Fig. 2. Architecture of the system. Elements represented with white boxes are concrete components providing Application Services and accessing Data Objects, whilst the light dotted lines and boxes are used to add information regarding a specific component. Arrows with white triangles represent inheritance.

the Front-End application and it follows the pipeline described in Figure 3. The requests contain in their body all data from the assessment including name of the enterprise, name of the assessed entity, evidence type, and the proper assessment evidence.

After the reception of the request from the React application, the evidence is formatted and used as input for a neural network that was previously trained with historical data. The neural network used in this work is a Long Short-Term Memory Network (LSTM) (Hochreiter and Schmidhuber, 1997), a type of network (Hassoun et al., 1995) that is intended to solve problems in which long-term temporal dependencies must be learned. The model receives as input a set of text sentences describing a certain entity. For Process Capability assessment, the network provides ratings for each sentence, which are then aggregated to provide the overall rating for a certain Indicator of the process. Indicators can be seen from different perspectives: in the ISO/IEC 33020:2015 standard (ISO/IEC 33020), which is used in this work. They represent sources of evidence explaining the value of the attribute of a process, and they are organised considering Base Practices and Generic Practices, which are also grouped into Process Attributes (PAs). For instance, the rating for Process Attribute 1.1 - Process Performance (PA11) in ISO/IEC 33020:2015, which is a measure of the extent to which the process purpose is achieved, depends on the ratings given to the Base Practices of the process. Thus, an aggregation step must be performed in order to obtain the final rating of the PA.

Once the ratings for the PAs that are under consideration are obtained, the next step is to define a new set of individual instances from a pre-defined ontology. Ontologies allow to represent shareable and reusable knowledge describing some domain (Klein and Fensel, 2001). They serve as metadata schemas, providing a vocabulary of concepts with explicitly defined semantics that can be processed by computer programs (Maedche and Staab, 2001). The ontology used in this work defines a set of concepts related to Process Capability assessment from the perspective of the ISO/IEC 33020:2015 standard. The ontology has concepts such as Requirement, Capability Level, Process Attribute, Base Practice, Generic Practice, Recommended Practice, among others. The ratings provided by the organiser are used to calculate the ratings for Process Attributes and the achievement of Capability Levels. Moreover, recommended practices to improve the assessed process towards the achievement of a certain Capability Level are also defined. These results are then saved in a JSON database through another POST request, and a final answer containing the Assessment Results are sent to the Front-End application. Once the answer from the Organiser is received, the Front-End application updates the view so as to present the results to the user.

Note that both, the neural network and the ontology could be structured and defined differently depending on the entity to be assessed and the assessment framework that is used. Moreover, the type of assessment evidence is also relevant for the configuration of both elements. The current version of the tool allows to perform Process Capability assessment for text evidence only, and the network and the ontology are specific for such purpose. However, future work will extend the capabilities of the tool considering this limitation. On the other hand, it is worth mentioning that the tool also allows to register a new type of process, with the possibility to define its list of Base Practices. It also provides support to report bugs.

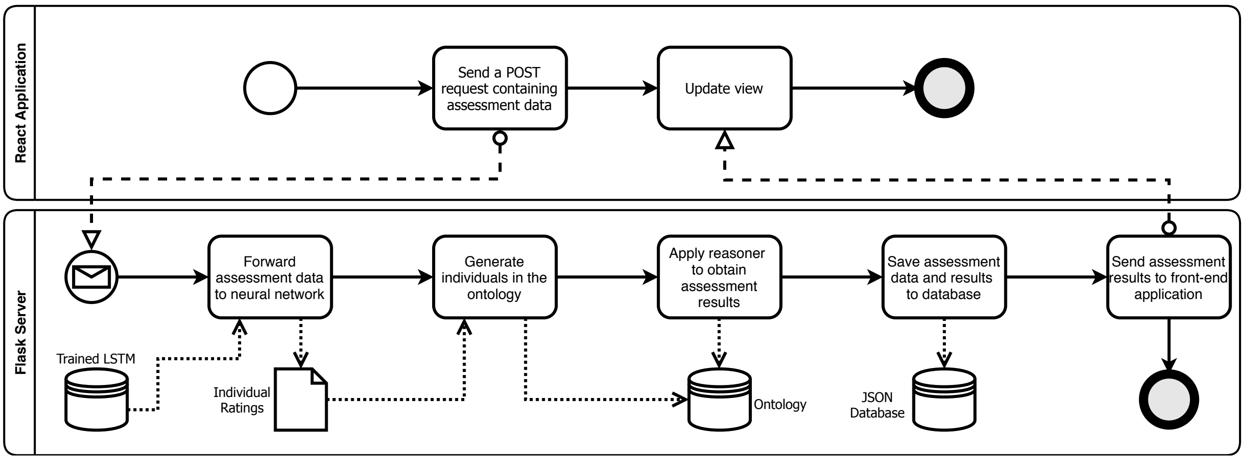


Fig. 3. Overview of the tasks performed by the Front-End and the Back-End applications of the software tool.

## 6. TOOL VALIDATION

The main steps of an assessment performed using the tool is presented in Figure 4. The assessed entity is a business process that comprises activities of reception, treatment, destruction, and returning of different types of chemical samples that are used in an organisation. The data is configured in text format, and it comprises descriptions of different aspects of the process. The objective is to provide the measurement of the capability level of the considering practices up to capability level 1. The first step is to input the information about the assessed entity and the scope of the appraisal (screen 1), and the text evidence describing the practices to evaluate (screen 2). Then, the user clicks on the *Perform Assessment* button, and the process described in Figure 3 takes place. Once the assessment is finished, the results are displayed in a dedicated page (screen 3). Since we aim at assessing capability level 1, four specific Base Practices (BPs) were defined to be rated by the system: BP1 - Management of samples reception, BP2 - Management of samples processing operation, BP3 - Return of samples, and BP4 - Destruction of samples. The system provides rating for each practice and they are then aggregated to define the rating for Process Attribute 1.1 - Process performance (PA 1.1). If the rating of PA 1.1 is equal or higher than L - Largely Achieved, then capability level 1 is reached.

## 7. CONCLUSION

This work introduced a software tool devised to perform assessments in enterprises. The development of the tool was performed following the Design Science Research methodology and it was guided by the Smart Assessment Framework. The former aims at improving an environment through the incremental development of artefacts following a specific design cycle, whilst the later defines a set of conceptual elements structured in layers to guide the development of smart systems dedicated to support assessments. To validate the artefact and show its applicability, we performed an assessment of a chemical samples management process targeting capability level 1.

Future work will aim at improving the tool through the possibility to use other types of assessment evidence such as enterprise models, audio and video files, and raw data coming directly from sensors, without the need to rely on human assessors to input data. On the other hand, the possibility to select profiles and use other assessment frameworks besides the ISO/IEC 33020 standard will also be addressed. Moreover, different enterprise entities or aspects could be evaluated, in addition to the already

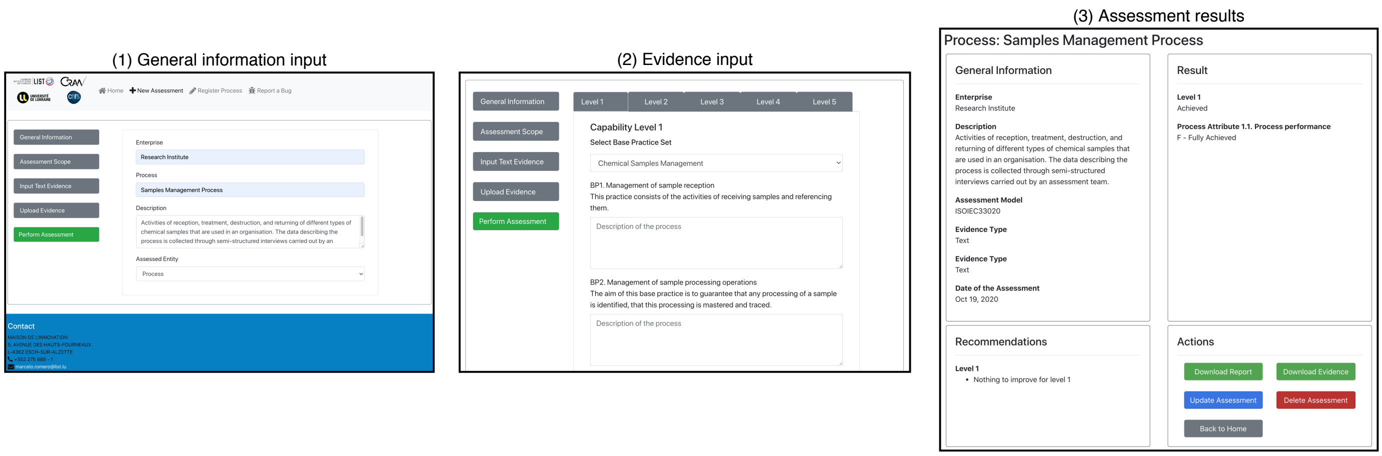


Fig. 4. Main screens of the application that allow to perform the assessment.

available support for business process assessment. Finally, other elements acting with the Organiser component of the system could be designed and implemented, depending on the type of assessment evidence to be used.

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