MODEL-BASED FAILURE ANALYSIS OF BUSINESS PROCESS

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Abstract: The success of most organisations are based on how well the organisation can engineer and execute their business processes in order to better manage the extra value that these processes can provide. However, business processes may fail to deliver the functions which are designed. In order to help the understanding of how and why a business process may fail, we considered the techniques in system safety engineering and integrated them with existing techniques of business process modelling and analysis. We proposed a framework of business process failure analysis. The kernel of the framework is that we extended the workflow net of a business process by modelling failures as coloured tokens and so that the failure behaviours of the business process can be simulated. In addition, we developed a tool based on the codes of an open source project to support the analysis. The applications of proposed technique have demonstrated that it is a powerful and easy-to-use technique for the management of business processes in large complex enterprise systems.

1 Introduction

The concept of business process has received considerable attention by the community of business administration as organisations have been seeking how they do their business more efficiently. And some organisations are process-centric, i.e, the business of such organisations are usually divided and managed according to their business processes. The examples of such process-centric organisations are banks and hospitals. Any failure in their business processes will directly lead to a disaster to their business. For example, considering a hospital discharge system, a failure in the execution of the hospital discharge process may cause troubles to both the patient who is discharged from the hospital and the hospital itself because the failure may lead to serious impacts e.g, a delayed discharge, or re-hospitalisation, or even death of patients. Thus, when (re)engineering a business process, the managers and engineers who are involved always have to answer following questions:

- Why can this process fail?
- How can this process fail?

And in most cases, the failure of a business process is due to the failures of the activities in the process. So the additional questions can be asked:

- How is a process effected by a failure of an individual activity in the process?
- What is the most vulnerable activity in the process?
- How can potential failures be eliminated or controlled?

These questions cannot be answered without having a clear understanding of the business process and its environment. In system engineering, a few techniques, e.g, Failure Mode and Effect Analysis (FMEA), have been proposed and successful applied to analyse hazards and failures in safety-critical systems. In this paper, we propose a framework which integrates the concepts and practices of FMEA especially process FMEA from safety engineering domain with existing technique of process modelling and analysis from the domain of BPM so that the failure analysis and performance analysis of a business process is bridged together.

The core of our framework is a model of faults propagation in the business process, which is a Petri net model with extension of colour, called Failure net.

2 Framework of Business Process Failure Analysis

2.1 Definition of Business Process

A business process, by its definition in (OMG, 2008), is a collection of related, structured **activities**. The specification of a process defines the set of activities as well as the procedure and conditions on when such activities will be performed, i.e, in what order an activity is executed and how. To emphasise that a business process may have a hierarchical structure, here we add a sentence to this definition that a business process is composed of a set of activities linked together in order to interact, where each activity is another process, etc; The recursion stops when an activity is considered to be atomic: any further internal structure cannot be discerned, or is not of interest and can be ignored.

Failure is the term in our research to describe a state or condition which does not meet a desirable or intended objective, and is viewed as the opposite of *correctness*. For the analysis of business process failure, it is also necessary to distinguish two terms: *function* and *service*. In our research, the term *function* is used to refer to what the process is intended to do and is usually detailed in the specifications in terms of functionality and performance; and the term *service* is used to describe what the instance actually behaves to achieve the function of the process.

2.2 Framework of Business Process Failure Analysis

Business Process Failure Analysis (BPFA) has a simple process, which is shown in Figure 1. During the analysis process, the business process being reviewed is firstly step. The entire business process is modelled into smaller activities (*t1* in Figure 1). Next, the process managers can register all possible failure modes to the system so that the process designers/engineers can model the propagation behaviour of each activity according to the failure modes. Then for each activity, the faults, and possible causes of each faults are identified and documented (*t3.1* in Figure 1). After all activities are analysed, the business process is reviewed by applying selected faults in the process model and simulating their propagation process through the business process (*t4* in Figure 1).

In the process of BPFA, the activity *t1* is important, but we will not explain it in details because it has been discussed as the same as in papers of modelling business process in workflow net. In this paper, our focus is the rest activities of BPFA which are real contributions of our research.

2.2.1 Modelling failure as coloured tokens

Once all activities are identified, for each activity, the following steps are performed:

1. Define the activity being analysed.
2. Define the functions of the activity being analysed.
3. Identify all potential failures for the activity.
4. Determine the possible causes of each potential failure.

During the execution of a business process, a correct service is delivered when the service satisfies the specification of the process function. A service failure, often abbreviated here to **failure**, is an event that occurs when the delivered service deviates from correct service.

We can describe the failure of a process from the following dimensions/categories:

- **completeness**, whether the outcome of the process is complete?
- **validity**, whether the outcome of the process last for a right period of time?
- **consistency**, whether the outcome of the process is consistent whenever the process is executed?
- **timeliness**, whether the outcome of the process is generated on time?
- **accuracy**, whether the outcome of the process is adequate for the purpose?

To identify the possible failures of an activities and then analyse them in a systematic approach, we designed a set of tables to help the analysis and the documentation. Table 1 is an example. The table is activity-based, i.e, there is a table for each activity. For each activity we need to list all possible failures in each failure dimensions/category listed above, and the references which cross-links the failure to the requirements or standards of the activity. In the table we also have to identify the possible causes of each failures which can help us to trace back the root of each failure. Table 1 lists a part of this failure analysis of an activity (Blood Test) in the process of stroke care in

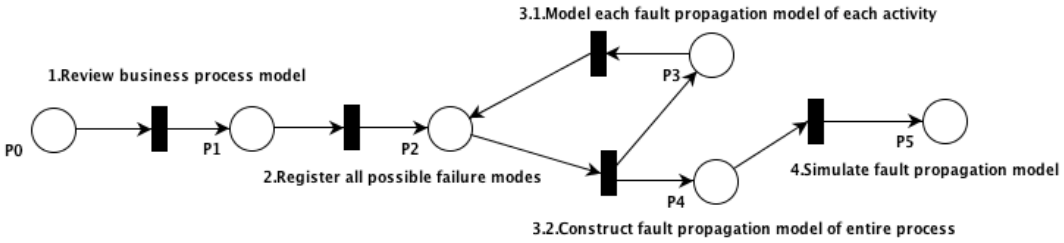

Figure 1: BPFA process

hospital ER department. For the category **completeness**, the activity may have a failure of incompleteness, i.e, less results of blood test provided. This failure is directly against the requirements of the national clinic guide.

In the analysis, we cared about not only all possible failures at each activity, but also the causes of those failures. The operation of an activity in the business process is designed to transform inputs into **useful** outputs. However, the failure may occur during the operation of the activity. The causes can be either the incorrect result of previous activity in the process, or some internal errors during the operation of this activity. By modelling the business process with failures as a coloured workflow net, we can easily define each activity may have one of following failure behaviours:

- *propagation*, the colour of output token is as same as input token's of an activity;
- *transformation*, the colour of output token is different.

An example of failure behaviours can also be found in Table 1. In its operation of this activity, new failure can be introduced due to internal errors; or failure transformed from one to another (e.g., information that is erroneous when it received at the activity remains erroneous when it delivers to the next activity), or transforms to a failure of a different category (in Table 1, an *incorrectness* failure is transformed to an *incompleteness* failure by the activity **Blood Test**.).

Once the failure analysis of all activities has been done, the rest work is to simulate the process model and review the results of the simulation.

2.3 Failure analysis of the business process

In general, failure net is based on the workflow net model of a business process with an extension of coloured tokens. Coloured tokens models fault services of activity, and the correct service of an activity is mark with default colour(i.e, **black**).

Simply speaking, the purpose of failure analysis of a business model is to answer the questions listed at the beginning of this paper. Simulation of Petri nets as mature technique and well-supported by most tool can fit for this purpose. By review the results of the simulation, the failure behaviours of a business process can be explored in much details so that the evaluation or re-engineering work of the business process can be done.

2.4 Tool support

WoPeD (Workflow Petri Net Designer) [1] is an open-source software. It provides a simple software tool for modelling, simulating and analysing workflow process and resource descriptions using workflow nets, an extended class of Petri nets. Based on the codes of WoPeD, we developed a tool to support our proposed failure analysis of business process.

3 Applications of Failure Net

In the project, we collaborated with our partners to help the improvement of NHS stoke care service in North Yorkshire. In this section, we will briefly demonstrate how we applied our BPFA to evaluate the process of stroke care service, and discuss our findings of failure analysis of business process in general.

[1] http://www.woped.org/

Table 1: An example of activity failures

ID: A16 Activity/Process: Blood tests

Index	Category	Possible Failure	Reference	Possible Cause
1	Completeness	Incomplete results: Activity A16 should provide results of at least 5 different types of blood test, including blood glucose level, full blood count (FBC), urea, electrolytes and creatinine.	Ref 25: The diagnosis and acute management of stroke and transient ischaemic attacks. NICE 2008	Some tests are not requested by mistake.
				A15.7: incorrect judgement of Activity A15: Investigations

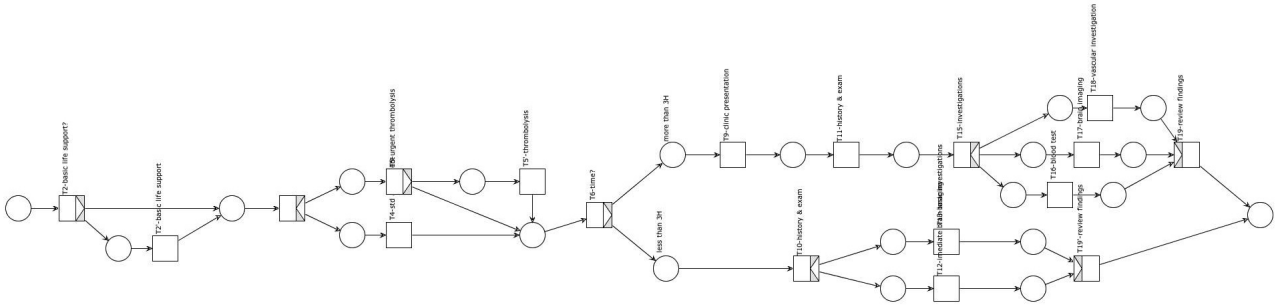

Figure 2: An Example of Business Process Failure Analysis

3.1 Failure analysis of stroke care process

In the case study, there are 16 key activities in the process [2]. For this particular failure (incorrect judgement after activities of review investigation results, we identified various reasons which may cause the failure. And the most important is that we also identify the most vulnerable activities which may cause the failure. They are A5 - judgement of application of urgent thrombolysis with 3 hours, A9 - clinic presentation, A10/11 - review history of health care and examinations, and A17 - brain imaging.

During the analysis, we found that the quality of the services provided by those activities are highly relied on the experience and skills of the operators. Thus to improve the quality of entire stroke care service in the area, the central/local government should focus on those key activities and the efforts to improve the service may include various training, the mechanism of reviewing, etc.

[2]it excludes the last activity - classify whether is acute stroke or TIA, or haemorrhagic strok, or other attacks, because the analysis is performed to identify the key reasons of causing the incorrect judgement of acute stoke or TIA patients.

4 Conclusion

We have presented a new approach for the failure analysis of business process, based on its failure net models. The proposed technique enables the assessment of failure behaviour from the analysis of each activity in the business process. The proposed technique fully takes the advantages of using Petri net to model and analyse business processes, but also integrates the techniques of failure analysis from system engineering with existing techniques in business process management. The approach is easy to use and tool supported.

There are still a lot of work to do in the area of evaluation of proposed technique and the development of tool, for example, we considered to implement several plug-ins so that business process modelled by other methods, such as UML and BPMN, can be imported and analysed. We are also exploring techniques to visually represent and automatically generate analysis results.

REFERENCES

(OMG, 2008). Business process definition metamodel (BPDM), Process Definitions.