

Automated analysis with event log enrichment of the European public procurement processes

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Agenda

- Introduction
- Case study
- Methodology
- Results
- Conclusion and future work



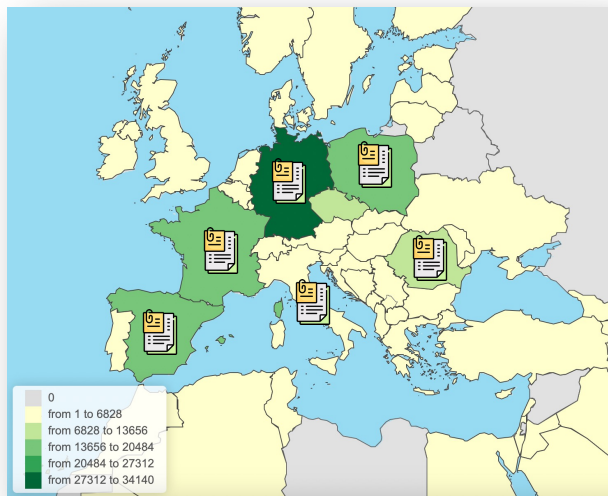
Introduction

- Public tender processes are often lengthy, which has an impact on the legal and political system as a whole.



Introduction

- In addition, special attention is paid to the **European landscape**, where there is difficulty in standardizing the legislative framework because of the different characteristics and practical applications peculiar to each member state.



Introduction

- Starting from *timed activities registered in information systems (event log)* we propose the adoption of automated **Process Mining (PM)** technique to:

RQ1 grasp relevant insights on public tenders;

RQ2 comparing the procedures of public tenders in different European member states;

RQ3 enrich the *legal event log* by extracting features from public tenders by using Natural Language Processing (NLP) techniques.

Case study

- Legal data of tenders and processes related to publication procedures of European Union can be found in the **Tenders Electronic Daily (TED)** website.

The screenshot shows the TED website interface. At the top, there's a navigation bar with links like 'Site map', 'About TED', 'Help', 'Legal notice', 'Cookies', 'Contact', and 'English (en)'. Below this, the main header features the TED logo and the text 'tenders electronic daily' and 'Supplement to the Official Journal of the EU'. A search bar is present with the text 'Search TED for public tenders' and links for 'Advanced search' and 'Expert search'. The main content area shows a search result for 'EU solidarity with Ukraine' with a link to 'Prozorro+: Ukrainian public procurement platform'. Below this, there's a 'Search result' section with filters for 'Search scope: Active notices', 'Notice type: [dropdown]', 'Common procurement vocabulary (CPV): [dropdown]', 'Place of performance: ITA x', and 'Country of the buyer: [dropdown]'. A table of results is shown with columns for 'Document number', 'Description', 'Country', 'Publication date', and 'Deadline'. The first result is '611994-2023' for 'Italy-Rome: Database services'.



735 thousand notices a year



~670 billion euro



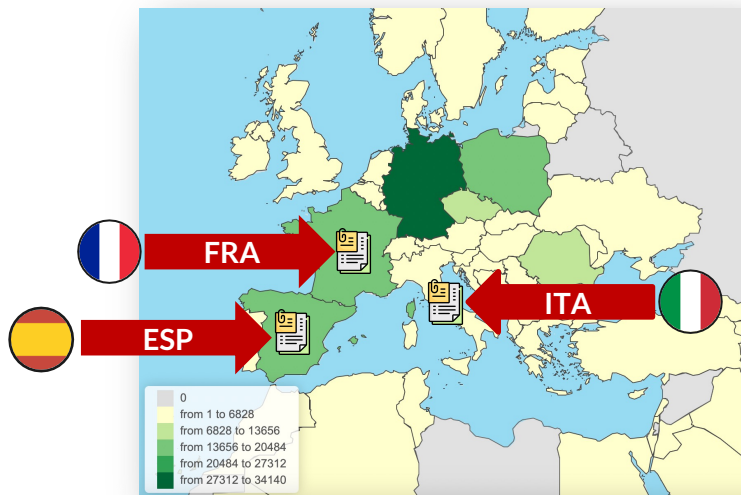
3 sector (works, supplies, services)



24 languages

Case study

- Following the suggestion of domain experts, we focused on regional authorities of the **French** (FRA), **Italian** (ITA), and **Spanish** (ESP) cases.
 - According to the domain experts, the three member states are similar in the legal review system.



Case study

- Tender **metadata** entry available on TED (in **CSV** format):
 - document number (*key value*), NUTS (country / region / province), sector, amount, activities and dates.

Metadata



Document number ▾	Description	Country ▾	Publication date ▾	Deadline ▾
<u>615722-2023</u>	Italy – Sewer cleaning services – SERVIZIO DI CONTROLLO, PULIZIA, SPURGO, DISINTASAMENTO E VIDEOISPEZIONE DELLE RETI E DEGLI IMPIANTI DEL SERVIZIO IDRICO INTEGRATO DELL'EX ATO SAVONESE Type of buyer: Public undertaking, controlled by a local authority Notice type: Contract or concession award notice – standard regime Type of procedure: <u>Open</u> Type of contract: <u>Services</u>	<u>ITA</u>	<u>11/10/2023</u>	

Case study

- Tender data entry available on TED (in PDF format):
 - unstructured text containing tender's information divided into paragraphs.

Data



ITALY - SEWER CLEANING SERVICES - SERVIZIO DI CONTROLLO, PULIZIA, SPURGO, DISINTASAMENTO E VIDEOISPEZIONE DELLE RETI E DEGLI IMPIANTI DEL SERVIZIO IDRICO INTEGRATO DELL'EX ATO SAVONESE

196/2023

Contract or concession award notice – standard regime

1. Buyer

1.1 Buyer

Official name: [CONSORZIO PER LA DEPURAZIONE DELLE ACQUE DI SCARICO DEL SAVONESE S.P.A.] —

Legal type of the buyer: Public undertaking, controlled by a local authority

Activity of the contracting authority: Environmental protection

2. Procedure

2.1 Procedure

Title: SERVIZIO DI CONTROLLO, PULIZIA, SPURGO, DISINTASAMENTO E VIDEOISPEZIONE DELLE RETI E DEGLI IMPIANTI DEL SERVIZIO IDRICO INTEGRATO DELL'EX ATO SAVONESE

Description: LOTTO 1: "APPALTO PER IL SERVIZIO DI CONTROLLO, PULIZIA, SPURGO, DISINTASAMENTO E VIDEOISPEZIONE DELLE RETI E DEGLI IMPIANTI DEL SERVIZIO IDRICO INTEGRATO DELL'EX ATO SAVONESE - CENTRO OVEST 1 - (SETTORE DI LEVANTE)" LOTTO 2: "APPALTO PER IL SERVIZIO DI CONTROLLO, PULIZIA, SPURGO, DISINTASAMENTO E VIDEOISPEZIONE DELLE RETI E DEGLI IMPIANTI DEL SERVIZIO IDRICO INTEGRATO DELL'EX ATO SAVONESE - CENTRO OVEST 1 - (SETTORE DI PONENTE)"

Procedure identifier: 3cd026d6-91b3-4c1a-ac04-3e975b6b0761

Type of procedure: Open

2.1.1 Purpose

Nature of the contract: Services

Main classification (cpv): 90470000 Sewer cleaning services

2.1.4 General information

Additional information: Il responsabile del procedimento in fase di affidamento dott. Mirco Conterno

Legal basis:

Directive 2014/24/EU

5. Lot

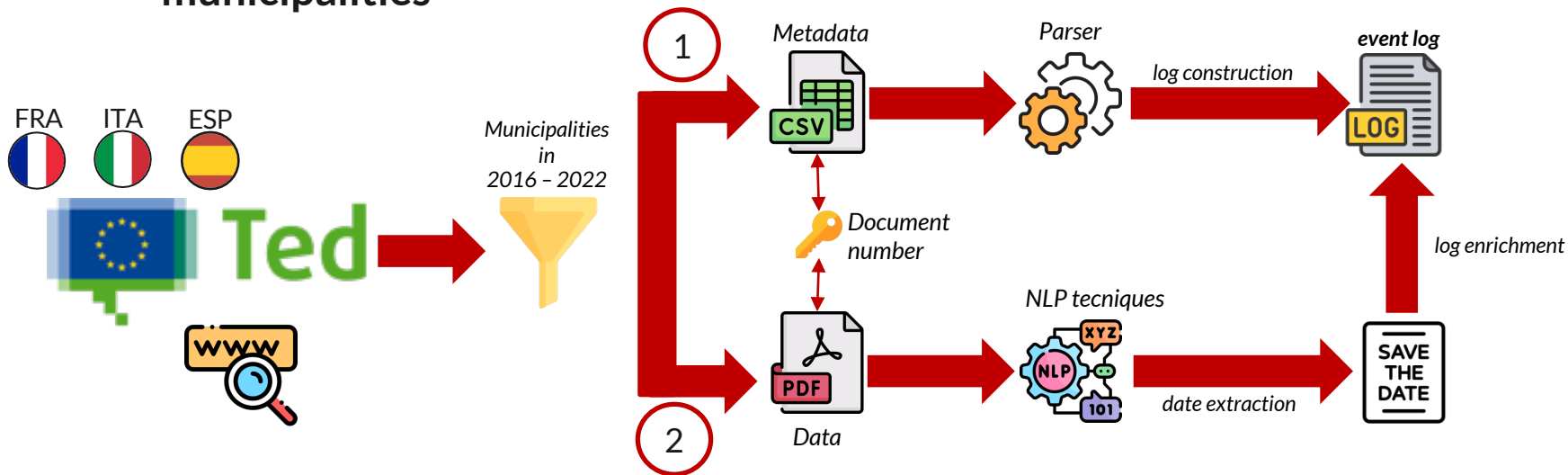
5.1 Lot: LOT-0001

Title: CIG: 9908883CEB

Description: LOTTO 1 - SETTORE DI LEVANTE: Comuni di Albisola Superiore, Albisola Marina, Bergeggi, Celle Ligure, Quiliano, Savona, Stella, Vado Ligure e Varazze LOTTO 1: € 689.000,00 oltre IVA di cui: € 260.000,00 inclusi costi per la sicurezza per il primo anno solare; € 260.000,00 inclusi costi per la sicurezza per eventuale rinnovo di max 1 anno; € 65.000,00 per eventuale proroga, stimata in massimo 90 (novanta) giorni necessaria alla conclusione delle procedure per l'individuazione di un nuovo contraente; € 104.000,00 per eventuali modifiche ai sensi dell'art. 106

Methodology

- The event log was created from the collection of **annual tender and award notices** available on the TED portal.
 - Our final collection: **FRA, ITA, and ESP** cases from **2016 to 2022** for **municipalities**



Methodology

- An **event log** is a set of **traces**, that includes at least *three* basic features:
 - 1) the *identifier* of the trace (**Case ID**);
 - 2) the name of the **Activity** which generated the event;
 - 3) the execution **Timestamp** of an activity.



Case ID;Activity;Timestamp;Sector;Amount;Nuts;Country

Trace 1

2017106814;PUBLICATION;2017-03-17;S;1035000.0;ITC13;IT
2017106814;PARTICIPATION;2017-05-09;S;1035000.0;ITC13;IT
2017106814;AWARD;2017-06-07;S;1035000.0;ITC13;IT
2017106814;CONTRACT-START;2017-09-01;S;1035000.0;ITC13;IT
2017106814;CONTRACT-END;2022-07-31;S;1035000.0;ITC13;IT

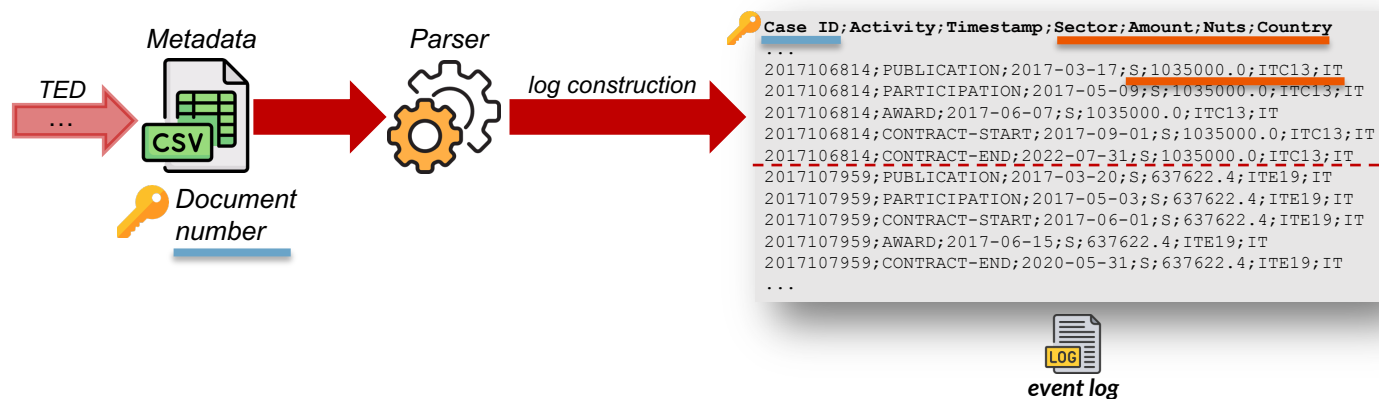
Trace 2

2017107959;PUBLICATION;2017-03-20;S;637622.4;ITE19;IT
2017107959;PARTICIPATION;2017-05-03;S;637622.4;ITE19;IT
2017107959;CONTRACT-START;2017-06-01;S;637622.4;ITE19;IT
2017107959;AWARD;2017-06-15;S;637622.4;ITE19;IT
2017107959;CONTRACT-END;2020-05-31;S;637622.4;ITE19;IT

...

Methodology

- In our case study, tender document-number is the Case ID.
- In addition, we add in the event log file as attributes the information on the corresponding tender's sector, NUTS, country, amount.



Methodology


- Starting from the **textual data** of the tenders, we found an event that was *not* available in the metadata, i.e. the **bids opening**.
- To enrich the event log with the bid opening, we dive into date extraction.

Spark NLP
DateMatcher annotator

VS

^[a-z]\$_


RegEx



ITALY - SEWER CLEANING SERVICES - SERVIZIO DI CONTROLLO, PULIZIA, SPIRUGO, DIRAMMENTAMENTO E VIDEOSPESSIONE DELLE RETI E DEGLI IMPIANTI DEL SERVIZIO IDRICO INTEGRATO DELL'EXATO SAVONESE
196/2023
Contract or concession award notice - standard regime

1. Buyer
Official name: [CONSORZIO PER LA DEPURAZIONE DELLE ACQUE DI SCARICO DEL SAVONESE S.P.A.] -
Legal type of the buyer: Public undertaking, controlled by a local authority
Activity of the contracting authority: Environmental protection

IV.3.8) **Modalità di apertura delle offerte**
Data: 18.1.2019 - 09:30
Luogo:
Sede comunale degli uffici pubblica istruzione siti in Busto Arsizio, via Alberto da Giussano 12, 21052 Busto Arsizio.
Persone ammesse ad assistere all'apertura delle offerte: sì
Informazioni complementari sulle persone ammesse e la procedura di apertura: Legali rappresentanti/ procuratori delle imprese interessate oppure persone munite di specifica delega. In assenza di tali titoli, la partecipazione è ammessa come semplice uditore.



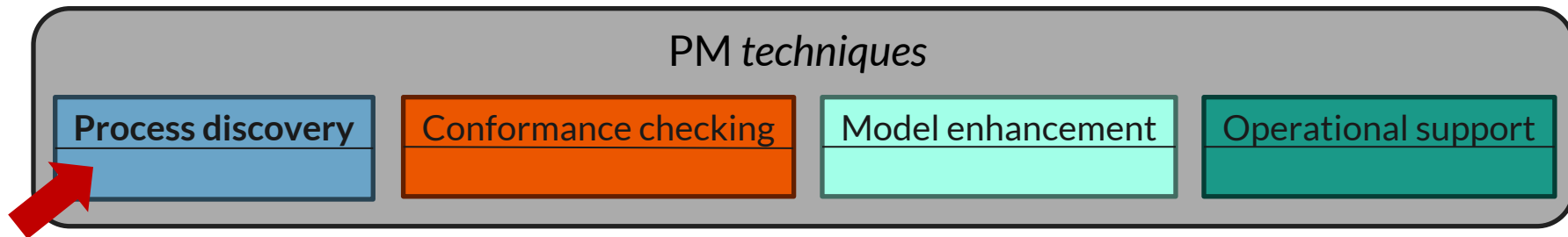
5. Lot
5.1 Lot LOT-0001
Title: CIG-969883CCEB
Description: LOTTO 1 - SETTORE DI LEVANTE: Comuni di Abbiate Superiori, Abbiate Marina, Beregnago, Cella Ligure, Gallarate, Saronno, Stalla, Vado Ligure e Varesina LOTTO 1: € 689.000,00 oltre IVA di cui € 260.000,00 inclusi costi per la sicurezza per il primo anno solare; € 260.000,00 inclusi costi per la sicurezza per eventuale rinnovo di max 1 anno; € 65.000,00 per eventuale proroga, stimata in massimo 90 (inventari) giorni necessaria alla conclusione delle procedure per l'individuazione di un nuovo contraente; € 104.000,00 per eventuali modifiche ai sensi dell'art. 106

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BID-OPENING section

Methodology

- PM starts from event log to answer a variety of process-related questions.



- Most of the commercial PM tools use **Directly-Follows Graph (DFG)** as a first means to *discover* the event log.
 - A DFG is a graph with nodes that correspond to activities and directed edges that corresponds to directly-follows relationships.



Results

- As result, there are **six** activities in the process *discovered* via DFG:



- 1 - initial event is the **PUBLICATION** of the tender;
- 2 - the **PARTICIPATION** of individual entities proposing a bid;
- 3 - the adjudication of the tender (**AWARD**);
- 4 - the contract is issued (**CONTRACT- START**)
- 5 - the contract ending (**CONTRACT-END**);



- 6 - the **BID-OPENING** which takes place *before* AWARD.

Results



FRA

Start

PUBLICATION
instant

35 d

PARTICIPATION
instant

54 d

AWARD
instant

21 d

50 wks

12 mths

CONTRACT-START
instant

CONTRACT-END
instant

End



Slow decision process



ESP

Start

PUBLICATION
instant

34 d

PARTICIPATION
instant

46 d

CONTRACT-START
instant

17 d

12 mths

51.6 wks

CONTRACT-START
instant

CONTRACT-END
instant

End



Slow decision process



ITA

Start

PUBLICATION
instant

39 d

PARTICIPATION
instant

36 d

AWARD
instant

53 d

29.2 mths

34 mths

CONTRACT-START
instant

CONTRACT-END
instant

End



Slow decision process

Results

- Comparison of three countries' event logs by the number of cases, events, mean and median case duration (*months*), standard deviation (SD) for *services* sector.

Country	Cases	Events	Mean↓ (months)	Median (months)	SD (months)
ITA	1,063	5,156	34.8	37.1	14.3
FRA	22,102	4,601	25.7	17.1	16.9
ESP	838	4,063	21	17.6	12.6

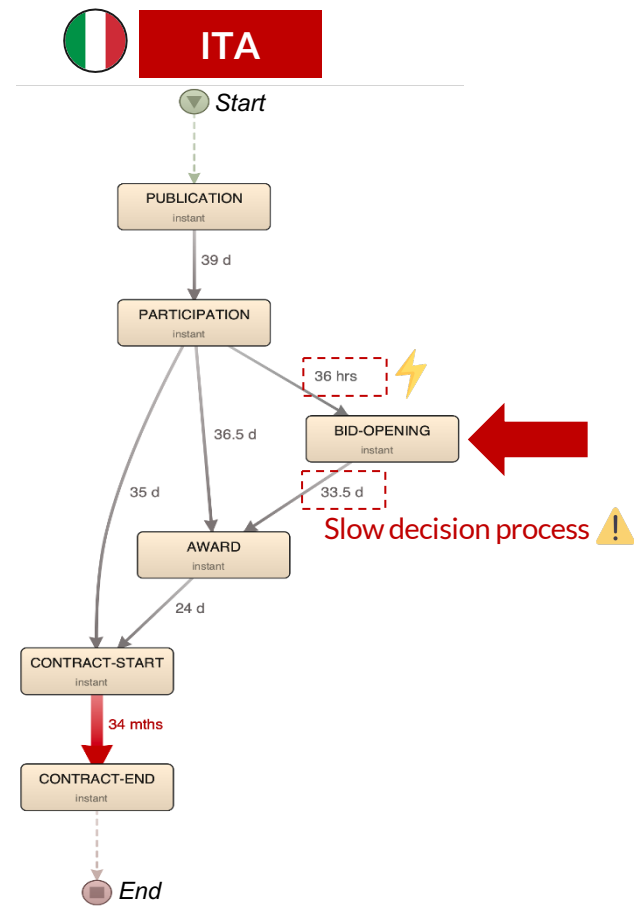
Results

- Starting from the 1,063 total cases for the ITA country, in the text of tenders the presence of the bid opening section in 270 cases.
- In the remaining 270 cases, the NLP techniques (DateMatcher and RegEx) were applied and compared.

Method	Dates found↓	Timing (min.sec)
RegEx	270 (100%)	~ 0.6
DateMatcher	223 (83%)	~ 1.1

Results

- The new event BID-OPENING extracted from the tender notices shows how the opening of received bids **takes place in a short time** (transition from PARTICIPATION to BID-OPENING).



Results

- Validation of the results was carried out with the domain experts through interviews.
- Domain experts confirmed the validity of the results:
 - to understand the quantity and timing of process activities;
 - to compare processes and timing from different countries;
 - to obtain other useful data from the texts automatically.

Conclusion and future work




- **Applied PM techniques** to a legal process to understand its execution in reality.
- **Compared the country-based processing** in terms of time performance for municipalities.
- **Applied NLP tasks** to the tender texts to explore some information extraction techniques as well as to obtain a new event to add to the italian cases.



- Adopt **automated variant** analysis techniques using ProM *process comparator* module.
- Explore other NLP techniques to **extract more data from the texts** and enrich the process event log even more, **also for other countries**.
- Explore the **application of prediction algorithms** to predict in advance:
 - outcomes (e.g., is the process going to a compliant or not);
 - processes' duration;
 - next event (e.g. is the process going to subcontract or variant).

End of presentation

Thanks

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