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Investigation of Modelling of Dynamic Business Processes

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Ph.D. Thesis Booklet

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Abstract

The notion of the process has become an essential asset for daily life in organizations and enterprises. It helps achieve organizational objectives and defines information systems (IS) management. One of the most relevant problems in IS research concerns business alignment with the change of the environment, customer's needs, and requirements. The alignment process was attempted to be integrated into several domains to achieve particular goals and desired outcomes for a long time. When a process's objective relates to the company's goals, the process will be designated as a Business Process (BP)

  The BPs are interrelated to each other considering their structure and functionalities which define their *static* and *dynamic* aspects. Most research efforts concentrated on static BP problems, i.e., on the process structure. Still, the traditional approach used to implement a BP in today's IS no longer covers the dynamically changing business environment that is the business's actual need. Because of that, this Ph.D. dissertation intends to widely cover BP concepts in general, with a particular interest in its dynamic aspect introducing a fresh, and new perspective that defines the proposed approach clearly.

  Previous studies dealt with only just mentioning the concept of the dynamic aspect of processes, and some related terms were described but without specific definition, researchers in the same domain as well did not define the different factors that impact it and their components during BP execution (*run-time*). Our study contributes to the domain of BP by providing its clear and comprehensive definition and the conceptualization of its dynamic aspect. The latter helps in familiarizing with BP functionalities during the run-time, and we also investigated factors influencing it and their change as well as elements or objects impacted by these changes. While some

researchers concentrated on the structure, although they neglected when BP elements changed and how they were modified. For that reason, we deeply investigated that area, we have identified the various elements (*components*) that can be affected by the factors of change and how the process adapts to this influence.

BP modeling describes the functioning of a process and defines all activities of the BP model for giving more understanding. The thesis establishes a taxonomy for the negative and positive features (*advantages and disadvantages*) for existing BP models. These similarities have helped us find syntactic code elements in the representation codes and functionalities that proved helpful in transformations between models. The field of transformations between models is a vast area, and a lot of methods for conversions were described but never between models chosen by us (BP Execution Language (BPEL) and Finite State Machines (FSM)), and (FSM and Hypergraph). The comparison across models may also lead to mixing and integrating different models to find a way to verify formally unapproved ones.

We have introduced the hypergraph concept in this modeling area that enables the utilization of graph algorithms, linear algebra, and the most current data science methods. This operationalized model supports the model checking after incorporating changes into the running instances of dynamic processes. We implemented some representations dealing with this concept with various matrices and forms. In our future works, we can use hypergraph and its models for either different models of processes or apply several new verification methods of the soundness of processes that were changed in a dynamic way. The implementation of our approach helps to use many tools to verify the process and check some properties through exploiting the hypergraph representation.

Thesis

There are a plethora of studies about IS, BP, its modelling, its management with diverse viewpoints of known researchers in the same domain. This part aims to provide an overview of all the study details of the research. It initiates the context of the topic and focuses on an overview emphasizing on the importance of the conducted research problem, as well as the list of motives, the set of the thesis that constructs my main thesis, and the list of the contributions.

In my master thesis, my interest was about the notion of BP and its domain. Our overall goal in this thesis is to increase knowledge regarding the concept of BP, with a deep investigation especially on the process aspects (*static and dynamic*).

Motivation

In this section, I wanted to shed light on the motives behind drafting these research questions that attempted to answer. It will discuss and mention all causes of why we are investigating the dynamic aspects of BP, its modelling, and its management.

While several research [5] [15] [14] [16] have been carried out in the field of static BP, the dynamic aspect is very limited in research. So far, there are no studies that focus on it. Most of the researchers concentrate on the structure of BP but not on its functionalities during the run-time (*execution time*), in addition, there are no publications discussing the different changes or factors impacting BP during that time. The scarcity of articles in this perspective hinders our understanding of organization adaptation to these types of factors. these various reasons are the motives behind investigating this topic.

In recent years, the term "*BP management (BPM) and modelling*" [4] became

widely known and plays a pivotal role in most organizations to adapt to new business philosophy and applied informatics. This has led to the emergence of a large number of BP modelling methods and tools for the elapsed decades. Methods for the business modelling process could be regarded as a description by which people and stakeholders of the enterprise can understand the object, documents, systems, and related phenomena.

Various process modelling methods are fundamental to describe the structure and the functioning of the company. In our research, we emphasize on BP models and existing representations, as we intend to compare these models based on some criteria (semantic, syntactic, and structural)to establish differences and similarities which help in transformations among similar ones. These transformations also aid to make combinations and integration between different models to find a way or tools (*such as formal verification tools*) to verify formally some models which might not be verified.

Our focus available BP models are to define business requirements and propose a BP model structure for flexible visualization of BP models and ensure more comprehensive business requirements. Additionally, these BP technologies differ in their requirements and their use contribute to building dedicated global information about functionalities, rules, and characteristics for supply and manage dynamic BP (the execution of the process during run-time) based on the concept of the process model (representation).

Existing approaches dealing with dynamic BP modelling and simulation are incomplete because they are lacking in terms of theory and practice (implementation). Furthermore, there is no commonly affirmed definition of dynamic BP, the same concern is noticed with the definition of dynamic BP, for that, our main goal is to deeply investigate the several existing and famous references in the domain to conclude with the most appropriate and our own definitions for the concept.

One of the other motives is related to the use of hypergraphs [3], they are a widely used graph-based formalism introduced for the modeling of various kinds of systems. The formalism of hypergraph is quite versatile and its main strength is its built-in capability of succinctly representing relationships between the unbounded number of nodes, A relatively lengthy section will be dedicated to hypergraph representation and code generation allowing us to describe it in different forms. This will enable

us to use it in an advanced stage to represent BP and solve many sensitive types of BP such as health BP and financial (economical) enterprise affected recently by the world situation (Covid-19).

Research Problem

To adapt IS to the versatility of the environment, organizations invest large budgets and efforts in managing the evolution of BP. However, one of the major encountered difficulties is the development of techniques and tools that deal with these changes. Indeed, in the context of dynamic evolution, the continuity of active instances, following the new process is a crucial problem that requires an analysis of the impact of changes in BP on active instances.

Changes in BP can arise because of several reasons including environmental changes, maintenance of management rules and alterations in the organization structure, the optimization of BP. As an immediate consequence of these changes, companies must continually renew and improve their BP to acclimate to the developments. To deal with the inherent changes in BP, we should focus on both static and dynamic aspects of BP, the *static* one means there are no instances of this process running. In this case, the changes will take effect only for new instances and they will not generally have any impact regarding the already completed instances.

For the dynamic one, there arises the crucial question-related management of active instances of a BP whose specification has been modified. For that, we are required to be more interested in the exploitation of BP concepts to adopt this technology. We thoroughly investigate existing BP functionalities and the various changes which can impact them during the run-time. We also deal with the various tools and techniques allowing both modelling and automation of the execution of the BP in an IS using different existing representations (models).

Based on expected outcomes and research objectives, the proposed research attempts to answer research questions summarized as follows:

- **Question 1:** What are the similarities, differences, advantages, and disadvantages between existing BP models?

- **Question 2:** How can we properly define the dynamic BP concept and its

modelling?

- **Question 3:** What are the factors influencing BP functionalities (during running time)? Moreover, which components could be impacted?

- **Question 4:** How can BP dynamicity be ensured, and what requirements of dynamic BP must be considered?

- **Question 5:** In the future, and after learning about the different changes that could impact it, can the organization adapt and control the different changing factors?

These questions will enable us to investigate the topic of dynamic BP and discuss the different problems that arise a for detailed analysis of the domain. Research objectives were broken down into analyzable research questions and the main research objective strongly connects to the problem statement formed in the previous subsection.

Theses

- **Thesis 1**: an adequate framework for the analysis of the research domain and understanding the various concepts related to the BP is defined that laid down the foundation of further investigation.

  We investigated the field in general and collect the most essential research details [10], definitions, terms, standards for IS, BP modelling, BPM and BP technologies such as Enterprise Architecture (EA)[2], Web services [1], as well as we presented the relation between those all cited notions, Our overall goal in this part is to increase knowledge regarding the concept of BP, its management. All those definitions found in chapter 2 and details help us to know more the research domain and facilitate later their use.

- **Thesis 2**: in this dissertation, A taxonomy is created for comparing the various existing process models. The taxonomy constitutes the theoretical ground of model transformation.

  We presented the most BP models and established taxonomy for the negative and positive features [12] (advantages and disadvantages) for each existing model. A comparative analysis [13] part were summarized in details in tables a

comparison which based on various criteria (*syntax, structure, and semantic*), these similarities concluded aide us to find syntactical element in the representation codes and functionalities that proved helpful in transformations between models (transformations have done: [9] [1]). The comparison across models may also lead to mixing and integrating different models to find a way to formally verify ones that might not be verified. At the end of this part, we can say that the first question of our investigation answered.

- **Thesis 3**: in this part, we discussed and answered that most questions posed. We investigated deeply the dynamic BP aspect definitions [7] using several references in the same domain. Our own definition of dynamic BP is created, which is one of the important goals of our study.

  The several factors influencing BP [11] during its functioning were well defined in chapter 3, we concluded them using a collection of information from various references, later the elements or objects impacted by these changes were explained. The question posed about requirements needed that must take into consideration for dynamic BP also answered in that part. we discuss as well how to ensure BP dynamically and how it should be managed [6]. At this thesis, a big part of our investigation done.

- **Thesis 4**: this thesis part introduces the hypergraph that enables the utilization of graph algorithms along with the most recent methods of Data Science. The notions (definitions and concepts applied to). An implementation done of hypergraph was well-explained. An implementation of the hypergraph concept [12] has done in Python, this representation using matrices and forms can be used in our future works to use hypergraph and its instances for either other processes and apply several new methods, the implementation aims to represent the hypergraph in different ways to easier the use of it later.

  Formal Methods and formal verification objectives are defined with particular attention to model checking. which applied on the representation of the hypergraph based on FSM approach [9] and verify several properties [8].

Contributions

In line with the problems outlined, I contributed towards the domain of BP in general by:

- Investigating in the domain, defining the majority of concepts [2] [7] related and explain the relation between them. There is a multitude of tools with varying sets of features for the modeling, we present the different existing BP models in details based on several criteria (*semantic, syntactic*, and *structural*) [13] and well defined their advantages and disadvantages [12],

  The comparison made contributed to finding some similarities and differences between such kinds of models which helped as well to search for not existing transformations between models and aided us to collect more ideas about those deals and made transformations and combinations between them.

  During our study there transformations were done, the first is a new functional approach that transforming abstract specifications based on FSM from BPEL Programs. The application that we have implemented [1] contains several functionalities allowing us to perform several tasks. It revolves around the transformation rules which enable the construction of a moving structure between the program written in BPEL language based on patterns.

  The proposed approach has been implemented in an environment that concertizes the implementation of patterns. The developed software tool also performs functions beneficial for protocol managers, such as BPEL code generators, verification, and visualization of some FSM properties and defining abstraction levels (model instead of language).

  The second one [9], was a proposed approach that aims to describe the hypergraph to model and all its elements and patterns based on the FSM concept in order to use a formal method on hypergraph to verify such BP properties which might never be verified before with formal method.

  All transformations mentioned before were never done only by us which contributed in the domain of transformations models and augment the possibility of sharing the verification method of several properties especially formal methods.

The third one [9], was a proposed approach that aims to describe the hypergraph to model and all its elements and patterns based on the FSM concept in order to use a formal method on hypergraph to verify such BP properties which might never be verified before with formal method.

All transformations mentioned before were never done only by us which contributed in the domain of transformations models and augment the possibility of sharing the verification method of several properties specially formal methods.

- We investigating both aspects of the BP static (*the structure of BP*) and the dynamic (*functionalities of BP*), because the researchers focus more on the static aspects, we are especially focused more on the dynamic one and enriching this domain by adding and give a new specific definition give a specific definition of this concept [11] (*providing our own definition*);

- The changes affecting BP during execution time were defined after a deep investigation, while some researchers were concentrated on the structure but neglected why BP elements changed. we listed the factors that might impact the functionalities and specify which components [11] can be affected or influenced by those changes factors.

  We focused on that and define different items that could be affected or influenced. addition to that, the functionalities that can be broken, stopped, or modified will be more specified to avoid them in the future and minimize their impact with new proposal approaches;

- The modelling of BP using different models gives BP easier management. In our studies as well we will try to represent the concept of a hypergraph and implement some representations with different forms.

  The representation can generally help in using many verification tools (formal verification tools) of the process, the different ways used to represent the hypergraph as matrices and forms which aide to manipulate it more, that combination which never done between hypergraph with other formal models like FSM helped us to check different properties of the process using a formal tool named model checker [8];

- Hypergraph representation allowing using it in a later stage to represent BP and solve new sensitive kinds of BP which are especially affected by the world contemporary situation.

Publications

This section summarises the list of my publications, in chronological order:

- **Publication 1:**

  - *Authors*: Molnár Bálint and Bouafia Khawla.

  - *Title:* Adaptive Case Management and Dynamic Business Process modelling A proposal for document-centric and formal approach.

  - *Conference:* The 12nd International Symposium on Applied Informatics and Related Areas(AIS 2017), November 9, 2017, Székesfehérvár, Hungary.

  - *Published in:* AIS 2020 Proceedings.

  - *Link:* http://ais.amk.uni-obuda.hu/proceedings/2017/AIS_2017_Proceedings.pdf.

  - *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

- **Publication 2**:

  - *Authors:* Bouafia Khawla and Molnár Bálint.

  - *Title:* An FSM Approach for Hypergraph Extraction Based on Business Process modelling.

  - *Conference:* The 3rd International Conference on Computer Science and its Applications (CSA 2018), April 2018, Algiers, Algeria.

  - *Published in:* Lecture Notes in Networks and Systems, vol 50. Springer, Cham.

  - *Link:*https://link.springer.com/chapter/10.1007/978-3-319-98352-3_17.

- *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

- **Publication 3:**

  - *Authors:* Bouafia Khawla and Molnár Bálint.

  - *Title*: Dynamic Business Process: Comparative Models and Workflow patterns.

  - *Conference:* The 11th Conference of PhD Students in Computer Science, $((cs)^2)$. June, 2018.

  - *Conference:* Proceedings of the conference.

  - *Link:* http://acta.bibl.u-szeged.hu/id/eprint/61760.

  - *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

- **Publication 4:**

  - *Authors:* Bouafia Khawla and Molnár Bálint.

  - *Title:* A Survey on Dynamic Business Processes and Dynamic Business Processes Modelling.

  - *Conference:* The 21st International Conference on Enterprise Information Systems (ICEIS 2019), 2019, Heraklion, Crete, Greece.

  - *Published in:* Proceedings of the 21st ICEIS, Volume 2: ICEIS, 556-563.

  - *Link:* https://www.scitepress.org/Link.aspx?doi=10.5220/0007627105560563

  - *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

- **Publication 5:**

  - *Authors:* Bouafia, Khawla and Molnár, Bálint.

  - *Title:* Opportunities for Supporting Digital transformation through Modelling Dynamic Processes.

  - *Conference:* The 21st International Conference on Enterprise Information Systems (ICEIS 2019), 2019, Heraklion, Crete, Greece.

  - *Published in:* Proceedings of the 21st DCEIS, 3-9, 2019, Heraklion, Crete, Greece.

  - *Link:* https://heptagon.in/2019/08/14/digital-transformation-through-dynamic-business-processes-modeling/

  - *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

- **Publication 6:**

  - *Authors:* Bouafia Khawla and Molnár Bálint.

  - *Title:* Analysis Approach for Enterprise Information Sytems Architecture Based on Hypergraph to Aligned Business Process Requirements.

  - *Conference:* CENTERIS-International Conference on ENTERprise Information Systems. November 2019, Sousse, Tunisie.

  - *Published in:* Procedia Computer Science Volume 164, 19-24.Published by Elsevier B.V.(counted as journal paper)

  - *Link:* https://www.sciencedirect.com/science/article/pii/S187705091932188X

  - *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

- **Publication 7**:

  - *Authors:* Bouafia Khawla, Ali Khebizi and Molnár Bálint.

  - *Title:* New Functional Approach to Transforming Abstract Specifications of Web Services Based on FSM from BPEL Programs[1].

  - *Journal:* American Journal of Innovative Research and Applied Sciences. ISSN 2429-5396 I www.american-jiras.com, April 2020.

  - *Link:* https://american-jiras.com/Abstract_3_April_2020.html

  - *Author contributions :* Khawla Bouafia worked on this paper together on the idea of Ali Khebizi under the supervision of Molnár Bálint; we write the original draft version, then we carried out editing the revision. Khawla proofread the draft and revision.

- **Publication 8**:

  - *Authors:* Bouafia Khawla, Maxim Kumundzhiev and Molnár Bálint.

  - *Title:* Application of Models and Hypergraphs on Dynamic Aspects of Business Process Performance Analysis.

  - *Conference:* Zoltán Horváth (Horváth Zoltán Matematika-informatika) EL-TE/ELU FoI/ICS/ELTE IK Department of Programming Languages And Compilers ; Adrian Petruşel (eds.) Collection of Abstracts : 13th Joint Conference on Mathematics and Informatics Conference: Budapest, Hungary 2020.10.01. - 2020.10.03. (Babeș-Bolyai University of Cluj-Napoca, ELTE Faculty of Informatics; Eötvös Loránd Tudományegyetem Informatikai Kar, ELTE Informatikai Kar, Eötvös Loránd University). Budapest: ELTE Faculty of Informatics; Eötvös Loránd Tudományegyetem Informatikai Kar, Universitatea Babeș-Bolyai UBB, Babes-Bolyai Tudományegyetem, Matematika és Informatika Kar, Babeș-Bolyai University of Cluj-Napoca, pp 37-37 (2020).Language: English

  - *Published in:* Conference paper (Abstract) | Scientific | RIS-Egyéb Integrált kutatói utánpótlás-képzési program az informatika és számítástudomány diszciplináris te...(EFOP-3.6.3-VEKOP-16-2017-00002) Funder: EFOP-VEKOP,

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[1]This work will be extended with another part soon

TKP2020-NKA-06(Thematic Excellence Programme TKP2020-NKA-06 (National Challenges Subprogramme)) Funder: NKFI Last Modified: 2021.02.03. 11:27 Tibor Szabó (ELTE IK admin 5).

- *Link:* http://macs2020.elte.hu/booklet/macs2020abstractBooklet.pdf
  Author contributions : Khawla Bouafia and Maxim Kumundzhiev worked on this paper on the idea together under the supervision of Molnár Bálint; we write the original draft version, then we carried out editing the revision. Molnár Bálint proofread the draft and revision.

- **Publication 9**:

  - *Authors:* Bouafia Khawla and Molnár Bálint.

  - *Title:* Formal Verification of Analysis Approach for Enterprise Information Systems Architecture Using Hypergraph Representation Based on Finite State Machines for Supporting Business Process Requirements.

  - *Journal:* Journal of Applied Business and Economics (JABE), (accepted under publishing). Vol.22(9), 03-01-2021.

  - *Link:* https://articlegateway.com/index.php/JABE/article/view/3686

  - *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

- **Publication 10**:

  - *Authors:* Jozef Stašák, Jaroslav Kultan, Peter Schmidt and Bouafia Khawla.

  - *Chapter Title:* Business Process Linguistic Modelling –Theory and Practice - Part II: BPLM Business Process Designer Process Requirements

  - *Book:* Open Access book, "Operations Management - Emerging Trend in the Digital Era" edited by Dr. *Antonella Petrillo* (waiting for the online publication of the chapter)

  - *Link:* https://www.intechopen.com/online-first/business-process-linguistic-modeling-theory-and-practice-part-ii-bplm-busine

- *Author contributions :* Khawla Bouafia contributed in dynamic BP parts in the paper,Jozef Stašák proofread the draft and revision, supervised the process.

Submitted Journal

- **Publication 8**:

  - *Authors:* Bouafia Khawla, Maxim Kumundzhiev and Molnár Bálint.

  - *Title:* Application of Models and Hypergraphs on Dynamic Aspects of Business Process Performance Analysis.

  - *Conference:* 13th Joint Conference on Mathematics and Informatics, October, 2020.

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  - *Link:* http://macs2020.elte.hu/booklet/macs2020abstractBooklet.pdf Author contributions : Khawla Bouafia and Maxim Kumundzhiev worked on this paper on the idea together under the supervision of Molnár Bálint; we write the original draft version, then we carried out editing the revision. Molnár Bálint proofread the draft and revision.

  - *Authors:* Khawla Bouafia and Molnár Bálint.
    item *Title:* Hypergraph Application on Business Process

  - *Journal:* Journal of MDPI (submitted 4 May 2021)

  - *Author contributions :* Khawla Bouafia and Bálint Molnár worked on this paper together; we write the original draft version, then we carried out editing the revision. Bálint Molnár proofread the draft and revision, supervised the process.

Dissertation Organization and Structure

The manuscript is composed of five chapters, the present preamble chapter is general introduction that specifies the context of the study, the motives behind the research, thesis contributions, my set of publications and the organization of the manuscript.

- In the first chapter, we provide a general idea as an introduction to our Ph.D. dissertation, motives, the contribution of this and the list of my publications.

- In chapter 2 We present the literature review and briefly recall the definitions, concepts, and standards for IS, BP and BP technologies. The focus will be particularly on the concept of BP, its modelling.

- In chapter 3: This chapter shows all concepts and research about BP models and various studies investigated with these models to insensitively compare between them and to point out the main differences between models *(negative and positive points)* as well as the model transformations made during our studies.

- In chapter 4 : This chapter aims to report on a study that looked thoroughly at the dynamic aspect of BP, it will further discuss the changes that impact the process during its functioning time and their adjustment.

- In chapter 5: In this chapter, our focus is on the hypergraph representation, its theory and the various application domains, a hypergraph representation that we created using Python will be represented to facilitate some tasks. Several definitions and terms related to formal verification will be later used to verify our proposal approach of hypergraph based on FSM representation.

- Finally, the general conclusion given in the conclusion summarizes the contributions of the thesis joined with the outlines and prospects for future research.

- At the end of the dissertation, appendices and references are listed.

Conclusion

The work in this dissertation represented the investigation on BP modelling and its management reached that its completion, we tried to answer the questions we say in chapter.

We began our dissertation with the theoretical background (chapter 2) summarizing our research domain and definitions. We started with the notions of enterprise, IS and its components. The main focus was on the concept of BP, and its modelling. Many BP technologies were described as well like: workflow, web services, EA . . . .

We thoroughly reviewed the literature written about existing BP models such us: Petri-nets, FSM, BPMN, UML diagrams . . . , we based on *semantic, syntactic*, and *structural* criteria of each model to insensitively compare between them, to point out the main differences and to conclude negative and positive points for each, this also helped in concluding methods of transformations between those BP and languages. A set of transformations done during our studies were presented well in this chapter.

In chapter 4, we aimed to report on a study that looked thoroughly at the dynamic aspect of BP, and we further discussed the changes that impact the process during its functioning time and their adjustment. We concluded with our definition of dynamic BP conceptualization. We also answered most of the questions related to dynamic BP posed before.

In the last chapter 5 of our detestation, the concept of the hypergraph, its representation, and the approach of the hypergraph based on the FSM approach was represented. Formal verification will be applied to verify several properties.

We concentrated on the concept of the hypergraph and its representation and because it was implemented in different approaches and forms, this helped us in our future work to use it directly to represent process problems and for more complex types of BP such as *health* processes, which are characterized by being sensitive to the contexts in which they are implemented and are therefore highly variable. As well as economical BP which is more influenced by environments (*internal and external*) and the current state of coronavirus, this will be our future work.

I am aiming to conduct further research that goes under applying of process mining and machine learning approaches (the proposal idea discussed) in order to verify and align BP (focusing on health and economic BP that are sensitive and more impacted in last the world state) using BPMN model.

As other future work will be the implementation of the published study [2] consisting of an application to represent the EA (actual research) and verify it using the representation [12] and different forms to demonstrate its use and efficiency.

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