UNIVERSITÀ DI PISA

Department of Computer Science

Laurea in Data Science and Business Informatics

Business Processes Modeling

Visa

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Contents

Abstract

Let us consider the simplified scenario of a temporary worker visa request.

The person must register at the online service of the Embassy and then receives the guidelines and instructions about required documents. The person must then contact the employer to get the necessary documents. After having converted all documents in electronic format, the person compiles the online form of the Embassy, uploads all files and waits to receive the answer.

The Embassy may decide to deny the visa, or to request some revised or additional documents (e.g. more information about the employer) or to schedule an interview.

If the visa is denied, then the person informs the employer and the process terminates.

If some documents are requested, the person contacts the employer to get them and submits a new form.

If an appointment is to be scheduled, the person interacts with the Embassy to agree on a data: this may require to iterate the proposal of the date until an agreement is reached. When a date is fixed, the person informs the employer and the process is concluded.

Design and analyse suitable processes that model the above scenario.

Extend the processes so that the person can decide to cancel the request by informing the employer and the Embassy.

Chapter 1

BPMN Model

Before starting the analysis, it was important to identify all actors involved in the process. We identified three main actors that must interact with each other to carry out their respective activities. The actors are:

- The main actor is **The worker**, that is the person who is interested in having the temporary work visa, that we will call worker, as indicative of future worker o already is a worker. Because the temporary worker visa in this case it is possible to request it only for work.
- **The Embassy**, to which the worker must contact to apply for the Visa that it has the main task, of deciding whether to deny or grant the visa, but not only this. Users can initially interact with the embassy exclusively with an online application and by sending messages.
- **The Employer**, which will have a fundamental role in helping to obtain the visa for the worker.

The model first designed at a abstract level using **BPMN**, which were designed in **Cawemo**. Since the interaction between the actors is a key point in the whole process, we have decided to construct a **Collaboration diagram**.
We have design 3 pools, one for every actor:
the pool “Worker” with light blue background color, the “Embassy” with pink color and the

"Employer" in orange see Figure 1.1.

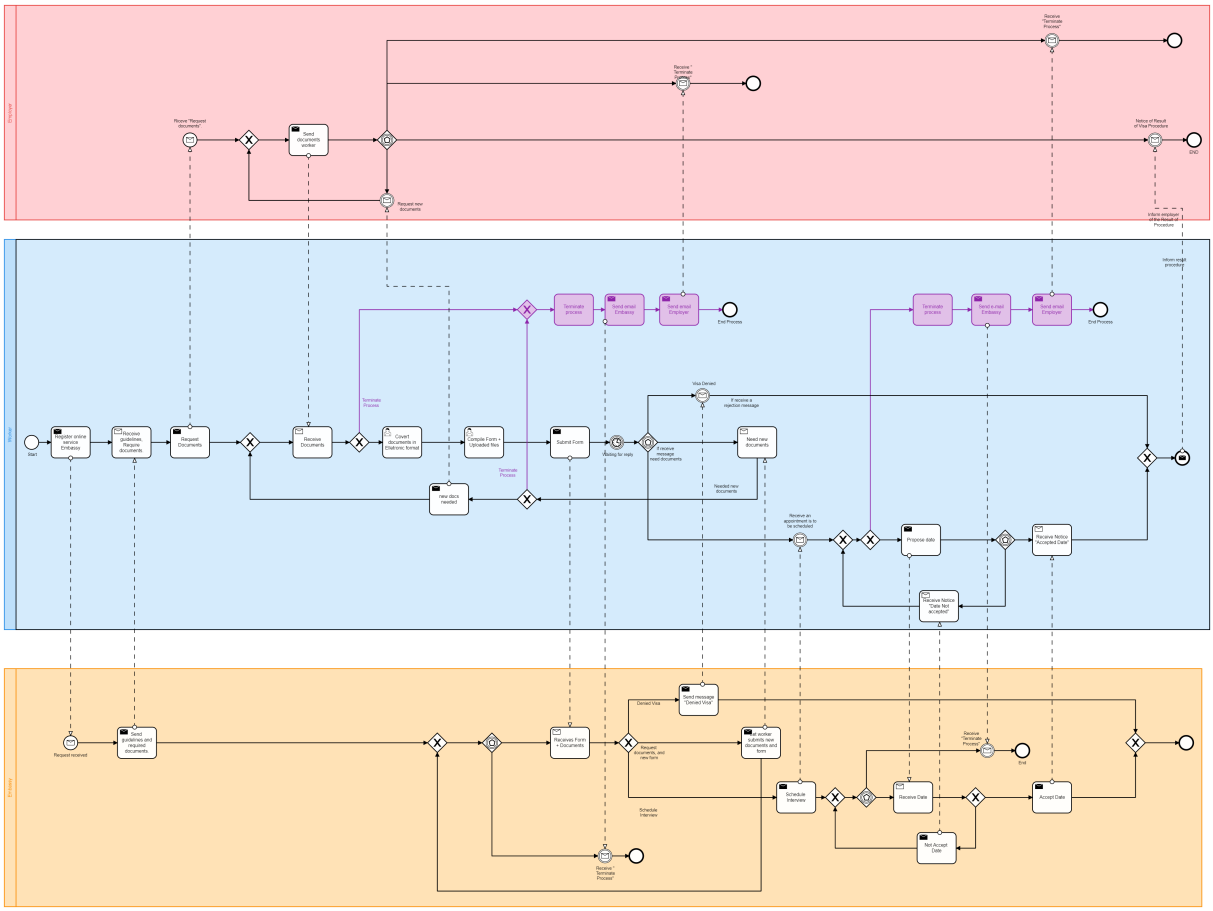


Figure 1.1: The Business process Model and Notation of Visa

Within each pool we have the flow of activities and events concerning a single actor. The control flow between events or and activities is represented by solid arrows. The interactions between the actors are represented by dashed arrows between one pool and another.

The main activities of each actor are:

- **The worker**: start the visa procedure fill in the form with the requested data, contact the worker to request documents, in case of acceptance of the visa arrange an interview with the embassy.
- **The Embassy**: receive the Visa application and the required documents, provide the worker with the necessary documentation for obtaining a visa, decide to approve the visa

or not, schedule an interview with the worker. The Embassy interact with the worker to provide all necessary documentation.

Below we will describe and draw step by step the flow of act activities and events of every pool. **The process begins with the event start and immediately afterwards the worker will registers** to the embassy's online service; and finish with a send event when the Employer Receive message of "Result of procedure" (Employer's end event).

1.1 Worker Pool

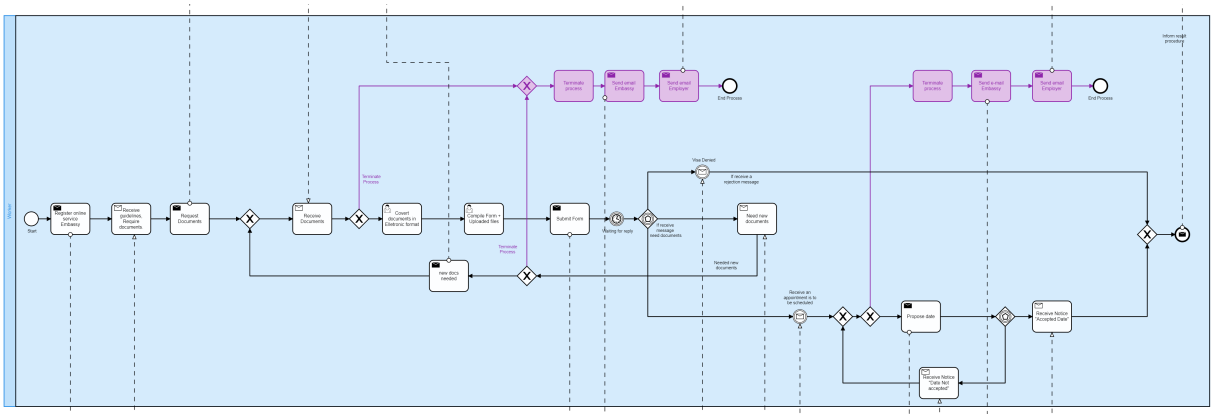


Figure 1.2: The BPMN of worker pool

The process begins with the event start and immediately afterwards the worker will registers to the embassy's online service (Figure 1.3).

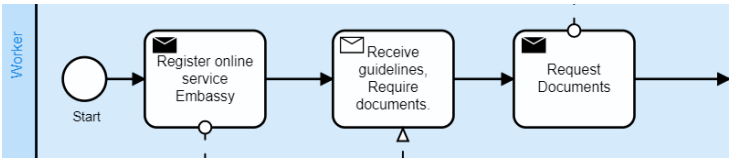


Figure 1.3: The first step of "worker"

The embassy will receive the worker registration and send the worker the guidelines and documents necessary to apply for the visa. So the worker Receive it (Receive task). At this point the worker will send a message to the employer requesting the necessary documents

(we can see a send task “Request document”).

After, the second step (Figure 1.4).

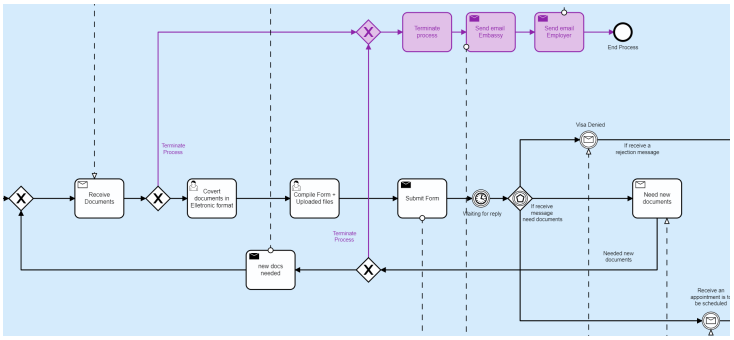


Figure 1.4: A zoom of second part of the worker’s pool.

There is a gateway, a “Data-based Exclusive Gateway”, later the worker may be asked for new documents, and in this case he will have to repeat a series of tasks. Let’s go on in the description:

1. Worker “Receive documents” from employer, after this there is a “exclusive gateway”, indicating that he can decide whether to continue the process or terminate it.

2. If he continue the process, he “Convert documents in Electronic format”, he “Compile form and Uploaded Files” (User Tasks), and “Submit form” (send task).

3. After this he will have to wait for the response from the embassy (Timer intermediate catch event).

4. At **Event-based Exclusive Gateway**, he is waiting for an event which it will use to determine which path the process should proceed along. An event-based gateway is required any time a decision is made by another participant based on data that is not visible to our process. In this case the worker must wait a message from embassy:

    - “**Visa denied**”, (message a intermediate trow event), the process is end and he must inform the employer of the result.
    - “ **Request new document**”, he must send a new request to the employer, “New docs needed” and must repeat the sequence of activities associated with the request

and production of documents and submission of forms (see first exclusive gateway in Figure 1.4).

- "**An appointment to be schedule**", (message a intermediate trow event), in Figure 1.5 a zoom of final part of worker' s pool, he can "Terminate the Process" or agree on a date for an appointment (see second exclusive gateway in Figure 1.5).

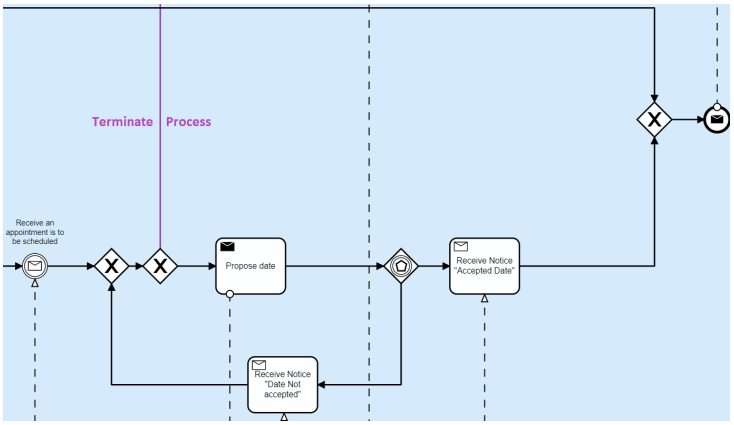


Figure 1.5: Zoom of final part of worker's pool

5.
- If he chooses to continue "Propose data" to embassy (send task). The proposed date may or may not be accepted by the embassy so we have to insert a "**Event-based Exclusive Gateway**", because the worker will have to wait for confirmation of the date from the embassy.
- If "date accepted" he send a message to employer of result of process (message end event) and process ends.
- If "Receive notice of date not accepted", he can choose between repeating the process of agreeing the date of the interview (first exclusive gateway in Figure 1.5) or he can decide to "terminate the process" (second exclusive gateway in Figure 1.5) .

An in-depth analysis of the "End process" procedure is shown in Figure 1.6:

When the worker decides to terminate the process, he must inform the employer and the embassy by sending a message to both (send task), and only after the process will be finished (end event).

We have decided to include in the diagram "ending the process" in points that we have a logic,

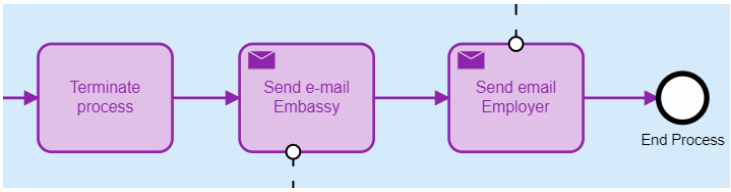


Figure 1.6: “Terminate Process”

which are as consistent as possible with reality. The worker will not be able to decide to end the process while he is waiting to receive a message from the embassy, or documents from the employer, but for example: when he has received the documents from the employer, after he has received the response from the embassy of ”request for new documents”, or when they will not be accepted between the proposed date for the interview.

1.2 Embassy Pool

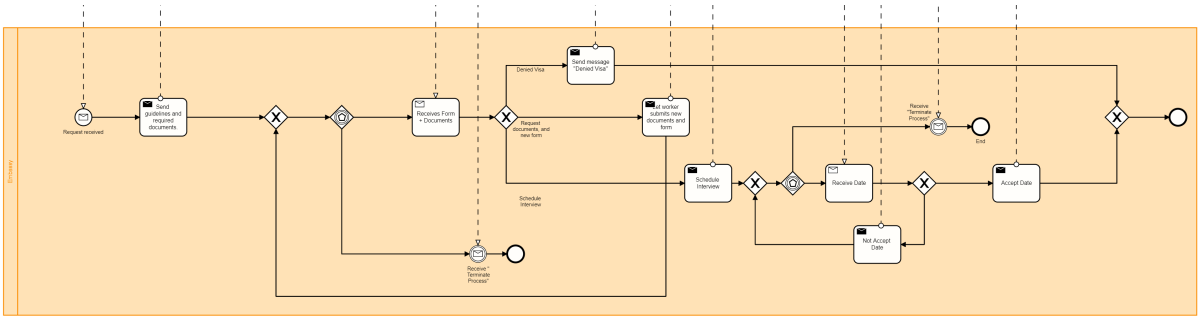


Figure 1.7: The BPMN of embassy pool

1. In the Figure 1.8 we can see a zoom of the first part of Embassy’s pool.

   The start of the embassy’s activities begins when it receives the Worker’s Online Registration (message start event), after it send to worker Guideline and Request document (send task). First gateway, a feed back task if the embassy will subsequently ask the worker ”Let worker submit new documents and form”.

2. After this a “**Event-based Exclusive Gateway**” the embassy can receive a message event from worker of “Terminate Process” or ”Receive form and documents”.

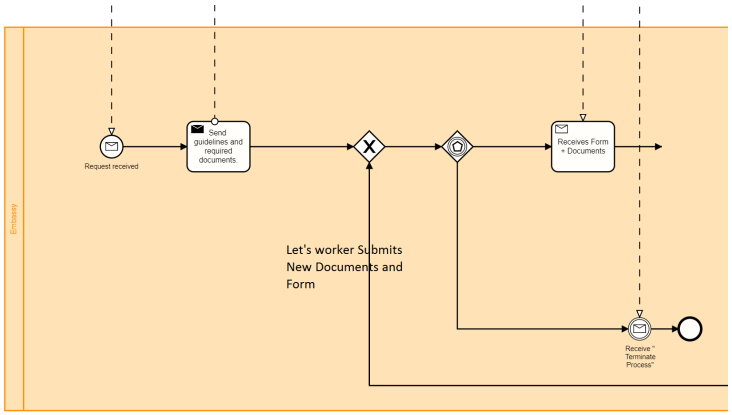


Figure 1.8: Zoom of first part of Embassy' s pool

3. If Embassy "Receive form and documents" the embassy will have to decide on the request visa and send a message to the worker. We have thus inserted an exclusive gateway. The embassy can send event to worker.

    - "denied visa"
    - "Let worker submits new documents and form"
    - or "schedule a interview"

4. If it decide to send "schedule interview" the process in this point is speculate at the process in the worker to agree on an interview date.

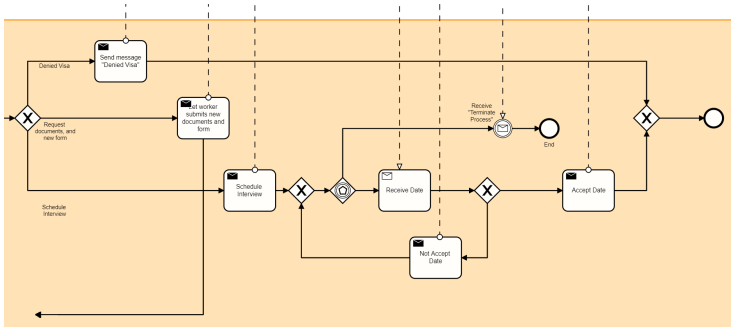


Figure 1.9: Zoom of final part of Embassy' s pool.

The gateway in Figure 1.9 after "schedule interview" is a repetition for agree a interview with worker if it "Not Accepted date" (send event). The worker propose a date that may or may not be accepted by the embassy so we have to insert a "A Event-based Exclusive

Gateway", because the embassy will have to wait a propose of the date from the worker or it can receive a "Terminate Process" from worker.

5.
   - If it "Accept date" he send a message to worker (send event) and the process of embassy is terminated.
   - otherwise it will send the worker a "Not Accepted date" message and the process of agreeing a date will be repeated.

1.3 Employer Pool

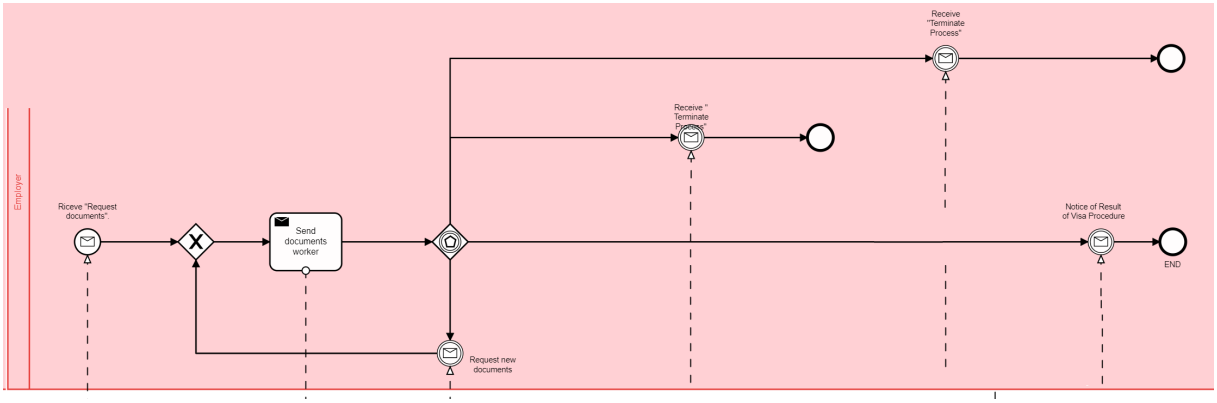


Figure 1.10: The BPMN of employer pool

In Figure 1.10 shows the employer's swimming pool.

1. The activity of employer start when the worker sends him a request for document (message start event).

2. After he send to worker it (send task) and after he must wait for a event (**Event-based Exclusive Gateway**), receive (send event)

   - "Notice of result of Visa Procedure"
   - or "terminate Process"
   - or "Request of new documents" and came back in the process, (first exclusive gateway in fig 10) or "Notice of result of Visa Procedure" or "Terminate Process" and so the process ends.

Chapter 2

Analysis Petri Nets

The BPMN diagrams were translated in workflow nets to do the semantic analysis. The whole conversion process is done on **Woped**, using **Woped** and **Woflan** for analysis separately.
We convert and analyze the 3 pools and the global respectively, and the whole conversion process is divided into **3 steps**:

1. Insert a place for each sequence flow and message flow
2. Convert flow objects to transitions and convert gateway
3. Add unique start and end.

Specifically, for global, when the process ends normally, the embassy and the employee will reach the end at the same time, so use **AND-join** to connect this two normal end. We use **XOR-join** to connect the end of termination within individual pools, use **AND-join** to connect the termination of all pools. Connect the normal and termination endings with **XOR** as the END.
For all the nets analysed, is possible observe that since the finiteness of the process in guaranteed, the coverability graphs will coincide with the reachability graphs.

2.1 Worker

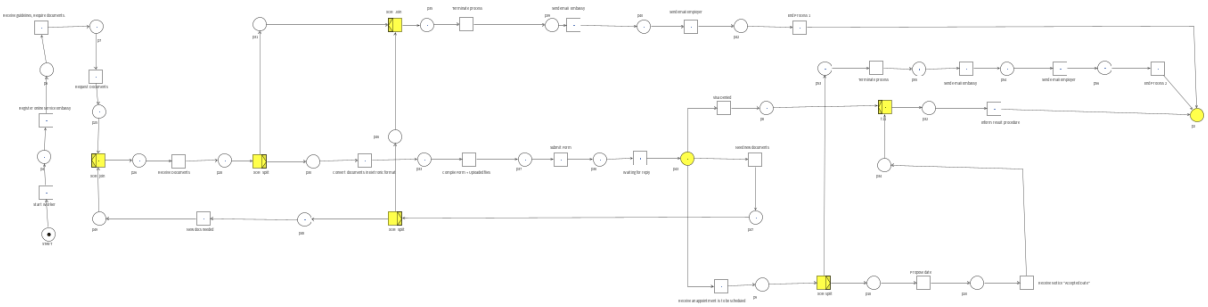
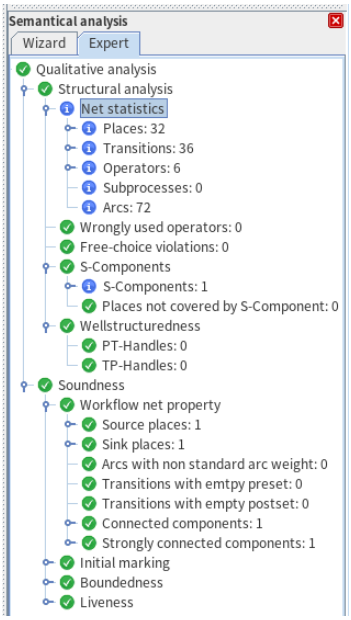


Figure 2.1: Petri net of worker



In Figure 2.1, we can see the Petri net of worker:

There are **32 places**, **36 transitions**, **6 operators** and **72 arcs**.

It‘s a **workflow net** because:

1. there is a distinguished initial place i
2. there is a distinguished final place o
3. every place and transition belongs to a path from i to o

It‘s **free-choice** since for each pair of transitions their pre-sets are either the same, or disjoint.

It‘s **Well-Structured** because there are no PT/TPhandles.

It‘s **S-net**, since the pre-set and post-set of each transition contains exactly one place, so it is **safe**, **sound , bounded**, **live** and **deadlock-freedom**. This also allows us to easily find an **S-invariant** for the networks: I=[k k ... k]

It‘s **Not T-net** ,because of XOR gateway(one place connect at least two transitions).

It N* is **strongly connected**: **S-net + strongly connected** so it‘s **S-Coverable** by 1 **S-component.**

It‘s **T-coverable**, because it‘s free-choice system also live and bounded.

Reachability analysis: The net is bounded, **reachability graph** coincide with **coverability graph**, with analysis of Woped, has 32 vertices and 36 edges.

2.2 Employer

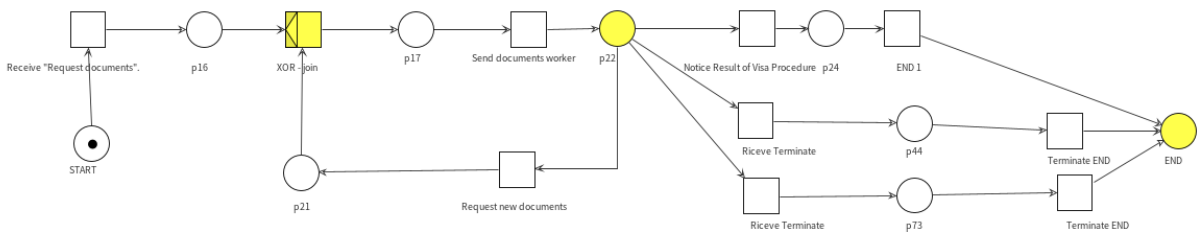
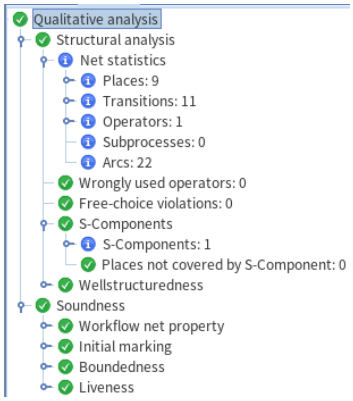


Figure 2.2: Petri net of empolyer



In Figure 2.2, we can see. The results of the employer pool analysis are similar to those of the worker pool:

It has **9 places**, **13 transitions**, **1 operator** and **22 arcs**.

It's a **workflow**

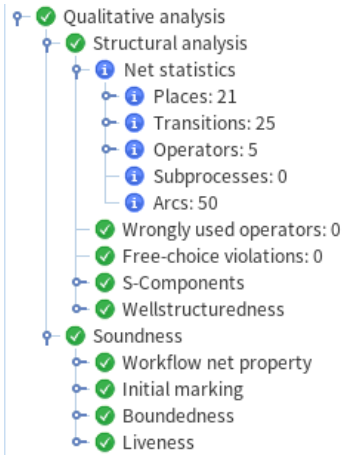
It's **free-choice** and **Well-Structured**

It's **S-net**, **not T-net**, **safe**, **sound**, **bounded**, **live**, **deadlock-free** have an **S-invariant**

It's N* is **strongly connected**, **S-component** and **T-coverable**.

The coverability graph has 9 vertices and 11 edges.

2.3 Embassy



In Figure 2.3, we can see the results of embassy pool analysis are similar to those of other pools:

It has **21 places**, **25 transitions**, **5 operators** and **50 arcs**.

It's a **workflow**, **free-choice** and **Well-Structured**

It's **S-net**, **not T-net**, **safe**, **sound**, **bounded**, **live**, **deadlock-free** have an **S-invariant**

It's N* is **strongly connected**, **S-component** and **T-**

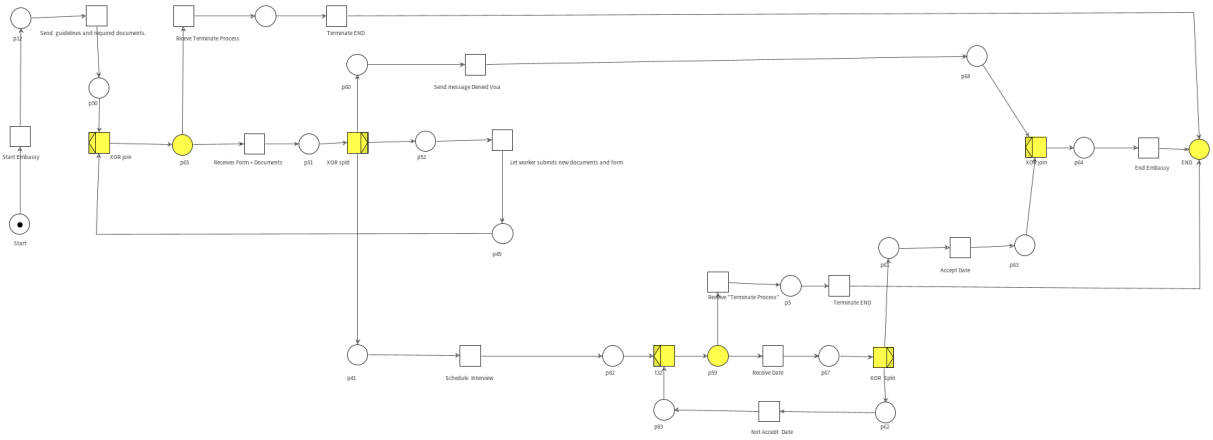


Figure 2.3: Petri net of embassy

coverable

The coverability graph has 21 vertices and 25 edges.

2.4 Global

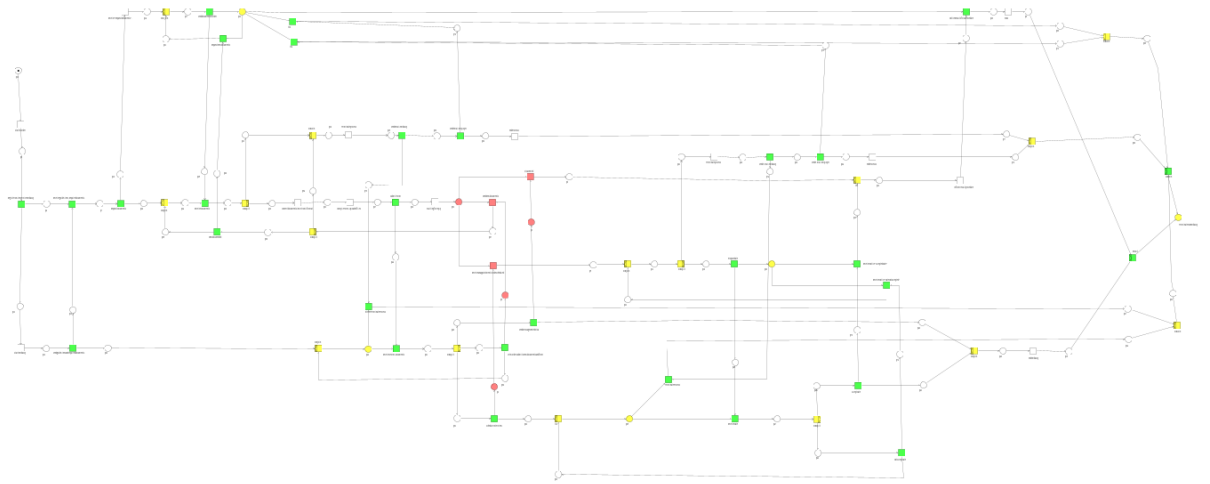
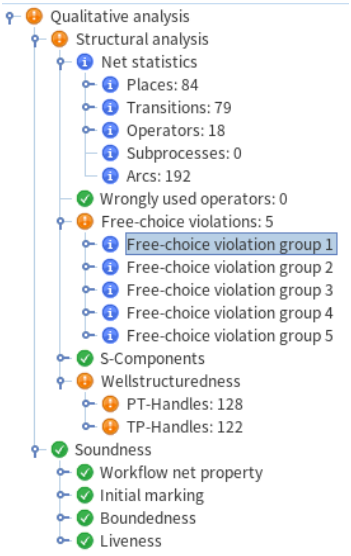
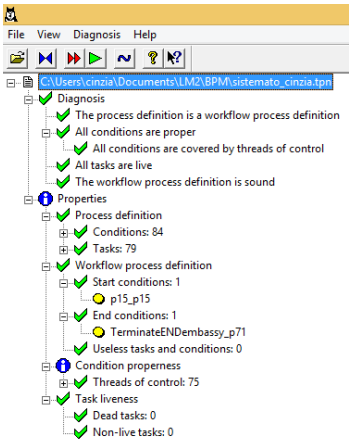


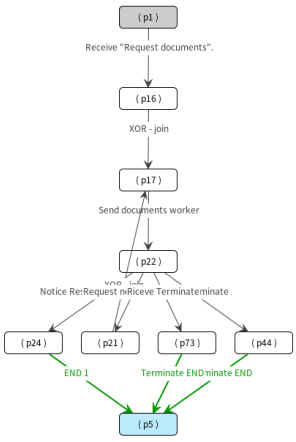
Figure 2.4: Global Petri net

The workflow nets were transformed in workflow modules by adding places in their respective interfaces. The obtained modules were structurally compatible, therefore i joined them in order to inspect the soundness of the final workflow system. After that, we add unique start

and end, as we said at the beginning of the chapter. We use Woped and Woflan for the global analysis respectively.







It has **84 places**, **79 transitions**, **18 operators** and **192 arcs**.

- It‘s a **workflow**
- It‘s neither **free-choice** nor **Well-Structured**
- It‘s neither **S-net** nor **T-net**
- It‘s **safe**, **sound**, **bounded**, **live**, **deadlock-free**
- It‘s N* is **strongly connected** and **S-component**

Due to the existence of **Event based gateway**, multiple transitions need to receive the same place, but they also need to accept different places for messages in other pools, so it is **can‘t be free-choice**.

Due to the existence of **Event based gateway**, it can‘t be S-net

Due to the existence of **AND gateway**, it can‘t be T-net

2.5 Coverability graph

We show below only the coverability graph for Employer due to space limitation. We can see that since it is finite, it is bounded.

If analyse the graph of N*, there is one cycle that starts at place p1 and moves top down along the reachable markings, until the state where we have only one token in p22 is reached.

From this point on we have the choice of repeating the cycle by putting the token back in p17 after firing transition “Request new documents”, or go to end by firing other transitions.

After this step, a token is put in place p5 and the process is completed. In this moment, there is no token in the other place.

We can put the token back in p1 is through the “reset” transition.

Hence, N is sound