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Toward a modeling Tool for Business Continuity Management

Ghassen Frikha *,*** **Elyes Lamine** *,** **Daouda Kamissoko** *
Frederick Benaben * **Herve Pingaud** **,****

* *Toulouse University, IMT Mines Albi, Department of Industrial Engineering, Route de Teillet, 81013 Albi Cedex 9, France (e-mail: elyes.lamine@mines-albi.fr, daouda.kamissoko@mines-albi.fr, frederick.benaben@mines-albi.fr)*
** *Toulouse University, ISIS, Institut National Universitaire Champollion, Rue Firmin-Oulès, 81104 Castres, France, (e-mail: elyes.lamine@univ-jfc.fr, herve.pingaud@univ-jfc.fr)*
*** *University of Sfax, National School of Engineers of Sfax, Km 4 Route de la Soukra, 3038 Sfax Tunisia (e-mail: ghassen.frikha@enis.tn).*
**** *Toulouse University, CNRS, LGC, F-31432 Toulouse Cedex 04, France*

Abstract: Nowadays, Business continuity management (BCM) has become an important topic in most sectors of activity, for government organizations as well as for business owners and their stakeholders, especially after the pandemic of COVID-19. For years, companies and organizations have been working on their BCM strategies to deal with disruptive events like floods, terrorist attacks, and pandemics. As the business environment is becoming increasingly competitive, having a well-established and clear BCM tool is a priority rather than merely providing verbose documents of business continuity plans(BCP) in which management rules and instructions are specified in a textual manner that makes their implementation very difficult. This present research sets out to fulfill this need by designing a dedicated tool, named "BeC@RE", which supports the efficient application of the BCM framework. Therefore, a literature analysis was conducted to investigate the scientific foundations of BCM in order to point out the main components and features needed to be implemented and supported by this dedicated tool. "BeC@RE" tool was implemented using the ADOxx meta-modeling platform which is openly available, allowing its adoption and use in BCM practice.

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Keywords: Business Continuity Management, Resilience, Model-driven engineering, Meta-modeling, ADOxx

1. INTRODUCTION

Not only in the context of crisis, but real-life experiences have also shown that creating a solid contingency plan to deal with disasters is the best way to protect organizations from possible catastrophic events, to keep their partners confident and to enhance their resilience – which is defined as the organization's capability to continue their key processes after chaotic moments and return to a normal state as soon as possible (Rejeb et al., 2014; Vogus and Sutcliffe, 2007).

This desired resilience requires the definition and implementation of a comprehensive method and tools to support critical processes in case of dysfunction. Thus, to help the companies meet these challenges, new paradigms are born.

Business Continuity Management (BCM) is one of these paradigms. It is considered as a response to this challenge (ISO, 2012). Business continuity management (BCM) provides business continuity plans (BCP) in order to cope with various disruptions and interruptions. This management approach aims to increase the resilience of the concerned systems, to maintain the continuity of critical activities and to restore the functioning of the systems to an acceptable level of operations, while minimizing the risk of impacts of failures that may occur (ISO, 2012).

Despite the significant benefits that can arise from the application of BCM, it suffers from a lack of dedicated tooling that is based on solid scientific foundations. Indeed, while there is a growing focus in literature to discuss BCM benefits and its life-cycle stages, less attention has been paid to properly formalize a BCP meta-model and to design dedicated tools to help guide the user in carrying out the different BCM phases (Rejeb et al., 2014; Schrüffer, 2018; Rezaei Soufi et al., 2019).

This present research work aims for bridging this gap by designing a dedicated modeling tool, named "BeC@RE" which supports the efficient application of business continuity management by enabling validation and simulation of BCM models. The groundwork of this project was pre-

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sented in (Rejeb, 2013) where a domain-specific modeling method for BCM was elaborated.

The remaining part of this paper is structured as the following: Firstly, an overview of business continuity management principles and current challenges is presented in section 2. In section 3 the focus is given to the engineering of the BeC@RE modeling tool realized with the ADOxx meta-modeling platform. Eventually, section 4 includes the conclusion and the outlines directions for future work.

2. BACKGROUND

The present section carries out a brief review of the literature on business continuity management key concepts.

2.1 Business Continuity Management Principles

Nowadays, implementing Business Continuity Management in companies is considered as a form of asset for them. Its purpose is to maintain, if necessary temporarily and in a degraded mode, the company's essential services, as well as the planned resumption of activities. As such, it enhances organizational resilience (Bhamra et al., 2011; Bennasar, 2010).

Most of the relevant literature advocates that BCM is a decision-making process; it includes the concepts of business resilience, long term performance, and value preservation.

(Gibb and Buchanan, 2006) stated that the BCM aims to provide uninterrupted availability of key organizational activities and resources to ensure the achievement of key objectives and missions.

BCM is also defined as a "holistic management process" that identifies potential threats to an organization and their impacts on business operations. This management process provides a framework for building organizational resilience with the capability of an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities" (ISO, 2012).

Hence, BCM strives to provide an "uninterrupted availability" of all key activities and resources which consist of recovering operations within a "predefined time", and reducing the "time required" to restore conditions to a state of business as usual (Rejeb et al., 2012).

Even in modern organizations that use high-technologies, BCM is strongly present. In fact, in (Labus et al., 2019) it was referred to as (e-BCM).

Applying BCM typically follows a procedural approach, known as the BCM life-cycle which phases are generally composed of main common stages that are found in most research:(1) initiating the BCM project, (2) understanding the organization, (3) identifying risks and their business impact, (4) designing a continuity plan and the necessary procedures, (5) implementing the settled measures (6) testing their effectiveness and exercising them for incidents (7) continuous maintenance and update of measures.

Most early studies as well as current works (Rejeb et al., 2014; Schrüffer, 2018; Rezaei Soufi et al., 2019) stated that the primary output from the BCM life cycle is a Business Continuity Plan (BCP), which is a set of procedures and documents describing a sequence of actions, and people responsible for carrying them , to resume business processes following a disruption as soon as possible(Rejeb et al., 2012).

2.2 Business Continuity Management Challenges

Notwithstanding, the potential benefits that could arise from the use of BCM, its proper implementation in the organizations remains relatively limited compared to the high number of companies and institutions especially in developing countries (Sawalha, 2020; Auzzir, 2019).

In addition to this reduced usage, there is no mentioning of a standard format for the plan development and execution part even though there is a high number of studies on BCM.

Besides, by analysing the Business Continuity Plans (BCPs) existing in literature, the lack of conceptual models has been noted.

In fact, we adopted the definition of the conceptual modeling framework proposed by (Karagiannis and Kühn, 2002) as a pillar for our analysis. The authors considered that a modeling method should include three main components: modeling language, modeling procedure and mechanisms and algorithms.

Based on these considerations, Table 1 presents a synthesis of related works that we made a comparison with it using the following set of criteria:

- Application domain: This criterion gives the research domain of the corresponding work.
- Modeling method: If each work defined properly the components of a modeling method.
- Meta-model: This criterion specifies if the work proposes a conceptual model (Meta-model) of the artefacts which are needed to conduct BCM
- Modeling tool: This criterion indicates if the work develops a modeling-tool to support BCM process.
- Number of point of view: This number indicates how many point of view (diagram) are possibly based on the meta-model and can be implemented in a modeling-tool.

From this review (eg, Table 1), we noticed that existing works have shown interest in the modeling procedure by defining clearly the steps in their approaches.

Three papers (Rejeb, 2013; Schrüffer, 2018; Anir et al., 2019) designed a meta-model based on model-driven engineering approach. For (Anir et al., 2019), the work focused on the construction of an enterprise architecture meta model integrating BCM, however there was no modeling tool developed. With respect to (Schrüffer, 2018), the proposed modeling tool supported only 7 point of views -diagrams- to work on the BCM, which is not enough to generate a strong and well-structured business continuity plan due to numerous requirements of BCM stated in (ISO, 2012).

Even though there was no modeling tool developed in (Rejeb, 2013), the meta-model in this work was taken as

	Application Domain	Modeling Method			Meta-model	Modeling Tool	Number of Point of view
		Modeling Technique					
		Modeling Language	Modeling Procedure	Mechanisms & Algorithms			
Rejeb (2013)	Health Care	+	+	±	+	–	8
Labus et al. (2019)	E-Business	–	+	–	–	–	–
Schrüffer (2018)	Generic	+	+	+	±	±	7
Al Ali et al. (2019)	IoT	–	±	–	–	–	–
Anir et al. (2019)	Business Management	–	+	–	+	–	–
Păunescu and Argatu (2020)	Generic	–	+	–	–	–	–

Table 1. Comparative overview of recent BCM approaches

a pillar for the BCM frameworks proposed in (Schrüffer, 2018) and (Anir et al., 2019).

Thus, we considered the work in (Rejeb, 2013) as a base stone, which can be enriched and enhanced. In fact, (Rejeb et al., 2012; Rejeb, 2013) proposed a BCM methodological framework based on (i) the definition and the design of a meta-model integrating BCM and enterprise architecture, (ii) the development of a set of criticality assessment matrix to support the business impact analysis, and finally on (iii) the definition of a modeling language adapted to concepts of BCM.

This methodological framework was created to cope with the problem of BCPs, how they are presented in the literature and technical reports in the form of documents, textual templates, written generally in an informal way.

Inspired from the (ISO, 2007), this meta-model encloses all the features of the BCM framework: the process and resources views are dedicated to studying the system, the failure view is focusing on the origin and the weight of the failures. Finally the structural part of BCP is dealing with the treatment system.

Fig. 1 shows an excerpt of the meta-model explaining the components of business continuity plan and to deal with the nonstandard existing BCPs issue.

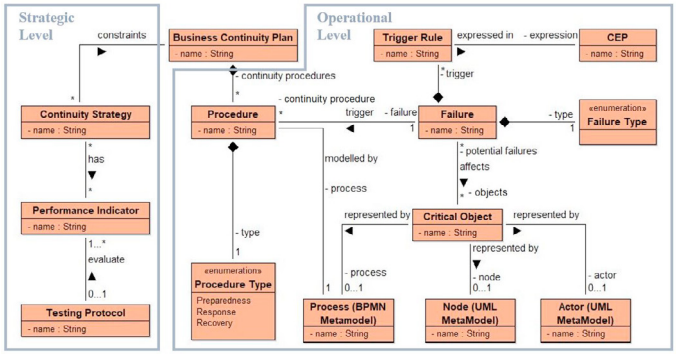


Fig. 1. Meta-model of a business continuity plan (Rejeb, 2013)

However, such an approach does not solve all the problems with the implementation of BCM in organizations. Thus, we can state the following:

- Managing data complexity: To implement each phase in the correct way, many interconnected pieces of information must be provided, for example: the organization features, the business process as well as the resources needed and many other data. This can create an issue while processing and analysing the data.
- Also, we know that there is a lack of dedicated tools and effective frameworks to develop suitable BCPs (Rejeb et al., 2012; Rezaei Soufi et al., 2019)

We conclude that there is a strong need of a comprehensive framework for BCM with a clear and coherent vision. The solution must be executable, exploitable and up to the integration of analysis algorithms.

In the next section, we are going to present a proposition for our framework with an explanation of all its features and components.

3. OUR PROPOSED MODELING TOOL DEDICATED TO BCM

To respond to these limitations, we created a modelling tool detected to Business continuity management, following an approach built on the findings of (Rejeb, 2013) namely the proposed meta-model and life-cycle and by using meta-modeling platform.

3.1 DSML and Meta-modeling Platform

The development of the BeC@RE tool presented in this section was based on the implementation and the use of domain-specific modeling language (DSML). It aims to offer an accessible facility to help users to create all necessary models for BCM.

A DSML is devoted to represent the key concepts of the specific domain allowing to formalize the structure, behavior, or requirements of the system component belonging to this particular domain. (Karagiannis et al., 2016). Generally, the definition of a DSML involves the following aspects: (i) the abstract syntax which refers to the domain concepts and rules, (ii) the concrete syntax, which consists of the graphical representations of these concepts (iii) language semantics that helps to specify the abstract syntax's elements meaning.

Meta-modeling platforms serve as means to implement DSML. Those platforms usually provide many features that can be used to edit the abstract syntax of a language in the form of a meta-model, to specify the graphic representations of the meta-model's elements, and to implement

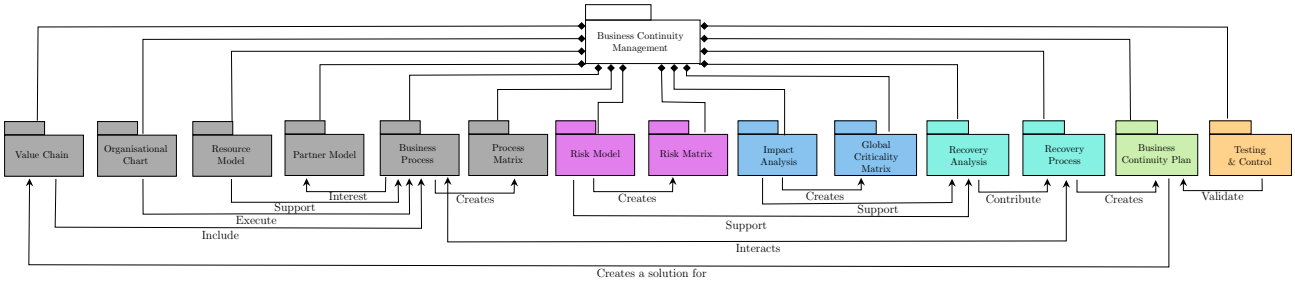


Fig. 2. The overall meta-model of the modeling method for BCM.

mechanisms & algorithms that process the knowledge expressed in the models (Karagiannis et al., 2016).

Hence, to prepare the ground for the implementation of our BCM dedicated modeling tool, we investigated and analyzed several meta-modeling platforms such as MetaEdit+ [1] ,Eclipse Modeling Framework (EMF [2]), Graphical Editing Framework (GEF [3]), Sirius [4] and ADOxx [5].

An extensive comparative study of the most relevant platforms is provided in (Lamine et al., 2020). Accordingly, the ADOxx meta-modeling platform was deemed the most appropriate for our needs. Indeed, compared to the others, ADOxx does not need a high skill programming level like GEF and EMF. It has provided tool support for more than 60 domain-specific modeling languages. Besides, it is a multi-user platform that provides a repository based on a relational database for models and supports multi-view modeling. In addition to all of these arguments, the local expertise about ADOxx in our research Laboratory helped us in choosing it and proceeding with it as our modeling framework to create our proposed tool for Business continuity management.

3.2 BeC@RE *core components*

Our BCM dedicated modeling tool, called "BeC@RE, mainly corresponds to the implementation of the BCM method proposed by (Rejeb, 2013) using the ADOxx meta-modeling platform.

Fig. 2 presents the different models that can be generated by BeC@RE tool following our proposed BCM modelling procedure. Each phase of this procedure is displayed in a different color. Starting from the grey color which corresponds to the organizational understanding: this phase aims to shed light on the several features of the organization using 6 different models. Using the Value Chain model, the main processes of the organization will be determined. The definition of the different types of resources is very important in the context of business continuity management, this will be insured using two models Org. Chart to define the nomenclature of a system and the resource model to define the non-human resources. In addition to resources, the list of partners and their requirements can be defined using the partner model. Finally, the business process model enables the description of a given process in terms of activities, objectives, resources and events. The described processes will be classified into critical/not critical in the process matrix model. This will give the user a better view of the organization.

The first phase will be followed by the risk assessment phase presented with the purple color. The risk model will help to detect the risk triggers and determine the possible consequences of a risk. Afterwards the risks will be classified in a risk matrix.

The blue colored models are part of the business impact analysis phase. The impact of the risks on the organization will be studied in the first model then this impact will be showcased in a matrix. The next sub-section will explain how to study the impact of a risk.

The light blue color is for the design phase, where the recovery possibilities will be studied in the recovery analysis, then the new activities will be embedded in the business processes.

The Implementation phase is presented with the green color, the BCP model will give an overview of the situation. The risk as a source problem and its impact on the organization. Thus, it is possible to know all the affected parties / participants in the implementation of the BCP.

Finally, the testing phase is colored in orange. The corresponding model will contain the actions and methodologies that will be taken to assess the BCP according to the situation.

At this point, it is important to mention that the modeling constructs necessary to formalize all theses models are specified using a common meta-model with multiple viewpoints which focus only on a subset of the concepts necessary for setting out the target model. This meta-model which is mostly inspired by (Rejeb, 2013) corresponds to the abstract syntax of our DSML dedicated to BCM.

3.3 Current functionalities of BeC@RE *tool*

BeC@RE provides a thorough environment to work on BCM. Currently, our tool supports:

- the editing of fourteen BCM diagrams corresponding to the models depicted in Fig. 2 ,
- Various modeling palettes related to the distinct viewpoints proposed in our DSML.
- A set of algorithms using the ADOscript programming language. These algorithms allow to:

[1] MetaEdit+: https://www.metacase.com/fr/mwb/
[2] EMF : https://www.eclipse.org/modeling/emf
[3] GEF: https://www.eclipse.org/gef
[4] Sirius: https://www.eclipse.org/sirius/
[5] ADOxx : https://www.adoxx.org/live/home

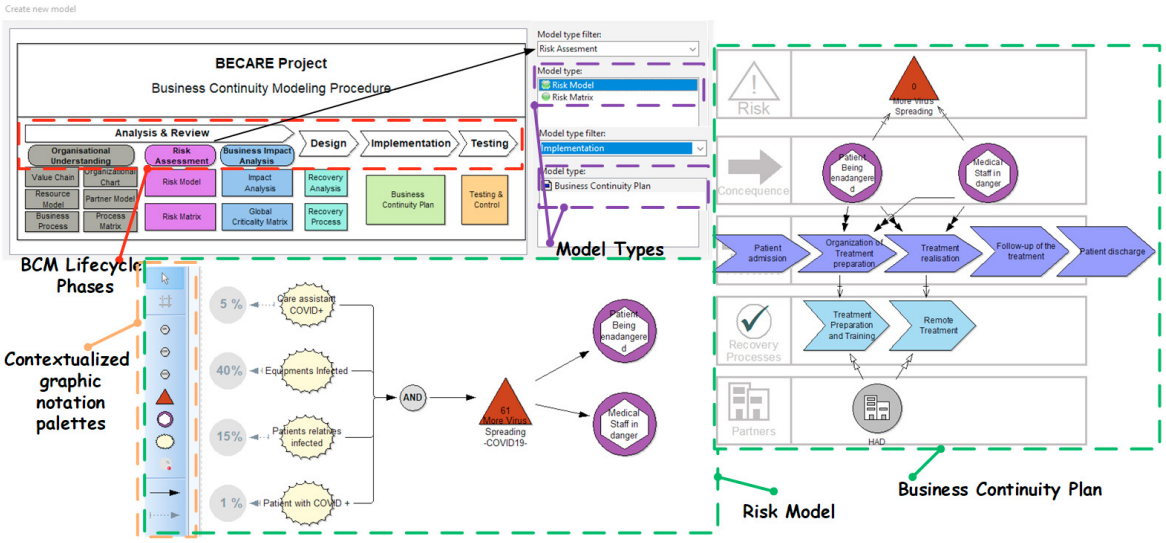


Fig. 3. Excerpt of the BEC@RE modeling tool.

- **Navigation Mechanisms Implementation:** This enables the user to navigate from a diagram to another using references between objects according to the modeling procedure.
- **Synchronisation algorithms:** Make the same connected objects synchronized in different diagrams.
- **Verification:** At some point, models need to be verified to ensure their validity / accuracy and check if all the constraints of the BCM modeling language are satisfied. The validation can vary from cardinality checks as syntactical checks to source-target validation. This validation is based on several defined syntactic and semantic rules.

Fig.3 gives an excerpt of the designed BEC@RE modeling tool. The BCM diagrams which could be edited using BEC@RE, are mapped to specific phases of the BCM life-cycle (top-leftside of Fig. 3).

Through this structure, the BEC@RE tool helps the user in choosing the right diagram according to the currently engaged BCM life-cycle phase as indicated within a purple box in Fig. 3. The graphic notation palettes are contextualized according to the model type that the user has selected (bottom left side).

Fig. 4, presents our three matrices as explained in the previous sub-section, to guide the user through the analysis and design of the business process plan.

First of all, key processes are identified then showcased in the Objective/Process Matrix, the criticality of a process is based on 6 criteria with a scale from 1 to 5: (5 as the most critical level). Fig. 4 presents a critical process "Realize the Treatment".

After being identified and analysed in the risk Model, risks will be classified in a matrix according to two criteria: Likelihood (calculated automatically from the likelihood of risk triggers) and Gravity (taken as an input from the user).

The last matrix is the Impact Criticality Matrix shown in Fig 4. This matrix will help in studying risk impacts on the organization. Each impact has its own criticality. This latter is influenced by 3 evaluation criteria: Time, quality and cost. However these 3 criteria may have different importance considering the field the user is working in. For that, each criteria is associated with a weight that can be modified according to the field.

This leads us to propose the following formulas (1) and (2)

$$Criticality = \alpha \times Quality + \beta \times Delay + \gamma \times Cost \quad (1)$$

$$\alpha + \beta + \gamma = 1. \quad (2)$$

The three variables Quality, Delay and Cost in formula (1) are referring respectively to Quality_Criticality, Delay_Criticality and Cost_Criticality of an impact. These variables are introduced by the user.

The user will be assisted during the implementation of the different diagrams with model verification and automated generation of matrices which will create a great advantage when developing the strategies and implementing the BCP.

4. CONCLUSION

Organizations are realising that without business continuity plans, this can lead to loss of profits at best and even more, total termination of business in a worse-case scenarios.

COVID-19 Pandemic demonstrated the necessity of such a plan to deal with those crises situations. During the first wave of the pandemic (March 2020), the economic impact was much stronger on companies and even governments for the lack of adequate BCPs.

Our main contribution in this work appears in the design of a BCM tool, and relies mostly on the research accomplishments of (Rejeb et al., 2012). The corresponding modeling tool is then designed and implemented using the ADOxx meta-modeling platform. The achieved results motivated us to improve our modeling tool in order to add more mechanisms and algorithms for (1) making the BEC@RE tool a quantitative solution that helps build the BCP considering the quantity of resources and calculate the cost

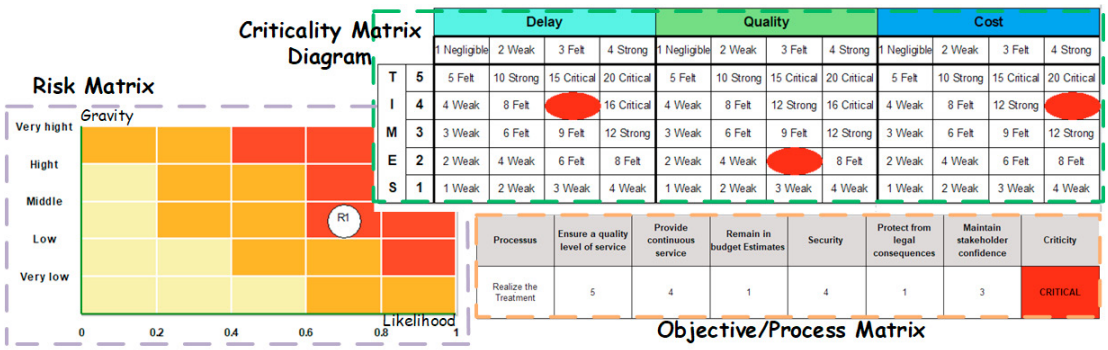


Fig. 4. BeC@RE Tool Analysis Matrices

of loss and (2) help more in the decision making with these new types of data, namely visualisation of diverse KPI (3) simulation of the feasibility and accuracy of the proposed BCP.

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