Categories of Change Triggers in Business Processes

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Abstract—Business processes need to constantly adapt due to changes in their environment and requirements. Therefore, one of the main activities in business process management is the management of changes. To effectively manage changes, there is a need for categorization of change triggers in business processes. However, existing categories of change triggers are limited to information systems and neglect the change triggers of business processes. We conducted a review with a well-defined methodology to identify categories of change triggers in business processes. This paper presents a generic categorization scheme of change triggers in business processes based on the results of the review. The new categorization scheme can serve as a checklist to elicit the possible future business process changes and, thus, support the process of change and risk management.

Index Terms—Business Process, Evolution, Change Triggers, Change Management

I. INTRODUCTION

Organizations are faced with several influencing factors such as new technologies or changes in requirements of stakeholders [1]. Thus, they have to continuously adapt their business processes to remain competitive [2]. The ability to manage changes efficiently is one of the most challenging tasks [3]. Further, the changes in business processes affect the product development and production activities [4]. Therefore, change engineering plays a major role in risk and cost management [4], [5]. To effectively manage changes, it is recommended to save triggers of changes in a database to identify patterns or categories of change triggers [6].

Software systems support business processes in organizations. Business processes can be considered as a set of activities to realize a business goal [7]. These activities can be divided into system steps (i.e., performed totally automatically by the software system) and actor steps (i.e., performed totally by a human actor) [8]. As a result, a business process and the corresponding software system affect each other in a mutual way. Thus, we cannot consider changes of business processes and software systems in isolation, as software systems and business processes co-evolve. During the co-evolution and the process of change management, change triggers in business processes lead to further changes in the corresponding software system [9].

Based on a discussion about change triggers, Swanson defined three categories (i.e., corrective, adaptive, and perfective maintenance) to describe software maintenance activities [10]. In the domain of information systems, Swanson’s categorization or its adaptation is primarily used. In the domain of business processes, a change trigger can be defined as an “event or circumstance that can bring about changes in an enterprise” [11]. [12] lists examples of change causes in the business process (e.g., to become more competitive or to reduce costs) resulted from an empirical study (i.e., questionnaire). Based on a questionnaire, Write and Burns present a set of change triggers such as information technology or globalization in [13]. Another empirical study (i.e., structured interview) shows that social/economic transformation (e.g. from a centrally planned economy to free market economy) or leadership style can result in changes in business processes [14]. However, there is a lack of a comprehensive and systematic categorization of change triggers in the domain of business processes.

In this paper, we present the results of our literature review performed to identify categories of change triggers in business processes. Our review is based on a well-defined methodology. The overall objective was to answer the following research question: Which categories of change triggers can be identified in business processes? Based on these results, we built a generic categorization scheme of change triggers in business processes. The developed categorization scheme is hierarchical and allows the categorization of change triggers in business processes along the following dimensions: participation, origin, and characteristics. The structure of our categorization scheme is generic and does not depend on specific business process contexts. Thus, it is applicable to any kind of organization. Furthermore, by using such categories of change triggers, analysts can elicit possible business process changes and the resulting future requirements. Thus, it supports the process of change engineering in business process management and allows eliciting future requirements and risks for project planning. Supplementary material for the review study is given in [15].

The remainder of this paper is organized as follows: Sec. II gives an overview of the research methodology. We present the results of the study in Sec. III. Our categorization scheme based on these results is introduced in Sec. IV. The last section outlines the main conclusions and discusses future work.

II. RESEARCH METHODOLOGY

The review method is based on guidelines for performing evidence-based studies in software engineering research domain.
A. Pilot Study

We conducted a pilot study to define our review protocol. In the pilot study, an iterative approach was used i) to define research question, ii) to identify the best search strategy, iii) to refine inclusion and exclusion criteria, and iv) to formulate the data extraction form. First of all, we defined the initial research question referred to our overall objective and evaluated several search strategies. As we did not use an initial set of papers, we initially used the database search strategy. Thus, we examined the reference-based search strategy in further iterations. As the research question is multidisciplinary, we could not limit the review only to a set of venues for manual search. Analyzing random sets of papers from several venues showed that a set of venues may lead to biased results.

Our pilot study was composed of four iterations. In the first two iterations we used a keyword and a descriptor-based approach to identify the search terms. However, these iterations resulted in a very high number of hits in the database search strategy (e.g., in some cases more than 300000 hits) and did not contain relevant results in terms of categories of change triggers. Thus, based on the results of the first two iterations, we used structured and generalized search queries in the last two iterations to improve the results of the database search. In the following, the last two iterations (i.e., 3. and 4. iteration) are described:

1) 3. Iteration: A so-called change facet is defined in the following as a general term referring to all aspects of a change for example change trigger or change impact. In this iteration, we narrowed the change facet in the search term to only “change trigger” and its synonyms. As a consequence from the first two iterations, we used general search queries. The general search queries are independent of a special context or a specific subdomain in the business process (e.g., business process flexibility). In this iteration, we examined two types of a search query: A search query is a cross product of three or four search terms: i) synonyms of the research domain (i.e., “business process” or “workflow”), ii) “change”, iii) synonyms of “trigger”, and optional iv) synonyms of classification scheme (e.g., “category”). We used cross product instead of AND and OR concatenation, as several databases support concatenation up to a certain input length (e.g., the search of IEEE Xplore is limited to a maximum of 15 search terms).

However, the results of the database search showed a high number of hits. Thus, we analyzed random sets of the search results for both search query types. The analysis showed that the results do not contain research papers with focus on change triggers, as AND operator does not result in a strong connection between “change” and synonyms of “trigger”. To overcome this problem, we semantically merged the second and the third search terms using the following techniques: i) using the proximity operators (e.g., change* NEAR/5 trigger*) and ii) merging the two search terms to one term and use a phrase search (e.g., “change trigger*” or “trigger* for change*”). However, analyzing random sets of search results for each technique showed that the proximity operators are not supported by all electronic databases. Thus, we used the second search strategy in 4. iteration.

2) 4. Iteration: As a consequence from the 3. iteration, we merged the synonyms of “trigger” and “change” in a phrase search (e.g., “change trigger*” or “need for change*”) for a search query. Thus, a new search query is either i) synonyms of research domains and the phrase search of synonyms of “trigger” and “change” or ii) synonyms of research domains, the phrase search of synonyms of “trigger” and “change”, and synonyms of classification scheme. The goal of this iteration was to identify the best search query. Thus, we analyzed and compared the results of both search queries. The analysis of a random set of resulted papers of each search query type showed that the first search strategy contained more relevant research papers. Additionally, the analysis showed that a full-text reading of the random set of papers needs to be conducted. The full-text reading of the included papers in the random sets allowed extracting further synonyms for search terms.

Final Search Queries: The resulted search queries in this iteration is the cross product of: i) the synonyms for the first search term: “business process” and “workflow” and ii) the second search term is a combination of the change facet (i.e., “trigger”, “reason”, “force”, “driver”, “cause”, “need”, “origin”, “category”).
“source”, and “lever”) and “change” in a phrase search (e.g., “change trigger*”) as a consequence of the 3. iteration.

**Electronic databases:** In the next phase, random sets of papers for the search queries of the multidisciplinary resource databases Google Scholar (GS), Scopus, Web of Science (WoS), BASE, ACM DL, IEEE Xplore, AISEL, and SpringerLink were analyzed. Based on this analysis and the multidisciplinary characteristic of the research query, we used only the four electronic databases GS, Scopus, WoS, and BASE for the further analysis. Additionally, the results of the four databases contain the results of the remaining databases (i.e., ACM DL, IEEE Xplore, AISEL, and SpringerLink).

**Further Search Strategies:** In addition to the database search strategy, we used a modified snowballing method for the included papers. Therefore, we conducted a reference-based search in one iteration due to inefficiency of this method in our case. In this context, efficiency is defined as “the number of included papers in relation to the total number of candidate papers examined” [17].

**B. Review Protocol**

Based on the pilot study, we present the review protocol for the **research question:** Which categories of change triggers can be identified in business processes?

1) **Search Strategies:** The results of the pilot study showed that the database search is the appropriate search strategy. Based on the results of the 4. iteration, the search query consists of the cross product of the research domain (i.e., “business process” and “workflow”) and the phrase search of synonyms of “trigger” and “change” (e.g., “change trigger*”, “trigger* for change*”, “trigger* of change*”, and “trigger event*” for trigger). We used the multidisciplinary databases GS, Scopus, WoS, and BASE and adapted the search queries based on the syntactical characteristics of each database (i.e., using database search helps). Exact search queries for each database and the number of hits for each search query are given in [15].

2) **Analysis Strategies:** Based on a full-text reading of the papers, we could extract further synonyms for the change trigger. If a new synonym is identified, a new cross product with the synonyms of research domains is used for further search process. In general, we analyzed the first 20 hits of each search query (i.e., each cross product for each database). The number of results for each query from WoS, Scopus, and BASE is less than 1000, we analyzed the first 20 papers for this search query. If the number of papers is more than 1000, we decomposed the second part of the search query (i.e., the phrase search for the change facet) and analyzed the first 10 papers. For example, the number of results for the second part of the search query “driver* for change*” was at approximately 2110. We decomposed this search query to the following search queries: “driver for change”, “driver for changes”, “drivers for change”, and “drivers for changes”. Consequently, we proportionally analyzed more papers for a search query, if it has more hits in the GS search result.

b) **Modified Search Strategy:** The second method aims at avoiding the publication bias, as older publications have more citations and can be ranked as more relevant. In this phase, if the number of the papers of a search query is less than 500, we analyzed the first 20 papers. If the number of papers is more than 500 but less than 1000, in addition to the first 20 hits, we sorted the papers by time, and analyzed the first 20 papers between the years 2011 and 2017. If the number of papers is more than 1000, in addition to the first 20 hits, we analyzed the first 20 papers between the years 2011 and 2017, and the first 20 papers between the years 2006 and 2011. Besides avoiding bias, this method gives the search queries with more hits a higher priority, as more papers for such search queries are analyzed. Analyzing more papers since 2006 gives the current research a higher priority. The search queries and the number of hits for each database are given in [15].

3) **Inclusion and Exclusion Criteria:** In this section, we describe the inclusion and exclusion criteria. Additionally, we consider papers published until 31.12.2017.

The **inclusion criteria** were defined for the research question as follows:

- The paper relates to one of the aspects of the business process domain. The title, abstract, (author) keywords or descriptors, and introduction have to have a reference to the business process domain. Typical indicators of this domain are the terms and their synonyms such as change management, process management, business process change, business process modeling, business process management, business process flexibility, or workflow management.
- The paper explicitly mentions a change category or class in the business process with focus on change triggers. Additionally, the categories semantically aggregate examples and rationales referring to change triggers. Typical indicators are terms such as class/es, category/ies, or type/s and so on. Additionally, they can be part of a taxonomy or a framework. We consider only change trigger as a change facet. Other change facets, for example, change impact are not considered. The inclusion considers all contexts in the business process domain (e.g., “business process flexibility”). We consider only universal and not branch-specific categories for change triggers.
- Conferences, symposiums, journals, workshops, and magazines are considered.
The exclusion criteria are formulated as follows:

- The paper does not relate to the business process domain.
- Duplicates are excluded. If the same paper is published in several venues, we considered the paper including a more complete categorization.
- The number of pages of a paper is less than 7 (i.e., short papers are excluded).
- Gray literature (e.g., theses, presentation slides, technical reports, white papers, or books and book chapters) is excluded, too.
- We only consider papers written in English.
- The paper is not available for (free) download.

4) Reading Strategies: If a paper was resulted from the database search, we used the following reading strategy: A local reading of the title, abstract, conclusion, and the sections, in which the search query was found, were used to initially exclude the papers. For the further inclusion we skimmed the papers. As the next step, we used intensive reading in the phase of the data extraction. If the paper was identified using the reference-based search strategy, a local reading of sections was not possible. In this case, we conducted a full-text reading of the entire paper.

5) Data Extraction: Table I presents the data extraction form used in our review.

### III. FINDINGS

In the following, we present the major results obtained from the review. We applied the inclusion and exclusion criteria to the papers. One of the exclusion criteria was the gray literature (e.g., [18] in spite of reference to categories of change triggers in business processes). If a paper references a categorization of the change triggers in business processes from another literature, the referenced paper was analyzed. If the referenced paper is gray literature, we also excluded the paper. Further, the papers, that are not directly related to the business process domain, were excluded. These papers are usually sector-specific (e.g., in the health care or finance sectors) and, thus, have no generic categories with regard to business processes. Another example of excluded papers, which do not contain generic categories, are papers in the context of requirement engineering (e.g., [19]) or papers referring to only a specific subdomain such as supply chain management. Further, the papers, that do not explicitly refer to a category, were excluded (e.g., [20] refers to source of change without referring to the categories). The explicit reference to categorization is particularly important for the objectivity of the review process in order to avoid different interpretations of the reviewers regarding the categories. Furthermore, we excluded the papers that only refer to the categories of changes in the business processes without discussing the change triggers (e.g., [21] focuses on change strategies). Additionally, we eliminated the duplicates regarding the content (e.g., [22] and [23]).

After analyzing the relevant content of the included publications, we conduct data synthesis, which involves collecting and summarizing the results of the included papers (cf. [16]). Therefore, we chose a descriptive (i.e., non-quantitative) synthesis according to our defined data extraction form in Sec. II-B. The information extracted from the studies is illustrated in Table II. Although the research question was generally defined, we divided each paper into the specific context of the business process (e.g., business process flexibility).

Analyzing the categories in the identified papers showed that the internal and external categorizations of change triggers are implicitly or explicitly named in several papers, as they are based on system theory. One of the first general approaches can be found in [29]. Additionally, the most categorizations are hierarchically structured using subcategories. This recurring pattern and the hierarchical conception are also a part of our categorization scheme concept in the next section.

### IV. CATEGORIES OF CHANGE TRIGGERS IN BUSINESS PROCESSES

During the review, we created a “state-of-the-evidence” and “state-of-the-art” based on a well-defined methodology as provided in the evidence-based guidelines in software engineering. We could identify research activities in terms of change categories in business process domain focusing on change triggers. To this end, we followed the guidelines of Kitchenham et al. 2007 (i.e., [16]) and the database search helps of the digital libraries. Based on the results of our review study (cf. Table II), we derive a categorization scheme for change triggers in business processes in Sec. IV-A (cf. Table III). The categories of change triggers in business processes are explained in more detail in Sec IV-B. Sec. IV-C provides the benefits and purpose of the categorization scheme. Design decisions are described in Sec. IV-D. Finally, the threats to validity of the results are given in Sec. IV-E.

#### A. Concept and Terminology

Using the results in Sec. III and the underlying question “Why is there a change in business processes?”, we developed a multidimensional categorization of change triggers by formulating the following questions:

- **Who or What?** refers to the participation. It mainly describes a role in the considered business process.
- **Where?** relates to the origin of a change trigger. To build this dimension, it is necessary to regard the process or the business domain in general as a system. Therefore, we consider at least three subsystems: economy, sociology, and technology.

<table>
<thead>
<tr>
<th>Data Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>ID</td>
<td>Unique reference ID for the publication</td>
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<td>Title</td>
<td>Title of the publication</td>
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<td>Context</td>
<td>Research context or domain</td>
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<td>Venue</td>
<td>Conference, journal, symposium, workshop, or magazine</td>
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<td>Name</td>
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<tr>
<td>Category</td>
<td>Categories of change triggers in the domain of business processes</td>
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</table>
Based on the *w-questions*, we developed a new categorization of change triggers in business processes. The categorization scheme can be divided into four * abstraction layers*, as illustrated in Table III. The abstraction layers define the degree of specialization regarding the specification of a change trigger. The highest abstraction layer (i.e., Layer 1) is divided into three *components*: i) participation (i.e., *who or what*?), ii) origin (i.e., *where*?), and iii) characteristics (i.e., *when or how*?). A component can be considered as self-sufficient. Each component can be subdivided into further fine-grained subcomponents in the next lower abstraction layer. Additionally, it is possible to classify a specific change trigger along several components (i.e., participation, origin, or characteristics) or its subcomponents. In the following, the categorization scheme is introduced in more detail.

**B. Dimensions of Categorization Scheme for Change Triggers**

This section represents the main components relevant to specify a change trigger in business processes. As discussed in [5], a change can start a chain of changes. The proposed categorization scheme can also support the classification of change triggers in a chain of changes. The components *participation, origin, and characteristics* in Layer 1 represent the *w-questions*. In the following, the refinement of each component in subcomponents in next lower layers is described.

1) **Component 1**: The component *participation* (cf. Layer 1) includes three role descriptions in Layer 2: two antagonistic subcomponents *initiators* (e.g., [P8], [P11]) and *reluctant participants* as well as *further participants* with a neutral or passive role description. Based on the change model of Kurt Lewin (1947) [30] regarding the derivation and restraint of forces, the defined antagonistic principle is an important element to describe a change trigger. The subcomponents *initiators* and *reluctant participants* are indicators for identifying a change.
### Change Triggers in Business Processes

<table>
<thead>
<tr>
<th>Layer 1</th>
<th>Layer 2</th>
<th>Layer 3</th>
<th>Layer 4</th>
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<tbody>
<tr>
<td>participation</td>
<td>initiators</td>
<td>internal and external stakeholder</td>
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<td></td>
<td>non-legal entities</td>
<td>control and monitoring systems</td>
<td>key performance indicator</td>
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<td>further systems (e.g., hardware, software, infrastructure)</td>
<td>methods of communication</td>
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<td>reluctant</td>
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<td>participants</td>
<td>further participants</td>
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<td>origin</td>
<td>internal origin</td>
<td>person-related influence</td>
<td>skills and expert knowledge</td>
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<td>business domain (process and structure)</td>
<td>culture and ethical reasons</td>
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<td>business strategy, business goals</td>
<td>leadership style</td>
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<td>business rules</td>
<td>internal stakeholder requirements</td>
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<td>quality and performance</td>
<td>organizational structure and further events</td>
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<td></td>
<td>external origin</td>
<td>person-related regulations</td>
<td>external stakeholder requirements</td>
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<td>socioeconomics</td>
<td>demography</td>
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<td>further regulations</td>
<td>standards and norms</td>
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<td>certification, seal/label (seal guarantees)</td>
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<td>competing conditions referred to economic system</td>
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<td>characteristics</td>
<td>degree of urgency</td>
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<tr>
<td>degree of intensity</td>
<td>low</td>
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<tr>
<td>degree of complexity</td>
<td>low</td>
<td>medium</td>
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<tr>
<td>degree of prediction</td>
<td>predictable</td>
<td>unpredictable</td>
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<tr>
<td>degree of hierarchy</td>
<td>top-down change</td>
<td>bottom-up change</td>
<td>hybrid change</td>
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</table>

2) Component 2: The second component of Layer 1 describes the origin of a change trigger. Based on the concept of system theory (cf. Sec. III), we define the subcomponents internal origin and external origin in Layer 2 (e.g., [P5], [P6], [P10]). This concept is applied to three subsystems: economy, sociology, and technology (i.e., subcomponents of internal origin and external origin). It is also possible to define hybrid-approaches like socio-economics, which increases the degree of complexity for a component term (e.g., subcomponents of external origin). Thus, we define the separation of the components in Layer 3 according to these described subsystems.

The subcomponent internal origin is divided into subcomponents person-related influence, business domain (process and structure), and technology and IT. The subcomponents of person-related influence in Layer 4 are skills or expert knowledge (e.g., optimization of the business process due to new knowledge), culture and ethical reasons (e.g., culture of an organization [P3]), leadership style (cf. [14]), and internal stakeholder requirements (e.g., [P8]). The second branch of internal origin is related to the business domain involving the following four subcomponents in Layer 4 business strategy/goal, business rules (e.g., [P4]), quality and performance (e.g., [P1], [P7]).
and organizational structure and further events. Particularly, the
intent of business rules can be described as “to assert business
structure or to control or influence the behavior of the business”
(cf. [31]). Thus, they are important change triggers due to their
regulation nature (e.g., [P9]). The quality indicators such as
performance or cost of products or services (e.g., [P7]) can
trigger changes in processes. The subcomponent organizational
structure and further events summarizes different occurrences
like introducing new organizational forms (e.g., [14]). The
technology and IT define three main separations. The first
separation refers to change triggers, which come from develop-
ments inside technical systems [3]. Inefficiencies or logical
errors in business design model (e.g., [P2]), hardware-related
problems (e.g., [P2]), or safety (e.g., [P8]) are further change
trigger categories with an internal origin.

In external origin, regulations have an important impact (e.g.,
[P7], [P9]). They set boundaries regarding the ability to act and
determine the frame of processes. Person-related regulations are
based on stakeholder requirements (e.g., due to contracts) (e.g.,
[P5]). The same applies to politics (i.e., national legislation
(e.g., [P2], [P11]) or international agreements/conventions (e.g.,
P4) depending on the location of a company). The sub-
component further regulations aggregates any circumstances,
which cannot be allocated to the subcomponents described
above (e.g., standards and norms (e.g., [P4], [P8]) like quality
DIN EN ISO 8402 [32]. The subcomponents of economy (e.g.,
globalization [13]) and location (e.g., competing conditions
regarding economic systems [P3], [P5]) represent the business
domain from an external perspective in system theory. Similar to
internal origin, technology (e.g., new production methods or
techniques [P11]) can also be a change trigger with an external
origin. Dividing technology into five subcomponents in Layer
4, results from several concepts (e.g., Moore’s Law [33]).

3) Component 3: The characteristics is the last component
of Layer 1. It has five subcomponents in the next lower
abstraction layer. In contrast to the two components described
above, the classification of characteristics ends in Layer 3.
The first subcomponent degree of urgency (e.g., [P8], [P11])
represents a certain kind of action or behavior. The first
subcomponent reactive has a forcing nature, while the second
one proactive has a preventive intention according to changes.
Proactive can introduce innovations and has a creative character.
The second subcomponent in Layer 2 degree of intensity
refers to the last item of w-questions (i.e., when or how). It
describes the immediate impact of a change trigger and has
three classification level (i.e., low, medium, and high).
Degree of complexity (e.g., [P8]) represents the degree of
intensity over time. We consider not only the effects of the initial
change trigger, but also the effects of the following change
triggers caused by the initial change trigger. Consequently, it
has the following subcomponents: low, medium, and high.
The subcomponent degree of prediction (e.g., [P8]) defines the
probability of a change trigger’s occurrence. The occurrence
can be predictable and unpredictable.

Degree of hierarchy (e.g., [14]) is the last subcomponent in
Layer 2 reflecting the organizational structure and the ability
of an enterprise regarding flexibility. Its subcomponents are
top-down change, bottom-up change, and hybrid change. While
a top-down change can be caused at a management level, a
bottom-up change can have its origin at the employee level.

The categorization scheme (cf. Table III) is based on the
aforementioned w-questions and the idea of system theory
applied to different subsystems (e.g., technology). It can be
considered as generic and is, thus, not limited to a specific
case of business processes. A specific change trigger can
be classified under one of the subcomponents along the layers
for each component.

C. Benefits

In the following, we discuss the benefits and the purpose of
the developed categorization scheme in research and practice:

i) As a business process can be considered as a set of
actor steps (i.e., performed by human) and system steps
(i.e., performed by information systems), there are mutual
dependencies between both domains. Information systems and
business processes are in operation over decades while being
continuously modified. Consequently, change management with
focus on a single domain (i.e., information system) is not
sufficient [9]. A systematic categorization of change triggers
for business processes aims at supporting change management
not only in the business process management, but also in
information systems, as it helps early estimation of changes
caued by the corresponding business process and the resulting
impact of information systems.

ii) The proposed categorization scheme can serve as a
checklist when eliciting possible changes, future requirements,
and tasks for project planning.

iii) In addition to change management, the categorization
scheme can be used as a framework for specifying description,
or modeling languages to support activities such as
documentation, risk or statistical analysis, business process
optimization, and controlling. It allows defining the semantic
and syntax according to requirements of different focus groups
and practitioners (e.g., business analysts). Further formalization
of change triggers can be done based on the proposed categorization concept.

iv) The proposed categorization scheme can be considered
as generic, as it does not depend on specific economic sectors
or contexts. As the categorization scheme allows categorization
along several dimensions and layers, it can be applied to any
organization and economic sectors.

D. Design Decisions and Assumptions

In the following, we discuss the design decisions regarding
the categorization scheme. It is structured hierarchically in
layers and components. This allows keeping the categorization
scheme flexible according to future changes. Thus, extensions
based on new knowledge (e.g., new change triggers) can be
considered and added to the structure easily. We recommend
to keep the degree of specialization of layers stable, as having
a higher number of layers makes the categorization scheme
flexible, too complex, and not clear to users. We developed
universal and not branch-specific change trigger categories. As
the categorization scheme allows to classify a change trigger along participation, origin, and characteristics, it is possible to specify an individual change trigger in different ways depending on the users’ requirement or business process view.

E. Threats to Validity

In the following, we discuss the threats to validity of our review results and summarize the taken steps against limitations. To conduct our review, we used database search strategy as recommended in the evidence-based guidelines in software engineering. To decrease the risk of an incomplete keyword list of change trigger synonyms, we extract authors’ synonyms from relevant papers during the conduction phase. This procedure helped to develop new search queries and enhanced the data to be analyzed. In spite of decreasing the hits in the database search and refining the search strategy during the pilot study, it was not possible to investigate every single publication of the RiSC.

In order to proof and to consolidate the antagonistic principle in our fine-grained categorization scheme for each dimension. The participation in business processes along of the following dimensions:

- generic categorization scheme according to change triggers
- pilot study to define our review protocol. The results show that categories of change triggers in business processes. We used a well-defined methodology. The main goal was to identify the categories of change triggers. The data selection and data exclusion criteria. Further, to reduce interpretations of different studies. To avoid subjective bias in the final data selection phase, it is only possible to investigate the first 1000 hits even if GS displays more results (i.e., if GS shows a number of hits over 1000 for a search query). In general, this might be a fundamental limitation for systematic studies. To avoid subjective bias in the final data selection phase, we necessarily discussed and evaluated our initial inclusion and exclusion criteria. Further, to reduce interpretations of different reviewers, we included only papers that explicitly mention the categories of change triggers. The data selection and data extraction phase was performed using peer review.

V. Conclusion and Future Work

In this paper, we presented the results of our review using a well-defined methodology. The main goal was to identify categories of change triggers in business processes. We used a pilot study to define our review protocol. The results show that several papers explicitly define categories of change triggers in the business processes. Based on these results, we built a generic categorization scheme according to change triggers in business processes along of the following dimensions: participation, origin, and characteristics. We also provided a fine-grained categorization scheme for each dimension. The categorization scheme aims at supporting comprehensive requirements elicitation and serving as a checklist for supporting the process of change and the risk management.

As future work, we aim at extending the review study to other change facet categories (i.e., change resistance) in order to proof and to consolidate the antagonistic principle in our categorization scheme.

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