Supporting Manufacturing Processes Design Using Stakeholder Opinions and Sentiment Analysis

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Abstract. In this paper we present a novel approach of empowering the design of business processes in manufacturing and broader by using sentiment analysis on collaborative comments collected during the design phase of business processes. This method involves the implicit information of sentiment hidden behind the suggestions for the process improvements. To discover and utilize the sentiment for process redesign we trained and tested our Sentiment Analysis Module (SAM). This module classifies and scores the sentiment of comments and acts as a part of software tool for BPMN based modeling and annotation. As initial step we designed a real world use case to demonstrate the possibilities of our software. The preliminary result with evaluation test case seem to be promising regarding effective ranking and classifying the improvement proposals on BPMN design of manufacturing processes. However, there is still plenty of space for improvements in trainings data segment and in extending the tool with social BPMN functionality.

Keywords: Sentiment Analysis · Business Process Redesign · Business Process Management.

1 Introduction and Motivation

Traditional process design approaches often follow a top-down decomposition resulting in a long running improvement process, that requires intensive negotiations for achieving effective changes. However, unpredictable market changes require more flexibility on this matter. Changing preferences in the customer's needs require fast changes in manufacturing process models. Hence, there is a need for an agile approach for reacting to the changing business landscape.

One of the possible empowerment could be using the advanced technologies like artificial intelligence and machine learning and methods such as sentiment analysis to analyze in fast and efficient way the opinions and insights from different stakeholder in manufacturing process. In this paper we consider such case by involving a sentiment analysis module into a conventional design process scenario and using it as empowering assistant for prioritization of redesign suggestions and comments on the process.

2 Related Work

2.1 Business Process Modeling

The overall goal of Business Process Modeling is to establish a common perspective and understanding for a business process within an enterprise between the relevant stakeholders involved. Hereby, the most common graphical representation such as flowchart [1] or similar serves as base to show the process steps and workflows. This approach is widely used to recognize and prevent potential weaknesses and implement improvements in companies processes as well as to offer a good base for comprehensive understanding of a processes in general.

2.2 BPMN

The BPMN 2.0 (Object Management Group, 2011) is a new standard for business process specification developed by a variety of Business Process Modeling (BPM) tool vendors. This standard is one of the most important forms of representing business process models, offering clear and simple semantics to describe the business process of a business [2, 3]. This language was developed with the intention of modeling typical business modeling activities [4, 5].

2.3 Business Process Redesign

Business Process Redesign (BPR) aims at improvement of vital aspects of business processes aiming at achieving some special goal e.g. reducing costs. The importance of BPR was initially outlined by the work of Davenport and Short [6] in early 90s. However, this wave of enthusiasm flattened out by the end of decade due to the concept misuse, immaturity of necessary tools and too intensive approach regarding the phase of application.

Revival of the BPR concept according to [7] happened in relation to BPM, where several studies that appeared showed that organizations which are more process oriented performed better then those which did not follow this paradigm. Studies that followed confirmed these findings. This established the new credibility to the process thinking. The BPR has been seen in this case as set of tools that can be used within BPM.

2.4 BPM Lifecycle

BPM lifecycle described in [7] represents different phases of the process beginning by analysis and ending by process monitoring and controlling and process discovery. Our usage scenario in this lifecycle is placed between the process analysis and process redesign phases. During the design phase of the BPM lifecycle, social software adequately integrates the needs of all stakeholders [8].

2.5 Sentiment Analysis and Opinion Mining in Business Processes

Data mining is being used in the field of BPM for process mining. The process mining is focused on processes at run-time, more precisely for re-creating a business process from systems logs. Opinion mining is a sub-discipline of data mining and computational linguistics for extracting, classifying, understanding and assessing opinions. Sentiment analysis is often used in opinion mining for extracting opinions expressed in text. However, current research is focused on e-business, e-commerce, social media and social networks like Twitter and Flickr rather than BPM and BPR [9].

3 Supporting the Process Design

We use our SentiPromo Tool [10] for this purpose to empower the (re)-design through integration of stakeholder's needs expressed as opinions. SentiProMo Tool[1] was developed in our department in order to provide a possibility of a role based social intervention within the business process (re)-design. The roles supported in this tool are leaned on prior research on business process knowledge management framework [11]: Activity Performer (AP), Process Owner (PO), Process Designer (PD), Superior Decision Maker (SDM) and Customer (C). According to [8] BPM tools that follow the social BPM paradigm provide a mechanism to handle priorities within a business process [8]. This also applies to SentiProMo Tool. Beside process modeler and business process repository

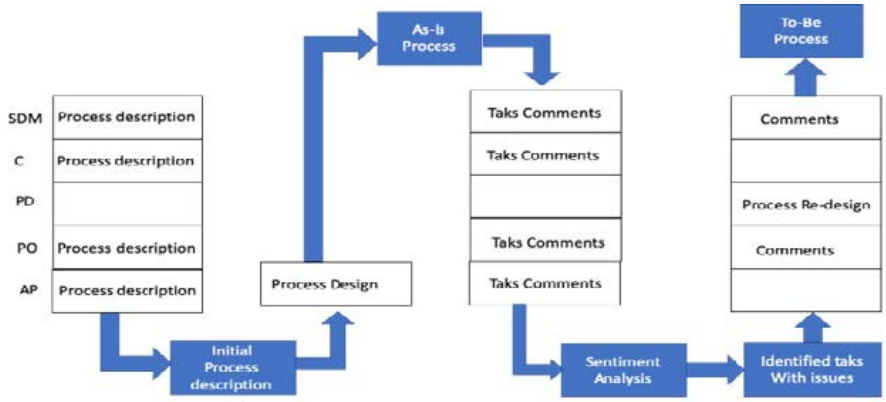

Fig. 1. Commenting workflow and the role of sentiment analysis.

module, the tool has the task commenting module which allows adding task-wise comments to process from the perspective of different roles.

[1] https://sites.google.com/view/sentipromo

As empowerment of commenting process in background runs the Semantic Annotation Module (SAM) which classifies the comments and assign them to a positive or negative sentiment using a real score. Sentiment Analysis Module (SAM) was implemented using the ML .NET for classifying comments in English language [12]. The SAM module uses supervised learning as base for comment classification. The training data originates from Sentiment Labeled Sentence Data Set from UCI Machine Learning Repository[2] and from Sentiment140 data set from Stanford[3]. The training was preformed with different number of iteration on different algorithms. Averaged perceptron binary classification model turned to be the best choice in this case. This model shows best AUC (Area Under The Curve) (approx. 0,89) and other relevant measures according to [13].

4 Application Use Case

Each time we use the task commenting module to comment a single task from a stakeholders perspective as shown in figure 2 SAM module calculates on the fly the sentiment score for the given comment.

Figure 3, shows the processed sentiment analysis of the stakeholders' comments over all commented tasks within the SentiProMo tool. Each processed comment is presented as a row. For each row, we have the following elements presented as columns from the leftmost to the rightmost as follows: the task identifier, the task name, the stakeholders' category (from the identified stakeholders we mentioned before), the comment made by a specific stakeholders, the calculated sentiment score as positive or negative number and a timestamp that registers the time of the comment insertion by the corresponding stakeholder.

Figure 4, shows an overview score as positive or negative number performed by SentiProMo of the sentiment of the whole process as negative sentiment and positive sentiment. The software calculates the resulting number by adding all negative and positives sentiments of each task.

Additionally the same score can be seen out the perspective of single roles in process. For instance in figure 5 we see te sentiment score over all tasks in particular for the role of 'Activity Performer'.

5 Conclusion and Outlook

We use sentiment analysis as empowerment, in the context of process design. Sentiment analysis seems to be a perfect fit for the field of BPR because we can analyze the user‘s opinions with it and engage immediate changes in the process re-design. In preliminary case study we obtained also encouraging results for accuracy, sensitivity, specificity and F1-score. In the future we will provide more training data to improve the performance of sentiment analysis module and we will extend our software tool with options to comment the process remotely using the web interfaces.

[2] https://archive.ics.uci.edu/ml/datasets/Sentiment+Labelled+Sentence
[3] http://help.sentiment140.com/for-students/

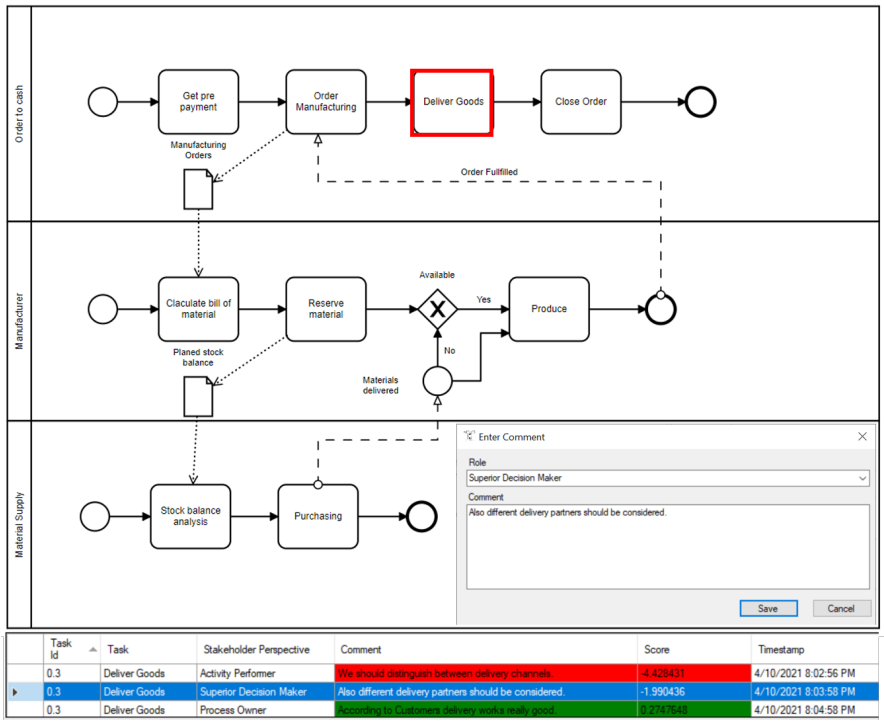

Fig. 2. Commenting Toyota supply chain management process as defined in [14].

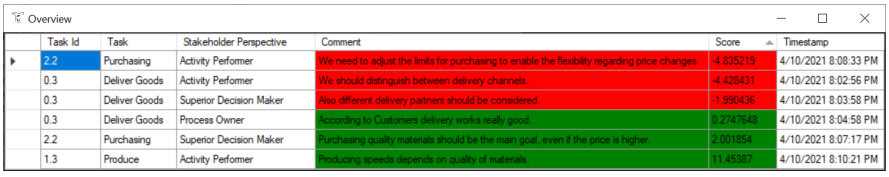

Fig. 3. Overview over all comments and sentiment ratings.

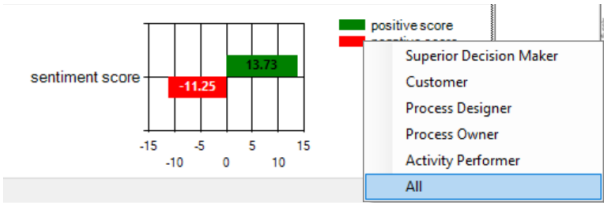

Fig. 4. Overall sentiment score in process.

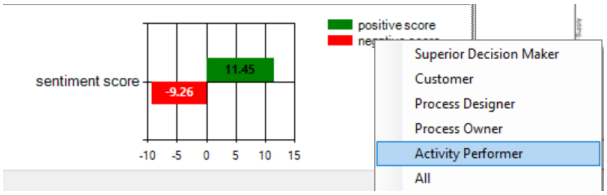

Fig. 5. Overall sentiment score of 'Activity Performer' role in process.

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