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# Towards an Ontological Approach to Business Continuity Assessment

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**Abstract.** Business Continuity (BC) methods use threat identification, continuous improvement, and recommendations to ensure running the organization's main activities in case of disruptive events. Information Systems, on the other hand, are increasingly based on service-based structures and are seen as fundamental instruments to guarantee business continuity. The paper presents the ontological foundations for representing business continuity semantics, which are based on a widely adopted information systems research framework. The overall aim of this work is to provide BC with formal semantics and business people with an emerging informal BC modeling method.

**Keywords:** Business continuity · Ontology design · Framework design · Risk management

## 1 Introduction

The repercussions of damaging and vicious events that occur at the source of crisis situations (pandemics, fire, flood, terrorist attack, etc.) are constantly increasing. Matter of fact, our society's increasing complexity and densification (i) generates more natural events, (ii) disrupts the environment, resulting in more natural events, and (iii) increases its sensitivity to events [1].

Preparation, prevention, response, and recovery are the four phases of crisis management [2]. The preparation phase is the one that is primarily considered in the Business Continuity Management (BCM). In fact, anticipatory management has become a top priority for many public and private stakeholders, including the government, public services, private businesses, law enforcement organizations, operators, and so on [3, 4]. To deal with these uncertainties, organizations tend to build strategies for their Business Continuity (BC) and to execute them. BC is the planning and management of contingency measures aimed at keeping critical operational business processes running in case

of disruptive events. Business continuity planning is a subset of organizational mitigation strategies, which is often referred to as risk management. Contingency planning and management in information security usually involve incident response, disaster recovery, and continuity management. Overall, the term BCM refers to both planning and management in an organizational setting [5].

The Business Continuity Plan (BCP) is one of the strategic steering instruments for senior executives [6], but it is frequently neglected [7]. Decisions on strategic IT- and Information Systems (IS), including business continuity planning, should not be delegated to a single member of senior management, the IT-department, or the like [6]. Because IT- and information security is becoming increasingly important in most organizations, the strategic components must be integrated into the senior management agenda on a continuous basis in order to be maintained and improved [8]. Senior management should own and devote time to strategic aspects of the business, as strategic decisions affect operational decisions at a lower level in an organization when working top-down [9].

For modelling BC some approaches were discussed within a handful of papers. The framework designed by Y. Asnar and P. Giorgini in [10] supports modeling and analysis of BCP from an organizational standpoint. In fact, the approach is based on the Tropos Goal-Risk Framework, which emphasizes the interdependence of assets in achieving business objectives. However, this approach is somehow formal, which makes it difficult to deploy in practical situations. Another work done by Griffith University in [11] defines a framework for BCM that, although being detailed and comprehensive, is still quite domain-specific because it only deals with the case of the university with its particular specificities. Another work done by A. Bialas in [12] exhibits an ontological approach to the BCM that is innovative and promising but still quite preliminary. Matter of fact, this paper's proposal tends to meet a proper level of formality but still usable by business professionals.

This research paper aims thus at answering the following main research question: **“How to better understand and assess the Business Continuity using an ontological approach?”** In other terms, this means designing an ontology in order to better comprehend the BC and be then able to assess it.

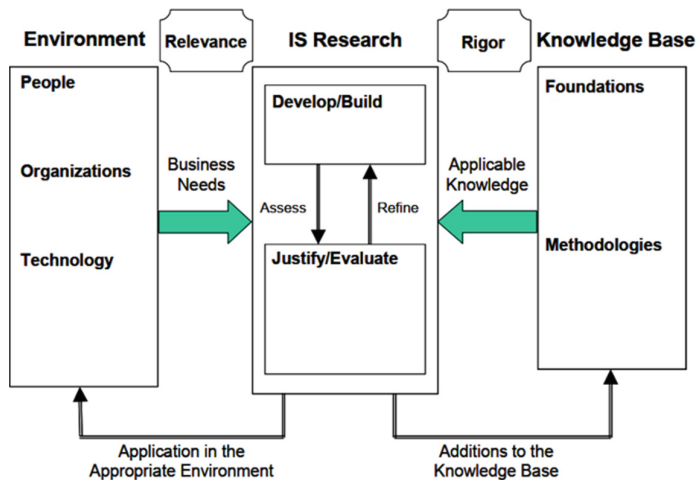
As a result, this paper is structured as the following: (i) the methodology that was followed to design the BC ontology, (ii) the findings of this paper and (iii) the next steps for this research work.

## 2 Methodology

To model business continuity, we refer to the Information Systems (IS) research framework defined by Hevner et al. in [10]. According to it, organizational strategies, structure, culture, and existing business processes are used to assess and evaluate business needs. They are situated in relation to current technological infrastructure, applications, communication architectures, and development capabilities. Together, these define the researcher's perception of the business need or “issue”. Research relevance is ensured by framing research activities to address business needs [13].

Given such a coherent and consistent business need, IS research is carried out in two complementary stages. Behavioral science approaches research by developing and

justifying theories that explain or predict phenomena associated with the identified business need as illustrated by Fig. 1 below. Design science approaches research by creating and evaluating artifacts that are intended to meet a specific business need. The goal of behavioral science research is to discover the truth. Theory is informed by truth, and design is informed by utility. An artifact may be useful because of a previously unknown truth. A theory may not have progressed sufficiently to the point where its truth can be incorporated into design [13].



**Fig. 1.** A sketchy view of the IS research framework defined in [13]

Information technologies (IT) have recently been identified as enablers of business continuity. Almost since the beginning of the e-business era, both researchers and IT-professionals have considered the application of various information technologies in improving levels of business continuity. From an economic standpoint, IT can be used to reduce downtime (increase uptime) and, thus, contribute to better financial results, as each minute of downtime has a cost. In this regard, continuous computing solutions are the most important requirement for business continuity [14]. For these reasons IS and BC are very complementary and useful one to another in many ways such as: (a) documenting and continuously editing the BCP requirements and validations, (b) implementing the BCP and integrating its features within the firm's SI and (c) testing the BCP and assessing its efficiency and robustness by troubleshooting the implemented BC features within the IS.

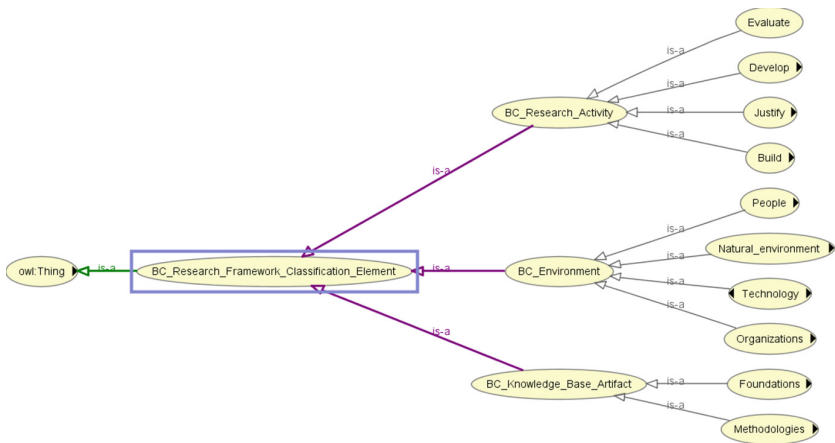
Although some ontology development methodologies already exist, such as NeOn [15] and Ontology 101 development [16] which are speeding-up and knowledge resources reusing ontology development processes, this work doesn't integrate any of them. The reasons behind that are basically: (a) the ontology within this work is built from scratch and forms a knowledge base only from the considered research query results, (b) it's a single ontological format and doesn't merge two or more ontologies, (c) it's formed manually referring to the IS research framework but exploited automatically and

(d) the concepts of the ontology are the papers' keywords and thus these are beforehand retrieved and classified manually in order to satisfy the notion of business continuity and its various requirements.

Therefore, a BC ontology was designed by this work which was essentially based on the IS research framework (Fig. 1) explained previously. In fact, no previous ontology that contributes to this work, by especially characterizing the BC environment and foundations was found. Thus, to create a Business Continuity ontology, some scientific papers referring to "Business Continuity" were pruned through a research query on SCOPUS. Other research engines such as Web of Science (WoS) were used to get a better overview of information such as country, year and WoS category of the publications. The purpose of this analysis is to deepen the understanding of the domain, the information was gathered from 2547 articles. For reasons of coverage, all papers have been retained but will be later, depending on the exploitation of the ontology, eliminated or kept according to their relevance. Next, the research papers were analyzed and all their keywords were extracted serving as concepts for the designed ontology. Thus, a preliminary BC knowledge graph was created. That includes the concepts or "topics", authors, article types (journals, meetings, books, etc.), and publication locations related to the article. Topics are associated with other topics based on the general occurrence of the topic. We also know the number of occurrences of each topic (that is, the number of papers). The graphic also includes the title, summary, DOI (Digital Object Identifier) and contributors.

The class hierarchy of the implemented ontology contains mostly the classes and subclasses of IS research framework and has the retrieved paper topic as concepts. Some hierarchal properties were implemented as well such as: papers "*has\_Author/has\_Type*" or "*concerns*" some topics, topic "*is\_Related\_To; provides\_business\_needs\_to* or *provides\_rigor\_to*" other topics, and other relationships. The concepts were afterward classified within the ontology to form a better understanding of the BC environment and methodologies. Since the concepts or "topics" are directly linked to the papers, accessing the rest of the information regarding a considered topic is relatively feasible. The ontology gets up to 4 levels (a 5<sup>th</sup> one is being created, but not finished yet) and is available for review here: <https://tinyurl.com/4pc2ejkf>.

The OWL visualization of the first two layers of the implemented ontological framework for the BC is given by the Fig. 2 below. It shows the classes and the relations between them within the first two layers. In fact, OWLViz is designed and integrated to work with the protégé owl-editor; it allows class hierarchies in the OWL (The W3C Web Ontology Language) ontology to be viewed and incrementally navigated, allowing comparison of the asserted and inferred class hierarchies. In order to develop the proposed ontology, a comprehensive examination for source of componential analysis was conducted [17].



**Fig. 2.** The BC ontology class graph visualization

### 3 Findings

One fundamental issue in sustaining the BC ontology development is understanding how the BC is currently conceived, what technologies have contributed to shaping its concept, and what the current challenges for further development are. When used for crisis responsiveness, integration, and disambiguation of ground data and information, ontologies for BC processes are undoubtedly a viable means of providing such answers because they reflect current knowledge while also contributing to the creation of new knowledge. Such as the case in for smart cities in [18], designing an ontological framework is a useful thing to do. An ontology also allows for knowledge sharing, handling, reusing, collecting, interaction, and reasoning [19].

As a result, the following finding were possible:

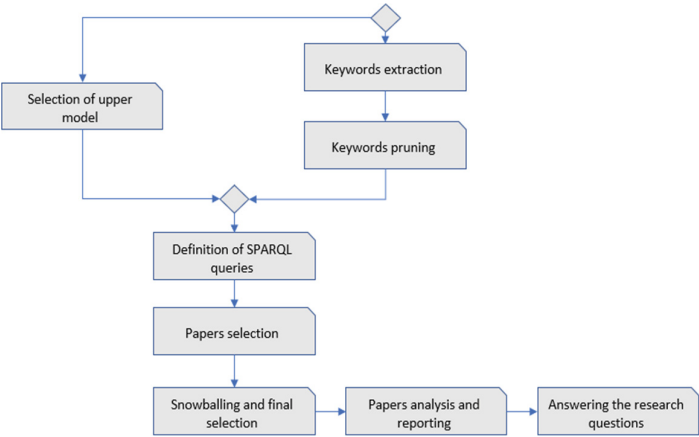
1. Apprehending the BC environment, research activities and knowledge base. In fact, by classifying the concepts within the BC ontological framework such aspects could be identified and more information could be extracted using the designed framework. As the concepts point directly or indirectly on the relevant research papers, it's completely possible to peruse the methods and environment components for the BC in general or within a particular sector as well.
2. Building a knowledge base for the BC. In fact, all the classified topics as a whole and the filled ontological framework, especially its knowledge base artifacts part form an interesting and complete knowledge base for the BC. The research papers linked to the concepts could be thus forming the different parts of the knowledge base subclasses such as methods, constructs, theories, study cases and so on.
3. Identifying threats for the business continuity: The threats for the BC could be identified easily using the accident subclasses of the BC environment components. An example of the present threats within the ontology could be pandemics, terrorism, floods, cybersecurity attacks and so on. These threats are essential to help building a BCP since the BC process identifies mostly the potential threats to an organization

and provides a framework for building resilience and the capability for an effective response that protects the interests of its key stakeholders, reputation, brand, and value creating activities [20].

#### 4 Further Research and Use of the Methodology

Based on the findings in the previous section, and on the horizons of this research work, the following future results are expected:

1. Use the ontology to define the semantics of BC rules; procedures/instructions that carry out the BCPs such as basic rules of communication in the face of an emergency, rules of reaction to typical threats, scenarios of expected extensive disruptions and how to react to them, rules for including current disruption experiences in future versions of emergency plans as well [21].
2. Query the data through ontology using a query language such as SPARQL which is a query language and protocol for searching, adding, modifying or deleting RDF data. In fact, the Resource Description Framework (RDF) is a graph device intended to formally describe Web resources and their metadata so that such descriptions can be processed automatically. RDF is the Semantic Web's basic language [22].
3. Combining (1.) and (2.) to implement a systematic literature review process and build a survey article on the BC. This process given by Fig. 3 below is mainly inspired by the research work done in [18]. It mainly consists in selecting the papers and extracting their keywords so that they can be later used in the ontology and queried using SPARQL queries. This will allow: (a) obtaining the relevant paper for the selected concepts in order to answer the research questions of the survey and (b) evaluating the relevance, consistency and integrability of the created ontology.



**Fig. 3.** The BC systematic literature review process

4. Apply the metamodel defined by this ontology and the extra classes such as BC threats to form BC indicators and use them to assess the BC within a case study following these steps: (a) define the socio-technical company profile, (b) identify the BC threats, (c) define socio-technical questions for the firm and design BC indicators, (d) instantiate the indicators into calculated metrics, and (e) use these indicators to assess the BC within the considered case study. This assessment does not need to be scientifically precise, but might be based on assumed likelihood [23].

## 5 Conclusion

This research work proposes an ontological framework for assessing and creating a knowledge base for the BC. Whereas the proposal was launched by designing and implementing the ontological framework. Further steps such as formalizing and executing the semantic literature review process and testing the metamodel's findings on a study case are still to be made.

Another limitation of this work, and thus a potential improvement for future work is that the framework consists only of the knowledge base, environment and research activities for the BC. Matter of fact, it could be complemented by creating extra classes such as BC threats, indicators and questions such as explained previously in the 4<sup>th</sup> point of Sect. 4. This could help to assess the BC using the ontological framework but also test and implement the results on a real case study.

At this stage, this research work allows to conceptualize the BC aspects in an ontological framework but proposes on the other hand, a possibility to implement important features to assess the BC such as threats and indicators as an extension to the ontology by following the same design methodology. This gives the possibility to three future works: (a) using the ontological framework to build a BC survey, (b) implement BC assessing features (threats, questions and indicators), and (c) evaluate the BC ontology's theoretical results on a specified field case study.

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