UNIVERSITY OF PISA
Department of Energy, Systems, Territory and Construction Engineering

Process-Mining-enabled audit of Information Systems:
a case in a Mediterranean port

Pierluigi Zerbino, PhD
pierluigi.zerbino@ing.unipi.it

Further details in: Zerbino et al. (2018), "*Process-mining-enabled audit of information systems: Methodology and an application*", Expert Systems with Applications, Vol. 110, pp. 80-92

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Agenda


The case


Results and discussion


Lessons learnt


Further PM capabilities in auditing

2

Why to audit port operations (1)

30/01/2019 650 kg of cocaine Origin: Honduras Destination: Spain

3

Why to audit port operations (2)

31/01/2019 Origin: Colombia Destination: Spain

4

Why to audit port operations (3)

23/06/2019 | 55 tons of hazardous waste | Origin: Venezuela | Destination: Italy

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The case (1)

Objective of the case

To audit an IS-supported port logistics process

To check the compliance with the prescribed document and process flow

Customs | *Control bodies* | *Regulations* | *Monitoring*

Port Community System

Export

National cabotage

...

Port taxes

Import

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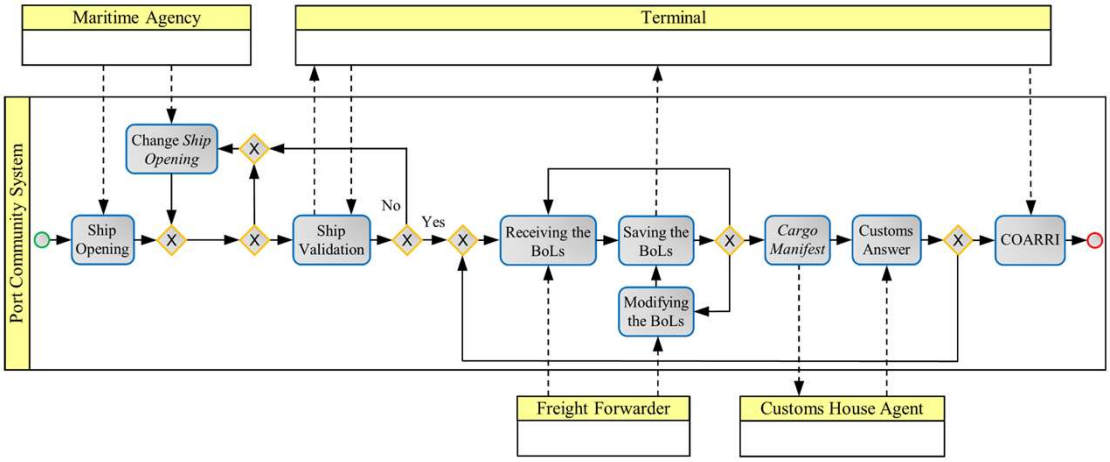
The case (2)

De jure model



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The case (3)

Dump of data

> 15 GB

52 tables

15 views

10^2 attributes

Encrypted

8

The case (4)

Content removed for privacy concerns

9

The case (5)

Excerpt of the export data

Content removed for privacy concerns

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The case (6)

01 / Jan / 2016
30 / Jun / 2016

Data cleansing and filtering

Final dataset

686 cases (vessels)
171630 events

Same data attributes of the previous analyses

Timestamp	Activity	Lifecycle	IMO	Route
29/04/2016 10:18:49:775	Customs Answer	Start	925xxxx	04xxxx
29/04/2016 10:18:56:887	Customs Answer	Complete	925xxxx	04xxxx
29/04/2016 10:20:31:098	Ship validation	Start	936xxxx	06xxxx
29/04/2016 10:20:31:169	Ship validation	Complete	936xxxx	06xxxx
29/04/2016 10:24:37:131	COARRI	Start	920xxxx	CXxxxx
29/04/2016 11:01:39:073	Customs Answer	Start	947xxxx	41xxxx

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The case (7)

Algorithm selection

Several Process Mining algorithms, *e.g.* Heuristic Miner (Weijters, van der Aalst, & De Medeiros, 2006) or Genetic Miner (Lang et al., 2008), yield hard-to-interpret process maps in complex contexts

Content removed for privacy concerns

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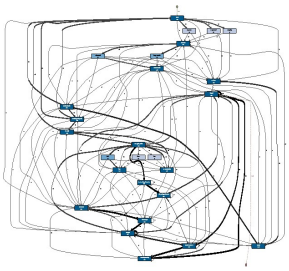
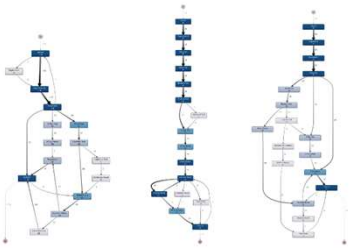
The case (8)

Spaghetti processes



VS

Lasagna processes



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The case (9)

Algorithm selection

Scientific research concerning complexity metrics in business processes is still ongoing!

Complexity Index (Zerbino et al. 2018) $\mu = \frac{number\ of\ process\ deviations}{total\ process\ instances} = \frac{624}{686}\left[\frac{instances}{instances}\right] = 90.9\%$

Fuzzy Miner algorithm suitable for complex contexts (Günther and van der Aalst, 2007; De Weerdt et al., 2012)

Disco

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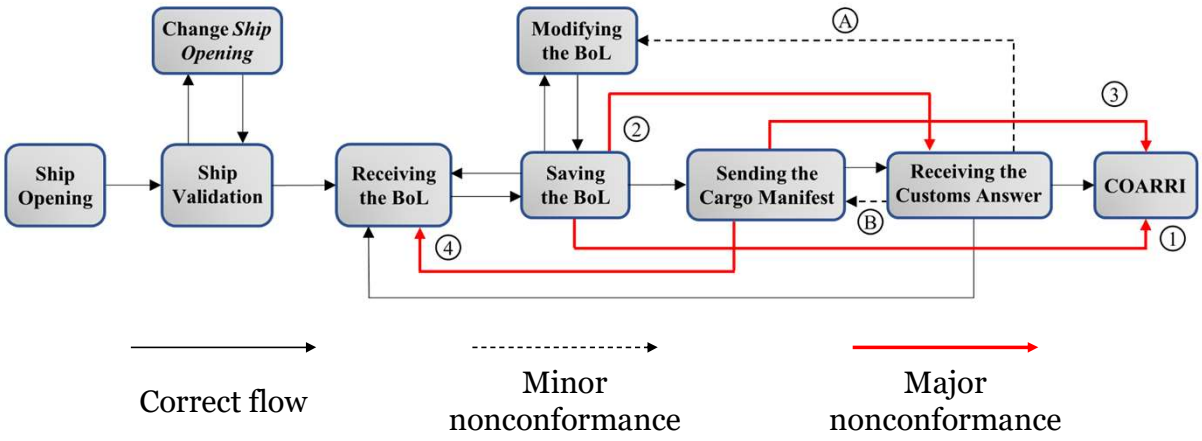
Results (1)

De facto model



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Results (2)

Statistics

Code	From	To	Absolute Frequency	Case Frequency	Total Duration	Median	Mean	Max	Min
A	Receiving the Customs Answer	Modifying the BoL	119	104	17.8 days	15 min	3.6 hrs	48.4 hrs	3.4 s
B	Receiving the Customs Answer	Sending the CM	322	211	29.9 days	14.3 min	2.2 hrs	4 days	14.4 s
1	Saving the BoL	COARRI	54	54	17.8 wks	23.7 hrs	55.5 hrs	25.9 days	66 min
2	Saving the BoL	Receiving the Customs Answer	459	244	9 days	3.3 min	28.3 min	49.4 hrs	218 ms
3	Sending the CM	COARRI	29	29	36.1 days	25.5 hrs	29.9 hrs	4.8 days	94.7 min
4	Sending the CM	Receiving the BoL	352	214	6.2 days	2.7 min	25.3 min	45.4 hrs	796 ms

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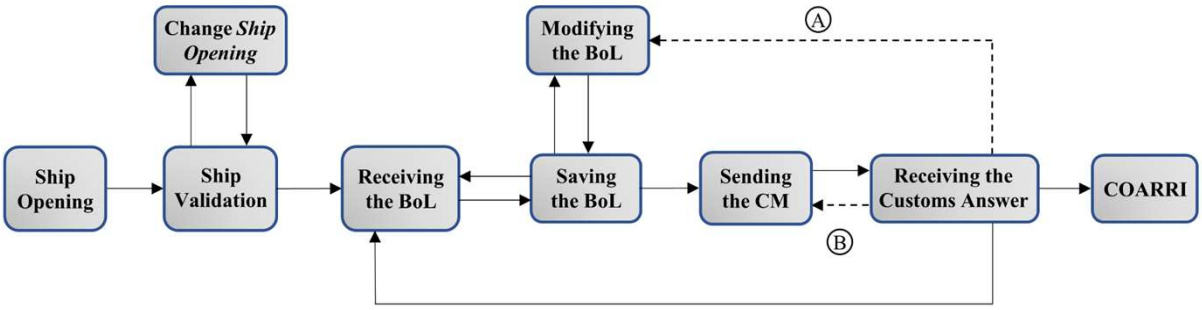
Discussion (1)

Arches A and B



The *de jure* requires a feedback to *Receiving the BoL*

Arches A and B were consciously introduced by the programmer

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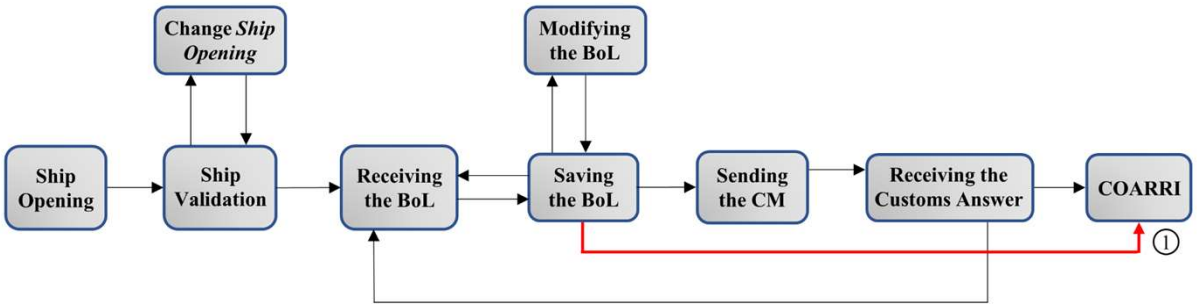
Discussion (2)

Arch 1 *(case frequency = 54)*



- No Cargo Manifest (CM) in 9 cases;
- No updates in the CM after the negative answer from the Customs, in the other cases.

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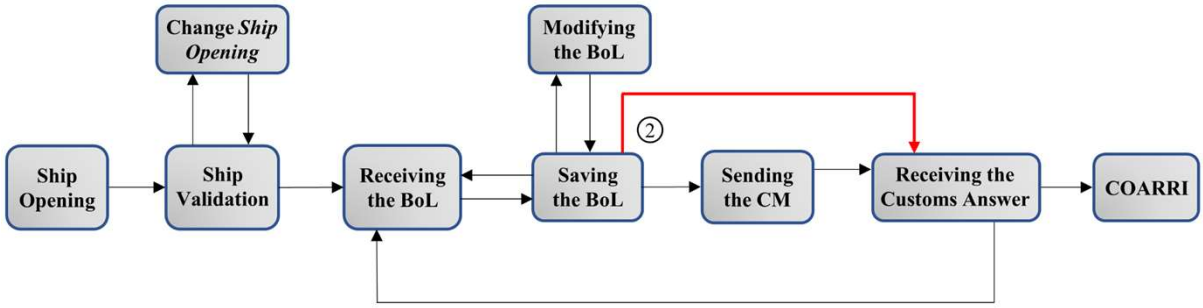
Discussion (3)

Arch 2 *(case frequency = 244)*



- The 244 process instances did not actually skip the CM;
- Possible dummy deviations.

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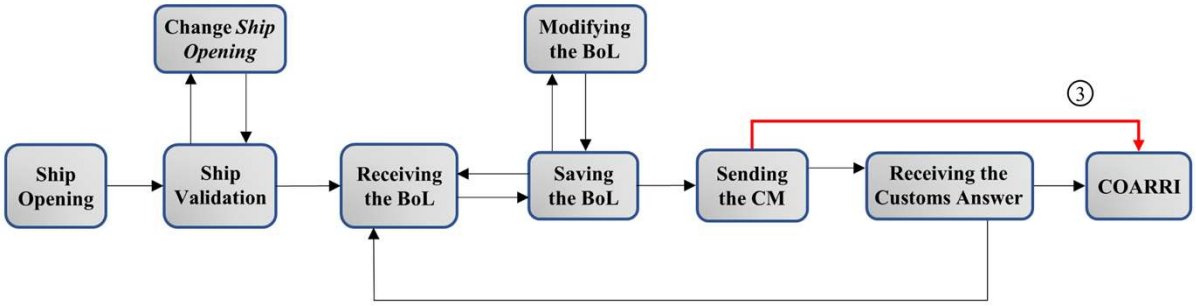
Discussion (4)

Arch 3 *(case frequency = 29)*



- 22 cases did skip the Customs check in the last iteration (akin to Arch 2);
- 7 cases did not perform a Customs Check.

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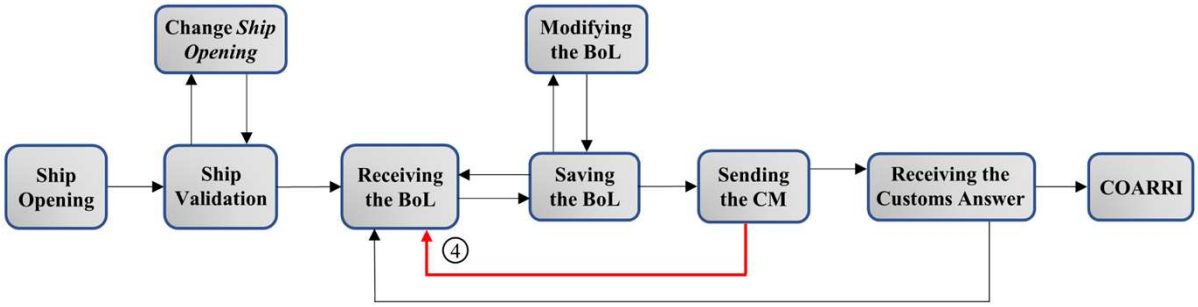
Discussion (5)

Arch 4 *(case frequency = 214)*



- All the cases present a CM;
- In 22 cases, the BoL were modified without updating the CM or checking for its correctness.

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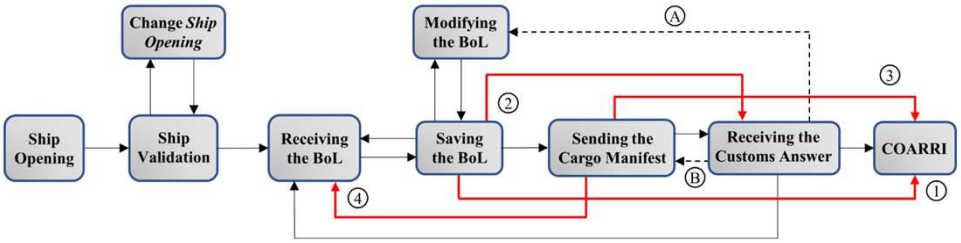
Discussion (6)

No issues with Customs Answer were detected …

… but there might be a gap between what is declared within the CM and what is actually loaded (further investigation needed);



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Discussion (7)

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Discussion (7)

https://www.ilmattino.it/napoli/cronaca/napoli_business_camorra_racket_bare_cinesi_morti-4532732.html
https://www.dailynews24.it/napoli-pentito-svela-che-fine-fanno-i-cinesi-morti-in-citta/

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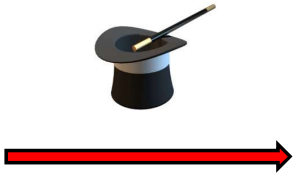
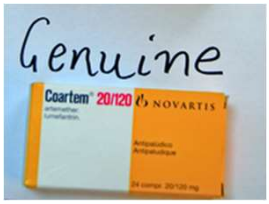
Discussion (7)





https://www.lastampa.it/cronaca/2019/06/10/news/farmaci-contraffatti-per-bambini-scoperti-in-un-container-nel-porto-di-genova-1.36540042

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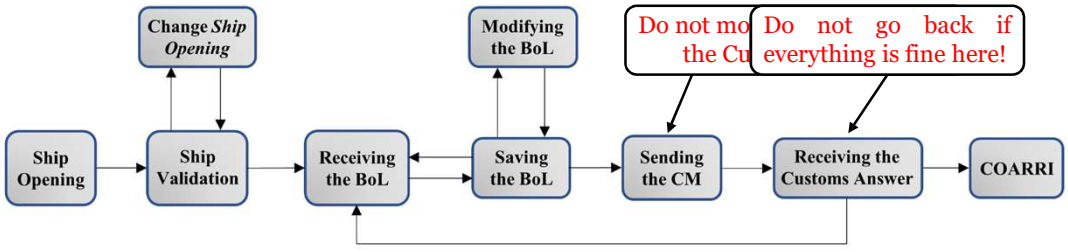
Implications (1)

Possible interventions

- To impede modifications in the BoL if the CC is positive;
- No feedback to the BoL process should be allowed after the submission of the CM but before receiving the Customs Answer;



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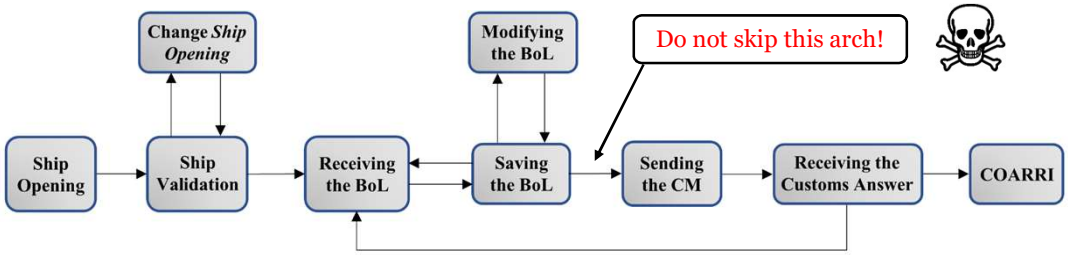
Implications (2)

Possible interventions

- To force the users to update the CM before its submission when the BoLs are modified;
- Reduce data entry errors with a double data entry (Barchard and Pace, 2011);



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Lessons learnt about PM (1)

No need for sampling;

Strongly automatable;

Little invasive;

Extremely high granularity;

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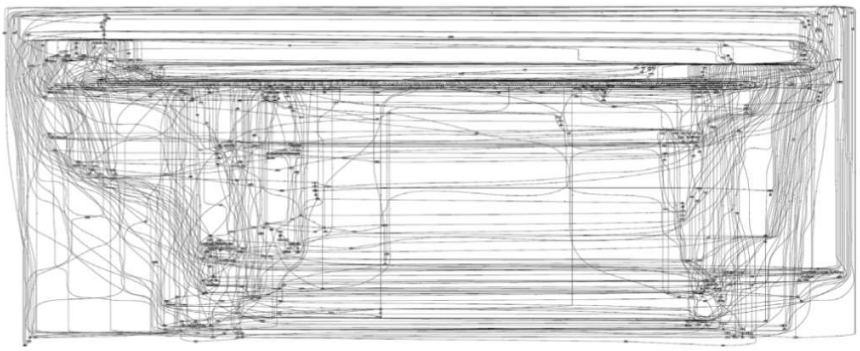
Lessons learnt about PM (2)

High granularity is a double-edged weapon!



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Lessons learnt about PM (3)

Additional issues

- Gap between the IS process flow and the actual process flow
- Issues in multi-stakeholder contexts (data ownership and privacy, authorizations, liability)
- Need for specific skills (data analysis, algorithm selection, PM-related know-how, attribute selection, data cleansing…)

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Future developments for PM-enabled auditing


Multi-sourcing from Internet of Things


Scalability to big Data?


Integration with management dashboard


On-line, real-time auditing


Predictive auditing

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Thank you

Pierluigi Zerbino, PhD


pierluigi.zerbino@ing.unipi.it

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Weijters, A. J. M. M., van der Aalst, W. M. P., & De Medeiros, A. K. A. (2006). Process mining with the heuristics miner algorithm. In Process mining with the heuristics miner algorithm: 166 (pp. 1-34). Technische Universiteit Eindhoven. Tech.Rep.WP.

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