Organizational Engineering Processes: Integration of the Cause-and-Effect Analysis in the Detection of Exception Kinds

Dulce Pacheco[1,a], David Aveiro[1,2,b] and Nelson Tenório[3,c]

[1]Madeira Interactive Technologies Institute, Funchal, Portugal

[2]Faculdade de Ciências Exatas e da Engenharia, University of Madeira, Funchal, Portugal

[3]Instituto Cesumar de Ciência, Tecnologia e Inovação (ICETI), Maringá, Paraná, Brazil

Keywords: Causal Analysis, Ishikawa Diagram, Organizational Change, Organizational Engineering, Organizations.

Abstract: Enterprises are dynamic systems that struggle to adapt to the constant changes in their environment. The complexity of these systems frequently originates inefficiencies that turn into the loss of resources and might even compromise organizations' viability. Control and G.O.D. (sub)organizations allow enterprises to specify measures and viability norms that help to identify, acknowledge, and handle exceptions. Organizational engineering processes are deployed to treat dysfunctions within the G.O.D. organization but often fail to eliminate or circumvent the root cause of it. In this paper, we propose an extension in the model to allow a thorough investigation of the root causes of dysfunctions within the organizational engineering processes. Grounded on the seven guidelines for Information System Research in the design-science paradigm, we claim that the organizational engineering process should be supplemented with a systematic and broader investigation of causes, namely the Ishikawa approach of cause-and-effect analysis. The main contributions of this paper are the improvement of the organizational engineering process for handling unexpected exceptions in reactive change dynamics and the freely available Dysfunctions Bank with common dysfunctions and its probable causes. This work should trigger a reduction in the number of organizational dysfunctions and help to keep updated the organizational self and the organization's ontological model.

1 INTRODUCTION

Organizations are dynamic systems that run in complex and ever-changing environments. The competitiveness of the global economy in the 21st century requires effective enterprises that can continuously adapt. Organizations try to respond to these changes by increasing self-awareness, by better structuring their procedures, and by implementing better information systems, especially in critical processes. Still, unexpected exceptions (problems) are common. Therefore, workers spend a large amount of their working time handling unexpected exceptions (Aveiro, 2010), which makes it an expansive process that may even compromise the viability of the whole enterprise (Aveiro, 2010; Aveiro et al., 2010; March, 1999; Saastamoinen and White, 1995).

Determining why a system is performing poorly is a key task within organizations, but it also represents one of the major challenges posed by unstructured systems (Smith, 1998). The complexity to detect the cause might be related to the fact that a single cause can have multiple effects and an effect can also have various causes (Ishikawa, 1986). Having a model that includes a systemic approach to the investigation of the root cause of the unexpected exceptions and the registration of the organizational knowledge related to it, may represent noteworthy savings when handling future exceptions and be the foundation of a more effective organization. We argue that the integration of the cause-and-effect analysis (Ishikawa, 1986) in the processes of organizational engineering within the G.O.D. Organization (Aveiro, 2010) may bring significant advances to enterprises' competitiveness.

This work starts by reviewing the literature connected to enterprise ontology models in the scope

[a] https://orcid.org/0000-0002-3983-434X
[b] https://orcid.org/0000-0001-6453-3648
[c] https://orcid.org/0000-0002-7339-013X

Pacheco, D., Aveiro, D. and Tenório, N.
Organizational Engineering Processes: Integration of the Cause-and-Effect Analysis in the Detection of Exception Kinds.
DOI: 10.5220/0008364904790486
In *Proceedings of the 11th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2019)*, pages 479-486
ISBN: 978-989-758-382-7

of the Enterprise Engineering discipline, and related work on the analysis of causes. Then we present our proposal, detail the application of the model and conclude with comments on future work.

2 RELATED WORK

Previous researchers refer that the function perspective of an organization is associated with the aspect of behavior (Dietz, 2006). However, recent views over the function perspective of an organization represent it as a more complex and dynamic model (e.g., Aveiro, 2010). The normative aspect refers to the existence of commonly expected values (that is, norms) for the vital proprieties of the system (Aveiro, 2010). A deviation from such norms implies a state of dysfunctions that may compromise the viability of an organization (Aveiro, 2010). Therefore, dealing with malfunctions is also another central aspect of the function perspective, especially when it changes the organization artifacts (Aveiro, 2010). An organization artifact (OA) is "a construct of an organization like a business rule (e.g., if invoice arrives, checklist of expected items) or an actor role (e.g., library member)" (Aveiro et al., 2011, p. 17).

Current developments in the discipline of Enterprise Engineering [namely the models of the Control Organization (CO) and the G.O.D. Organizations (Generation, Operationalization and Discontinuation Organization; GO)] come to include the concepts of organizational change and development into the DEMO (Design & Engineering Methodology for Organizations) framework, as the current notions in DEMO do not fully address the issue of change (Dietz, 2006).

2.1 Organizational Dysfunctions and Dynamics of Reactive Change

Organizational dysfunctions are deviations of the organizational norms, either by not complying with the current rule or by not meeting with what is expected (Christensen and Bickhard, 2002). The viability of the organization will depend on a timely and adequate response to such dysfunctions (i.e., incidents) (Aveiro, 2010; Pacheco and Aveiro, 2019). Organizations can deal with these dysfunctions with reactive change strategies to eliminate or circumvent that event. Reactive change dynamics may be implemented either by resilience or by microgenesis strategies (Aveiro, 2010).

Malfunctions are quite frequent and the handling of these exceptions can take almost half of the total working time (Saastamoinen and White, 1995). Therefore, handling and recovering from dysfunctions is an expensive organizational process (Saastamoinen and White, 1995), even though most management teams do not realize it. The Complex Adaptive Systems (CAO) theory advocates that, to solve new exceptions, rule pieces that constitute current resilience strategies may be reused in reactive change strategies (Aveiro et al., 2011; Holland, 1996). Information on the history of organizational change is an asset in moments where change is again needed (Aveiro et al., 2011) as it can make the change management processes more effective (Aveiro et al., 2011). However, previous studies show that information regarding the handling of past exceptions is seldom registered (Saastamoinen and White, 1995) and quickly lost, as actors can easily forget the sequence of tasks they have executed to handle an exception a few months back.

The main causes which are identified in the literature for not changing both the organizational reality and the ontological model of the organization that undergo change processes are two (Aveiro et al., 2011; March, 1999; Saastamoinen and White, 1995): Firstly, the absence of explicit representation of the specific exceptions and actions that were executed for handling the dysfunction and which organizational artifacts where engineered to solve the malfunction (Saastamoinen and White, 1995); Secondly, the removal of human agents from a certain organizational actor role which had established and tacitly memorized specific (i.e., informal) rules to handle particular exceptions occurring in such actor role (Saastamoinen and White, 1995). If the organization misses to capture the reactive change dynamics and insert it in its reality and ontological model it will result that, over time, the organization will be less aware of itself and less prepared to deal with change (Aveiro et al., 2011).

2.2 The Control Organization and the G.O.D. Organization

It is argued that both the CO and the GO exist in every organization and those are responsible for handling the reactive change processes (Aveiro, 2010). The CO and GO allow the modeling of the function perspective of an organization as a DEMO based design artifact (Aveiro, 2010; Aveiro et al., 2011, 2010).

If the dysfunction is expected, adequate resilience strategies should exist already and the CO can deploy them to eliminate or circumvent the causes (Aveiro, 2010; Aveiro et al., 2011; Christensen and Bickhard, 2002). The ontological model of the CO is the conceptualization of a generic organization considered to exist in every enterprise and responsible for controlling its viability (Aveiro et al., 2011). That is, the ontological model of the CO is a default subset of the ontological model of every organization (Aveiro, 2010; Aveiro et al., 2011).

If no applicable rules exist to deal with one specific dysfunction, it is considered to be an unexpected exception (Aveiro, 2010; Aveiro et al., 2011). In this last case, a microgenesis strategy is applied by the GO, starting an organizational engineering process (OEP) to identify the root cause of the dysfunction and the necessary acts to adjust the OA and eliminate or circumvent the unexpected exception (Aveiro, 2010; Aveiro et al., 2011), changing the organizational self (Aveiro, 2010). This type of exceptions must be solved with human intervention and with innovative OA (Mourão and Antunes, 2007). An OEP can be initiated for two different reasons: because there is no associated and known expected exception causing the dysfunction; or because all resilience strategies have been tried without success (Aveiro, 2010). In the OEP, there is an intertwining play between three major categories of acts: unexpected exception handling acts, OA state changes and OA operationalization acts (Aveiro, 2010). Based on previous work (Mourão and Antunes, 2007), Aveiro argues that all OEP starts with the detection of an unexpected exception, that is monitored and leads to a diagnostic (Aveiro, 2010; Mourão and Antunes, 2007). Recovery actions may be applied to eliminate or circumvent the unexpected exception (Aveiro, 2010; Mourão and Antunes, 2007). In this sense, the primary purpose of the GO is to preserve an updated organizational self and an updated ontological model (Aveiro, 2010).

The responsibilities for the handling and follow up of OEP should be clear (Mourão and Antunes, 2007) so that actors can stay accountable for their decisions. According to Aveiro (2010), the actor role ‘handler of the OEP’ is crucial, as s/he coordinates the several acts needed to change the organizational self, either by the operationalization or discontinuation of OA, as shown in the Actor Transaction Diagram (see Aveiro, 2010, p. 120). The Object Fact Diagram of OEP, under the GO, presents its classes, fact types, and results (see Aveiro, 2010, p. 115), while the Monitoring, Diagnosis, Exception and Recovery Table (MDERT) consolidates the information of the dysfunction monitoring, as well as its diagnosis (see Aveiro, 2010, p. 117).

2.3 Analysis of Causes

To accurately detect the root cause, a detailed assessment of the dysfunction and exception is required (Mourão and Antunes, 2007). The diagnosis should be an iterative process where different actors may collaboratively contribute (Mourão and Antunes, 2007). To aid in the handling of current unexpected exceptions, the organization should keep the record of past monitoring, diagnosis and recovery facts.

During the diagnosis phase, the responsible agent should review past dysfunctions related to that same viability norm or to other norms that might have suffered from similar exception kinds (Aveiro, 2010). A consultation with actors that have been previously involved in the monitoring and diagnosis of akin dysfunctions might also help (Aveiro, 2010). The actor's perception over the exception may change along the iterative process of diagnostic, especially when new facts are uncovered (Mourão and Antunes, 2007). The diagnosis, usually performed by the agent responsible for the OEP, should collect the information needed to detect the root cause of the exception (Aveiro, 2010). The monitoring phase includes the necessary actions to control the progress of the OEP, making sure that updated information about the exception is available to the agents that need it (Aveiro, 2010; Mourão and Antunes, 2007). Consequently, monitoring actions might bring environmental information to the system (Mourão and Antunes, 2007). During and after the diagnosis, actors may implement different recovery actions, as new data is obtained (Mourão and Antunes, 2007). The information about applied recovery actions should be kept (Mourão and Antunes, 2007). Based on the information collected in the diagnosis phase, a bundle of OA is generated, operationalized (or discontinued) and approved, to solve the exception handled by the OEP (Aveiro, 2010).

Authors argue that the concept of root cause seeks to prevent a diagnosis from stopping too quickly (Smith, 1998), but it should not be taken too far, as well. Hence, it is argued that detecting the root cause is to identify where effective action can be taken to prevent dysfunction recurrence (Smith, 1998). The literature presents different frameworks to detect root causes of exceptions (Bilsel and Lin, 2012; Ishikawa, 1986; Smith, 1998). The cause-and-effect diagram by Ishikawa is one of the most popular frameworks (Bilsel and Lin, 2012), as it recognizes that an effect can have more than one cause and that one cause can provoke more than one effect. The cause-and-effect diagram allows to group causes by categories, contributing to a more structured and broader analysis (Bilsel and Lin, 2012).

2.3.1 The Cause-and-Effect Diagram by Ishikawa

The cause-and-effect diagram (also called Fishbone or Ishikawa diagram) was created under the discipline of Quality Control, by Kaoru Ishikawa (1986), in the early 1940s, as one of the seven basic tools for quality control. That is a problem-solving tool that helps to systematically investigate and analyze all the real or potential causes of the exceptions (Bilsel and Lin, 2012; Ishikawa, 1986). The diagram can be built collaboratively, allowing to combine diverse expertise and skills (Bilsel and Lin, 2012). Furthermore, it sets the focus on the causes of the problem and omits complaints or other irrelevant discussions (Bilsel and Lin, 2012). Its format allows an easy graphical grasp of the unexpected exception and causes (Bilsel and Lin, 2012). On the other side, the cause-and-effect diagram does not conveniently represent the interrelations among different causes, does not differentiate the strength of the various causes and can become visually disordered (Bilsel and Lin, 2012). This diagram is more effective when the analysis is focused on a particular exception, as it will narrow down the scope of the analysis (Smith, 1998).

The cause-and-effect diagram is usually pictured with four to six main categories of causes that lead to the problem (Bilsel and Lin, 2012). The most common representation includes the categories of equipment, process, people, materials, environment, and management (see Figure 1). However, other categories may also be included, more related to the business sector or the goal of the analysis (e.g., methods, machine, measurement, employee, suppliers, skills, systems, product, promotion, policy) (Bilsel and Lin, 2012; Ishikawa, 1986; Smith, 1998).

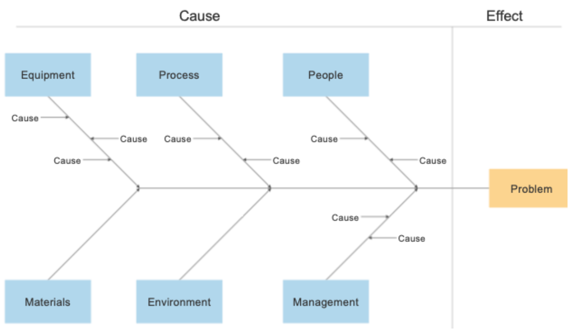

Figure 1: Example of a cause-and-effect diagram.

The cause-and-effect diagram starts by clearly identifying the problem (Bilsel and Lin, 2012). Then, the agent responsible for finding the root cause should brainstorm, with the main actors involved in that dysfunction, what could have been the probable or real causes for that exception. At this stage it is important to keep asking, in a string of questions and answers, 'why did this happen' until getting to the root cause, that is, identifying where effective action can be taken to prevent that exception to occur again (Smith, 1998). After determining the leading causes (real or potential) and categorizing them, the actors need to review the full list, plan and deploy the necessary actions to eliminate or circumvent the exception (Smith, 1998).

3 DETECTION OF EXCEPTION KINDS: THE CAUSE-AND-EFFECT ANALYSIS

Aveiro (2010) specifies that an actor must be designated to handle the OEP and, consequently, monitor, diagnosis, and identify the root cause. However, the author does not specify which methodology the agent should follow for the detection of the exception kinds. Other researchers (Mourão and Antunes, 2007) attribute a classification to the exceptional situations that take place in the diagnosis and in the exception handling strategies but focus solely on promptly defining recovery actions to eliminate or circumvent the dysfunction, not in detecting and eliminating the root cause of the exception. In the GO, the choice of cause and the choice of the solution are later qualitatively evaluated in the Dysfunctions Diagnosis and Actions Table (Aveiro, 2010), however, the criteria for this evaluation is also not clear in the model. Furthermore, in the examples provided in the literature (Aveiro, 2010; e.g., Aveiro et al., 2011), we can see that the choice of cause is frequently evaluated as *bad* and that dysfunctions reoccur. This may indicate that efforts to solve the exceptions do not eradicate the root cause behind the exception, that is, the OEP is inefficient. This inefficiency might be related to an inappropriate detection of the root cause, what might lead to inadequate actions, as these acts are not directed to eliminate the right exception kind. Consequently, the reoccurrence of dysfunctions that have been poorly handled in past OEPs is common. These repeated dysfunctions bring extra costs to the organization (e.g., costs in labor time, materials, customer dissatisfaction, product replacement) that might even compromise the viability of the whole organization and that could have been avoided if the OEP deployed after the first dysfunction occurrence was well handled. Based on the literature, we propose to add to the OEPs the cause-and-effect analysis by Ishikawa. Considering the methodology of the seven guidelines for Information System Research in the design-science paradigm (Hevner et al., 2004), we hypothesize that a more systematic and broader approach to the analysis of the exception kinds may lead to more accurate detection of causes and, consequently, to the deployment of suitable actions to eliminate or circumvent the exceptions, preventing its reoccurrence.

The GO (Aveiro, 2010) claims that each dysfunction has a single cause. Other authors have focused their work in recovery acts to circumvent problems, but without the focus on eliminating its causes (Mourão and Antunes, 2007). If no acts are defined to detect and eliminate the root cause of the problem, most probably it will persist in time and later on create new constraints within the organization. Our approach entices actors to identify more than a single cause for the dysfunction in more than one category. This approach corroborates previous authors who claim the miscellaneous nature of causes and effects (Ishikawa, 1986).

For each ‘exception kind’, an ‘exception category’ should be identified from the list of standard categories, or by creating a new one, if none of the existing applies. Enterprises frequently struggle to identify the root cause of the exceptions. However, there are common dysfunctions that may occur in different enterprises that belong to the same industry. Malfunctions connected to support areas (e.g., finance, human resources) may also be shared among organizations from different economic sectors. Therefore, to help in the continuous improvement and to encourage benchmarking practices, the authors of this model will gather a Dysfunctions Bank (DB) with common dysfunctions, along with their probable exception kinds and categories, that will be freely available online. The information on the DB will be collected through research and voluntarily supplied by the enterprises that use this model.

To represent our framework, we have updated the model of the GO, namely the Object Fact Diagram (OFD) of the Fact Model and the Actor Transaction Diagram (ATD) of the Construction Model. We argue to create a new object class EXCEPTION CATEGORY so that we can specify the category of each exception kind. To keep a record of the original fact resulting from the actions of this aspect of an OEP, we have specified the associated binary fact types and the unary result kinds:

[exception category] created in [exception kind]
[exception category] has been created

The OFD was also updated to include the new class, fact type, and result (see Figure 2). The ATD gains a new transaction kind that we call *categorization* (see Figure 3). This new transaction and corresponding executing actor role are associated with the new result kind specified in the OFD (see Figures 2 and 3).

In our model, following previous authors (Bilsel and Lin, 2012), we advocate that the detection of exception kinds should be an iterative process, where different actors can collaborate and actively contribute with their expertise and competencies (Bilsel and Lin, 2012).

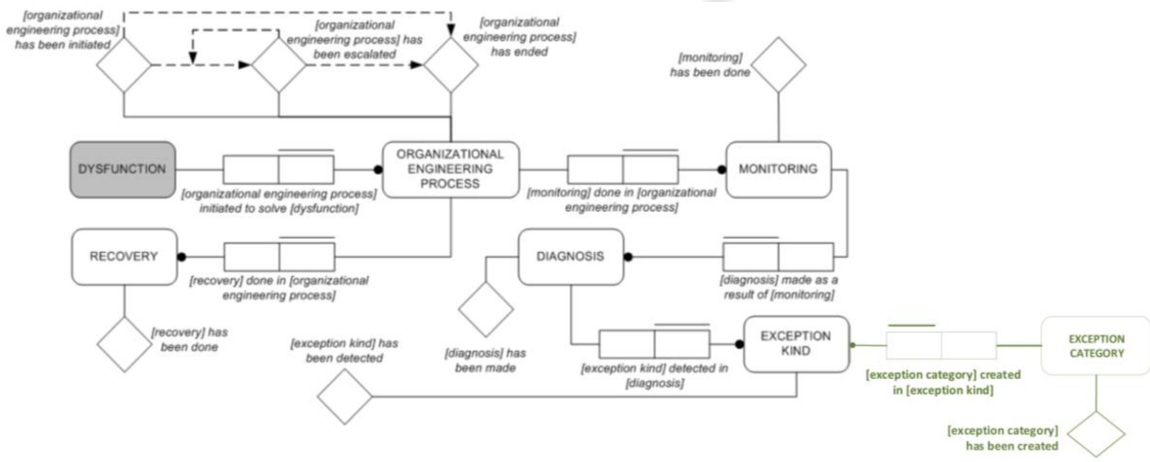

Figure 2: Proposal of new partial OFD of the GO (adapted from Aveiro, 2010, p. 115).

At this stage, to truly understand the situation and detect its causes, experience and records play an important role. As the actor gathers more information about the unexpected exception, her/his perception over the problem may change. Recovery strategies are usually defined based on a quick analysis of the dysfunction and without the previous detection of causes. Consequently, recovery strategies should be promptly deployed to minimize the risks and circumvent the exception, while the investigation of the causes is still on-going.

Data related to the unexpected exception is gathered in the Monitoring, Diagnosis, Exception and Recovery Table (MDERT), to which we propose some changes. The column 'recovery' presents the strategies that intend to circumvent the exception. Therefore, to improve its readability, we advocate that the column 'recovery' should be moved to the left, to be just after the 'dysfunction' (see Table 1). To register the 'exception category', we have added a new column, just before the column 'exception kind' (see Table 1). Each dysfunction can have more than one cause and more than one category (see Table 1).

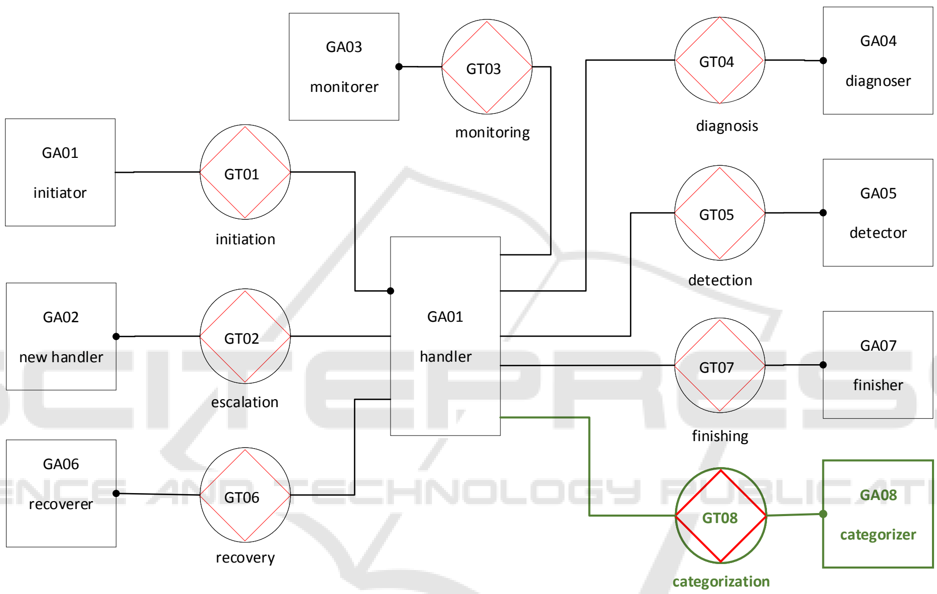

Figure 3: Proposal of new partial ATD of the GO (adapted from Aveiro, 2010, p. 120).

Table 1: Proposal of a new Monitoring, Diagnosis, Exception and Recovery Table (MDERT) of a library (adapted from Aveiro, 2010, p. 117).

OE process	dysfunc tion	(Viability norm)	recovery	monitoring	diagnosis	exception category	exception kind
OEP01	DF01	(max loan declines per week) (Goal: 30; Achieved: 38)		verify loan register	loans have been decreasing in the last year		
				ask secretary's opinion on decrease in loan requests	the secretary informed that there are less visitors than usual, but in some months many students have their requests declined due to the max_copies_in_loan limit		
			increase value of property max_copies_in _loan during exam season	ask students why they need so many books	every three months its exam season in nearby colleges and they need more books than normal	environment methods	abnormal high rate of loan requests due to exams season lack of planning for procedures to apply in periods of abnormal high rate of loans
OEP02	DF02	(min average # of registrants in book history courses 1 week before start) (Goal: 14; Achieved: 9)	delay course start dates for 2 weeks; design, print and distribute fliers announcing courses delay	do street survey to find cause	most people (70%) did not see our ad at the newspaper nor the radio; some interested people (10%) suggested to distribute fliers and posters in bars and restaurants nearby	process environment management	inadequate advertising general lack of interest in courses lack of a suitable promotional plan
OEP03	DF03	(min average # of registrants in book history courses 1 week before start) (Goal: 14; Achieved: 11)	delay course start dates until having enough registrants	do street interview to find cause	great majority of people (90%) show total lack of interest in the course	process environment management	lack of procedure to review and update courses general lack of interest in courses courses are not adjusted to customers' needs and expectations
OEP04	DF06	(min average # of registrants in book history courses 1 week before start) (Goal: 14; Achieved: 8)	cancel courses and transfer students to prevent dysfunction in monthly income	observe DDAT and MDERT tables	it appears that the general lack of interest in courses is getting worse as delaying courses start is not enough and more drastic actions are needed	process environment management	lack of procedure to review and update courses general lack of interest in courses courses are not adjusted to customers' needs and expectations

We extended the literature by adding to the model of the GO, a systematic and broader analysis of causes. The main advantages of this approach are the capability of reducing the re-occurrence of dysfunctions, as the thorough analysis of causes should eliminate the root cause of that specific exception and even prevent other dysfunctions that have not yet arisen. Consequently, it should lower workers' stress level and improve their well-being. The Ishikawa cause-and-effect analysis suggests that the actor thinks through the problem to identify the different causes that might have caused the malfunction, instead of focusing just on the most immediate one, which brings a global view of the effect and its causes. The actor then defines the needed actions to eliminate or circumvent the exception.

We have created this model to be accessible by any enterprise worldwide. Therefore, our model does not establish standard categories to classify the identified causes, as it might create an extra layer of complexity when applying this framework to different organizations. Having the exception kinds grouped by categories brings valuable insights to the management teams, as it easily allows a global analysis of the most common causes of dysfunctions and, consequently, reveals what needs to be acted on (e.g., if an enterprise has 40% of its exception kinds in the category people it means that human resources are making several mistakes and that should be further investigate to be mitigated). This model of including the analysis of cause-and-effect in the OEPs can be both applied as a response to unexpected exceptions (reactive change), but also in the OEPs that aim to detect opportunities for improvement (proactive change).

3.1 Model Application

We will use the MDERT (see Table 1) to demonstrate the application of our model. It includes the fact instances of the object classes and fact types for the case of the library (adapted from Aveiro, 2010). To facilitate the understanding of the data available in the MDERT, we added the third column, 'viability norm', from the Dysfunctions Table (adapted from Aveiro, 2010, p. 106). To be easily distinguished, all the information copied from the Dysfunctions Table is in parenthesis.

An OEP is initiated because it was detected an event that does not comply with the organizational viability norm (DF01) and for which no resilience strategy is yet defined. In the case of the library, for the DF01, we can see that the viability norm 'maximum loan declines per week' had the goal of 30, but 38 were already registered (see Table 1). Consequently, an agent started the OEP01 to handle this dysfunction. The actor designated to handle the OEP will start with the monitoring phase, namely by observing the dysfunction and doing a quick assessment. Based on this, the agent will define recovery actions. In this application, the recovery action defined for OEP01, as defined in Aveiro (2010), was of increasing the number of loans permitted over the exam season (see Table 1).

After the quick recovery actions, the actor responsible for the OEP01 may focus on the diagnosis. In this example, the agent concluded that s/he should 'ask students why they need so many books' and got to find out that nearby colleges usually have an exam season every three weeks, which leads students to request more books during that period. The exception kind registered was 'abnormal high rate of loan requests due to exams season'. Considering the model that we proposed in this paper, we need to categorize this exception kind. Since the abnormal books request is an external factor, we propose to insert it in the category 'environment' (see Table 1). Another addition of our model is that the actors need to think through the exception and try to find other causes for this problem. This is especially important when the exception kind is external and, consequently, the organization cannot do much to circumvent it. In this example, the actor concludes that there was another significant exception kind under the category of 'methods', namely the 'lack of planning for procedures to apply in periods of abnormal high rate of loans'. More categories and exception kinds could be identified. On Table 1, we can find other examples of causes and its categories for DF02, DF03, and DF06.

With the information about the relevant exception kinds, the actor may devise needed actions to eliminate or circumvent these exception kinds and report it to the management team. The information in the MDERT must be transmitted to the higher levels of the organization so they can be informed about the dysfunctions being identified and the measures that are implemented to overcome these exceptions. Having the exception kinds grouped by categories permits a broader view of the most frequent type of exception kinds registered.

4 CONCLUSIONS AND FUTURE WORK

The global economy demands more effective and dynamic enterprises that can continuously adapt to the changing environment, culture, technology, and requirements. Enterprises try to respond to this challenge by better structuring its internal organization and increase its self-awareness, usually with the help of complex information systems. However, unexpected exceptions are common and handling these exceptions can take almost half of the total working time, which represents both a high cost and a threat to the viability of the enterprise. Better detection and management of this unexpected exceptions should translate in financial savings, in a lower stress level in workers, as the unforeseen situations would be less frequent, and to keep updated the organizational self and the organization's ontological model. This represents a significant advance to the competitiveness of the enterprises.

This paper intends to contribute to the literature in the disciplines of Enterprise Engineering and Enterprise Ontology, by extending the current model of the G.O.D. Organization to include a broader analysis of exceptions kinds and, consequently, contribute to higher effectiveness and viability of organizations. The Dysfunctions Bank and the data collected on the most common categories of exception kinds are highly valuable to the management team, as it allows them to deploy focused actions to overcome these limitations. This model can also be applied to both reactive and proactive change dynamics, and it may be used by any enterprise, of any industry and any location. This framework offers important implications for practice and the sustainable economic growth of the organizations.

A key limitation of this model is the lack of empirical proof. Authors plan to deploy a test pilot to assess the validity of the model. The results of the study will be evaluated in terms of choice of causes, choice of solutions, and general performance.

ACKNOWLEDGMENTS

This work is supported by the Regional Development European Fund (Interreg), project FIMAC MAC-2.3d-181 (MAC-2014-2020).

REFERENCES

Aveiro, D., 2010. G.O.D. (Generation, Operationalization & Discontinuation) and Control (sub)organizations: A DEMO-based approach for continuous real-time management of organizational change caused by exceptions. Universidade Técnica de Lisboa.

Aveiro, D., Silva, A.R., Tribolet, J., 2010. Towards a G.O.D. Organization for Organizational Self-Awareness. In: Albani, A., Dietz, J.L.G. (Eds.), Lecture Notes in Business Information Processing. Springer Berlin Heidelberg, pp. 16–30.

Aveiro, D., Silva, A.R., Tribolet, J., 2011. Control organization: A DEMO based specification and extension. In: Albani, A., Dietz, J.L.G. (Eds.), Lecture Notes in Business Information Processing. Springer Berlin Heidelberg, pp. 16–30.

Bilsel, R.U., Lin, D.K.J., 2012. Ishikawa cause and effect diagrams using capture recapture techniques. Qual. Technol. Quant. Manag. 9, 137–152.

Christensen, W.D., Bickhard, M.H., 2002. The Process Dynamics of Normative Function. Monist 85, 3–28.

Dietz, J.L.G., 2006. Enterprise ontology: Theory and methodology. Springer, Leipzig, Germany.

Hevner, A.R., March, S.T., Park, J., Ram, S., 2004. Design science in information systems research. MIS Q. 28, 75–105.

Holland, J.H., 1996. Hidden Order: How Adaptation Builds Complexity. Basic Books, New York, NY, USA.

Ishikawa, K., 1986. Guide to Quality Control, 2nd Revise. ed. Asian Productivity Organization, Tokyo, Japan.

March, J.G., 1999. The pursuit of organizational intelligence: Decisions and Learning in Organizations. Blackwell Business, Cambridge, MA, USA.

Mourão, H., Antunes, P., 2007. Supporting effective unexpected exceptions handling in workflow management systems. Proc. 22nd Annu. ACM Symp. Appl. Comput. 1242–1249.

Pacheco, D., Aveiro, D., 2019. Cause-and-Effect Analysis in the Organizational Engineering Processes of the G.O.D. Organization. In: Proceedings of the 19th CIAO! Enterprise Engineering Working Conference Posters. CIAO Network, Lisbon, Portugal.

Saastamoinen, H., White, G.M., 1995. On Handling Exceptions. In: Comstock, N., Ellis, C. (Eds.), Proceedings of Conference on Organizational Computing Systems. ACM, New York, NY, USA, pp. 302–310.

Smith, G.F., 1998. Quality Problem Solving. ASQ Quality Press, Milwaukee, Wisconsin.