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APPLICATION OF FAILURE MODE AND EFFECTS ANALYSIS FOR RISK MANAGEMENT OF A PROJECT

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ABSTRACT

Highlights

- Risk management in new projects represents an important factor for the performance of a new product, and so for the success of project.
- Some approaches in project management aim to reduce existing risks of failure in new projects.
- Among the various tools to aid in the management of risks in new projects, the Failure Mode and Effects Analysis (FMEA) stands out.
- FMEA is regarded as a tool that can aid in the prevention of failures during the design of a process or product.

Purpose

- The goal of this article is to apply the FMEA as a support tool in the risk management process of a new project in an automobile company.

Design / Methodology / Approach

- For doing so, we used theoretical-conceptual research and case study procedures.

Findings

- We observed that the application of FMEA enabled the company to identify potential failures in several operations in the vehicle assembly process, and allowed them to take actions to correct it and prevent such failures before occurring.

Research limitations/implications

- Much has been discussed about risk analysis techniques / tools. ABNT in Brazil standardizes risk management through the ISO 31000 series of standards. One of suggestions for future research is to expand the discussion of the role of FMEA in the context of ISO 31000, as also to apply new principles and guidelines in the automobile company studied, based on this risk management standard.

Practical implications

- This article aims to provide greater understanding and dissemination, both in the business and academic environment, of the FMEA and the advantages that can be obtained through the use of this tool, such as reducing the risk of failure in new projects.

Originality/value

- This article presents the practical application of FMEA in the context of failure risk reduction in a new design of an automobile assembly plant, and can be used as a success case by companies in the automotive sector.

Keywords: FMEA, Project, Automobile company.

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1. INTRODUCTION

Due to the increase in competition and globalization, many projects still suffer from delays, changes of scope, failures and some can even be canceled due to non-viability, a fact that can be critical for the performance of a business (Shenhar, Raz and Dvir, 2002). Statistics on the success rate of projects carried out by the Standish Group (2014) show that successful projects are not predominant and, of the 175,000 projects observed, 31.1% were canceled before completion and 52.7% costed 189% more than their initial planning. The proportion of projects that had some type of failure reaches 52.7%, and the success rates, taking into account projects' schedule and budget, represent only 16.2% of the total studied.

In Brazil, the lack of data regarding the country's outlook for project success or failure hinders the consolidation of a view on the subject. However, Rovai (2005) states that most of the projects in the country are developed with no proper approach to a methodology and / or risk management models, a fact that results in financial risks and losses with significant impacts nationwide.

Given this scenario, the different tools available to assist in the successful development of projects are still not widespread enough and many have doubts on how to use them (Shenhar; Raz and Dvir, 2002; Kumar, 2002). According to Carbone and Tippet (2004), project risk management is becoming increasingly important for a company's success, since most of the obstacles encountered during project development can be predicted and avoided with an effective risk management process. According to Salles Jr. et al. (2006), the risk management arises from the need to measure and control uncertainty, since it is only possible to control and manage what can be measured. It is worthy to highlight that the ISO 31000:2009 standard provides guidelines and principles for risk management.

Risk management in new projects has been a subject much discussed in business environments of different segments. Authors such as Nakashima and Carvalho (2004) have addressed the use of project risk management tools in an Information Technology (IT) company. Lopes, Carvalho and Teixeira (2003) discussed a proposed methodology for risk management, based on transaction costs and other features in the markets. Gallotti and Assis (2013) talk about risk management in the hospital segment. Romano (2003) also has discussed the importance of the practice of risk management in building projects to bridge the gap between design and execution. Other practical applications of project risk management can be found in: Júlio and Carvalho (2013), Ferenhof, Forcellini, Varvakis (2013), Piurcosky et al. (2014), Sena et al. (2014), Espósito (2015).

According to the Project Management Institute (PMI, 2004), project managers should be provided with tools, techniques and methodologies to help identify and eliminate risks in order to reduce the chances of its negative effects and/or even a project failure. Paté-Cornell (2002) states that one of the most widespread tools to determine priorities in the risk management process in the business environment is FMEA (Failure Mode and Effects Analysis). There is a detailed analysis of weaknesses of previous projects in this tool that aim to improve the allocation of resources for new projects (Paté-Cornell, 2002). According to Project Management Institute (2004), FMEA is an analytical process with the purpose of investigating all the components of a system, analyzing its failure modes and, therefore, their effect on the reliability of the product, system or function required.

FMEA is a tool created by the US Army and was used to reduce the amount and likelihood of failures that could not be repaired in equipment, and was later adopted and improved by the automotive industry (Dailey, 2004). The use of the FMEA tool in risk management of new projects can be seen in studies of Santos and Cabral (2008), Miguel and Segismundo (2008), Cavalcanti et al. (2011), Lima et al. (2013), Paula et al. (2015), Brandstetter and Arantes (2015).

According to the Project Management Institute (2004), the management of a project comprises the following areas of knowledge: integration, scope, time, cost, quality, human resources, communication, acquisition and risks. This research aims to study the area of risk management solely, based on the premise that the adoption of management tools with the goal of reducing the risks of a new project can help companies to prioritize the risks for later taking of actions.

Thus, the research problem addresses the use in the area of project management of a tool that was used with a focus on quality management in the company studied. Therefore, the following research question was formulated: how to apply the FMEA to an automobile company that did not use this tool with a focus on management of project risks?

Based on the presented context and the research problem, the goal of this article is to apply the FMEA tool in a new project in an automobile company. This application is intended to help the business decision-making process so that the inherent risks of this project can be reduced.

To fulfill the goal this work was structured as follows: the next section addresses the bibliographic review about projects, risks and project management; Section 2.2 deals with the bibliographic review of the FMEA tool; Section 2.2.1 addresses the types of existing FMEA; Section 3 presents the methodology of the present study; In Sections 4 to 4.3 we find the case study developed; Section 5 presents the final considerations.

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2. THEORETICAL REFERENCE

In this section, we present the central concepts used for the execution of this research, such as the project concept, risks, management and FMEA.

2.1. Project, Project Management and Risk

According to PMI (2004), a project is an original and unique temporary effort undertaken in line with one organization's strategy to create a unique product, service or result and is characterized by presenting temporality (defined start and end points), result (Single product) and progressive elaboration (incremental steps). In addition to this definition, Gido and Clements (2007) state that a project is an effort to achieve a specific goal through the use of a unique set of interrelated tasks and the efficient use of resources.

For Heldman (2005), all projects begin by defining a goal that in turn must satisfy the goals the stakeholders accepted when initiating the project. According to PMI (2004), such goals are defined taking into account their time schedule, scope and project cost. These three aspects form what is called "triple constraint" and will define the quality of the project. These are so closely linked to one another that changing one of them will affect at least one of the other two remaining aspects.

Project scope means the work that needs to be done so that the product, service or output specified at the beginning of the project is achieved at its conclusion. The time aspects refers to the defined beginning and end points of a project, and this end is met by reaching the goals initially established or when it is found that they can not be achieved. Every project differs from the common operational work because it is temporary and exclusive, and it is delimited and restricted by available resources, which are in most cases, limited, planned and controlled (PMI, 2004).

Linked to the project concept there is the risk concept, which can be defined as any event that could totally or partially undermine the chances of success of a project (Alencar et Schmitz, 2005). For Heldman (2005), risks are potential events that can both threaten and benefit a project. In this sense, the Project Management Institute (2004) attributes as risk management roles the increase in the probability and impact of positive events, as well as the decrease of the probability and the impacts of adverse events to the project.

When a risk is consciously assumed, the outputs are expected to be better than the burden in case of injury (Heldman, 2005). However, it is important to note that risks can be potential benefits, that is, opportunities that will bring a positive impact to the project, and that both companies and people take risks only when the benefit of the project is greater than the consequences of a failure. According to the same author, it should be made clear that a slight confusion can occur between the definition of "risk" and "problem": problems are issues happening at the very moment, while risks may or may not happen.

Joining the concepts of "project" and "risk", we come up with the "project risk management" that, according to Gido and Clements (2007) means to plan and then to execute. For PMI (2004), managing a project is to apply knowledge, skills, tools and techniques to a project's activities in order to achieve the proposed goal, including processes that address the identification, analysis, response, monitoring, control and planning of risk management.

Again, according to PMI (2004), the goals pursued through project risk management are to increase the likelihood and impact of positive events. By doing so, it minimizes the chances of adverse events occurring to the project through better allocation of resources of engineering and decision making throughout project development.

It is worth noting that, unlike the management of a process, which deals with activities that are repeated over time, the management of a project relies on a well-summarized historical database, since data and facts are recorded with less frequency, which increases their exposure to existing risks (Alencar et Schmitz, 2006). Carvalho and Rabechini (2005) also state that, during decision-making, it is extremely important to be alert to the particularities of a company with regard to its degree of risk acceptance and corporate standards for risk planning and management. Rabechini Júnior and Carvalho (2013) complement this demonstrating the link between risk management and project success.

2.2. FMEA

The FMEA method, which means Failure Mode & Effects Analysis, emerged in 1949 in the American military industry. It was improved by NASA in the 1960s during the *Apollo Space Program*, with the goal of eliminating equipment failures that could not be fixed after launch (Miguel et Segismundo, 2008).

According to Stamatis (2003), FMEA is an engineering tool used to identify, eliminate and prevent failures in systems, projects, processes or services before they are delivered to the clients, so that they have something totally error free. It is a tool able to document in an organized way the modes and effects of component failures, through investigation and survey of all the elements, including possible human faults, that can interrupt or hinder the operation or the system in which this component is (SIMÕES, 2004).

Electronic Journal of Management & System
Volume 11, Number 4, 2016, pp. 444-454
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Ramos (2006) explains that the FMEA technique was created with a focus on the design of new products and processes, but due to its great success and benefits to the organizations, it has been used in the most diverse ways and in different types of environments. Some FMEA applications can be observed in Sant'Anna and Pinto Junior (2010), Bachega and Lima (2010) and Lima et al. (2013). Through the classification by the severity or determination of the effect of the failures in a system, this managerial tool allows us to analyze the potential failure modes of a system (Allbien; Grot and Schneidereit, 1998).

Helman (1995) states the prescription of actions that reduce the incidence of potential causes or modes of failure as a distinctive goal of this method. Puente et al. (2002) add that the goal of this tool is also able of identifying and prioritizing possible product and process failures. Ebrahimipour, Rezaie, and Shokravi (2010) go a step further, stating that by calculating their RPN (Risk Priority Number), the FMEA discovers and prioritizes the potential failure modes that result in any negative effects on the system and its performance.

Ruppenthal (2013) advocates the use of FMEA as a risk analysis technique. It should be noted that ISO 31000 provides principles and guidelines for risk management (ABNT, 2009).

Ebrahimipour, Rezaie et Shokravi (2010) present the steps to be taken to conduct an FMEA as follows: i) describing the product or process; ii) defining functions; iii) describing the potential failure modes; iv) describing the effects of failures; v) determining the causes; vi) defining control methods or describing current controls; vii) calculating the risks; viii) taking actions; and ix) evaluating / estimating the results.

Maddox (2005) reports that after each component is studied and its possible failure modes are identified during the execution of an FMEA, three scales are assigned to each failure mode identified: the probability of occurrence of a failure ("O"), the severity of this failure ("S") and the ability to detect this failure before it actually happens ("D"). After multiplying these three values, we obtain the risk priority number, also called RPN.

Puente et al. (2002) state that conducting an FMEA requires caution and the following issues must be observed:

- Evaluation and prioritization through RPN can not always be done by detection means ("D");

- There is no precise algebraic rule for determining occurrence ("O") and detection ("D") indices;

- There may be distortions during the RPN calculation, because the probability of non-detection and its respective score follow a linear function while the relationship between the probability of occurrence of a failure and its score does not follow this same function;

- Different scores for occurrence and detection can lead to a same RPN, even if the risk involved is completely different;

- RPN is not able to measure the effectiveness of any proposed actions;

- Calculation of the RPN does not consider the risks associated with project delays, deviations of scope and budget.

Pollock (2005) also notes the fact that it is quite common for teams involved in the initial stage of FMEA to move to the next steps of a project abruptly, abandoning or delegating to other areas of the company the monitoring of FMEA actions.

On the other hand, some authors, such as Tramel, Lorenzo and Davis (2004) and Carbone and Tippett (2004), have developed works that address the use of FMEA in a more integrated way, in order to provide some advantages such as identification of client specifications, reducing the time and cost of launching new products by eliminating re-designs, changes and testing, increasing product and process reliability and quality, and increasing customer satisfaction.

2.2.1. Types of FMEA

According to Dailey (2004), there are two types of FMEA: DFMEA (Design Failure Mode and Effects Analysis) and Process Failure Mode and Effects Analysis (PFMEA), and additional customizations added to the FMEA can favor the performance of this tool in an organization, because it takes into account particular and unique characteristics of a given project.

Stamatis (2003) states that the goal in DFMEA is to identify failure modes before the product/service is actually produced and delivered to the client, so investigative and corrective actions must occur during the project specification stage.

On the other hand, what is expected in the PFMEA is a product free of defects, considering the possible flaws in the planning and execution of the process, based on the knowledge of the project specifications against the nonconformities of the product (Silva; Silva, 2008).

Electronic Journal of Management & System
Volume 11, Number 4, 2016, pp. 444-454
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Dailey (2004) briefly points out that the basic difference between the DFMEA and the PFMEA is the source of the information because, while the Project FMEA uses a structured list of materials, the Design FMEA makes use of process flow diagrams as its source information documents.

Stamatis (2003) talks about the existence of two other types of FMEA: the System (or Concept) FMEA and the Service FMEA. The system FMEA is a variation of DFMEA, which analyzes systems in the initial stage of conception and design, that is, it focuses on system failures in relation to their functionalities and in meeting customer expectations, being directly linked to customer perception in relation to the system. In contrast, the service FMEA is a variation of the PFMEA and its focus is the identification of potential failure modes, as well as the provision of investigative and corrective actions, prior to the delivering of the first service.

3. METHODOLOGICAL PROCEDURES

This study used the following procedures: theoretical-conceptual (Berto et Nakano, 1998, 2000) and case study (YIN, 1994) approach. The theoretical-conceptual study, also called bibliographic review, was carried out with the purpose of clarifying the approach to the topic of risk management in new projects and the use of the FMEA tool as a form of theoretical pre-guidance.

The case study was used to promote understanding of the use of FMEA as a way to manage risks at an automobile plant that has a new project in progress. We analyzed two assembly lines that are directly linked to the new product. Of the three areas comprising the company plant (as Body Welding, here called as area 1, Painting - denominated here as area 2 and Assembly – designated in this study as area 3), only the Assembly facility was involved in the study, due to the time available for its execution and completion. It is worth mentioning that the company made use of the FMEA tool in all areas. We collected the information required for the research through existing databases of previous projects, brainstorming with employees, experience obtained in similar projects, as well as interviews with the managers in the area under study. The data collection period lasted four months.

The study stages followed the method proposed by the Institute of Automotive Quality (IQA, 2008) and the Project Management Institute (PMI, 2004). For the execution of the present case study, the steps presented and described in Figure 1 below were adopted, as follows:

1) Forming a multidisciplinary team composed of members who have the necessary knowledge to execute the FMEA, with relevant experience and necessary authority, to ensure the information and collaboration of all functional areas affected;

2) Defining the scope to establish FMEA analysis limits, the type of FMEA to be carried out and what will be evaluated, so that the proper direction and focus are set at the beginning of the process;

3) Defining client. We took into account 4 main clients of great relevance for the proper execution of FMEA, which are the end user, the manufacturing centers comprising the areas responsible for product assembly operations, the supply chain involving the major suppliers of materials and production parts, and the regulators which are composed of government agencies, which play an important role in defining requirements and monitoring project compliance with the laws that involve safety and environment.

4) Defining requirements, specifications and effects of the corresponding failure modes. In this step the goal of the project was clarified in order to assist in the identification and understanding of the relevant functions, requirements and specifications for the scope defined.

5) Identifying potential failure modes. This stage defined the ways or manners in which the product or process could fail to meet the requirements of the process.

6) Identifying potential effects, which is the listing of the potential effects of failures as perceived by the customer, and what should be described in terms of what the customer can perceive or experience. In this step, we included the analysis of the consequences of failures and their severity.

7) Identifying potential causes. This can be defined as an indication of how the failure could occur, in terms of something that can be corrected or controlled. This step may demonstrate a great indication that there has been some weakness in the design that evidences the failure mode. Within this stage, we also analyzed the likelihood of occurrence of these causes.

8) Identifying control measures, which are the existing activities to prevent or detect the cause of failure or failure mode. It is important, when developing controls, to identify what is going wrong, why and how to prevent or detect this failure. The probability of detection was also calculated at this stage.

Electronic Journal of Management & System
Volume 11, Number 4, 2016, pp. 444-454
DOI: 10.20985/1980-5160.2016.v11n4.1150

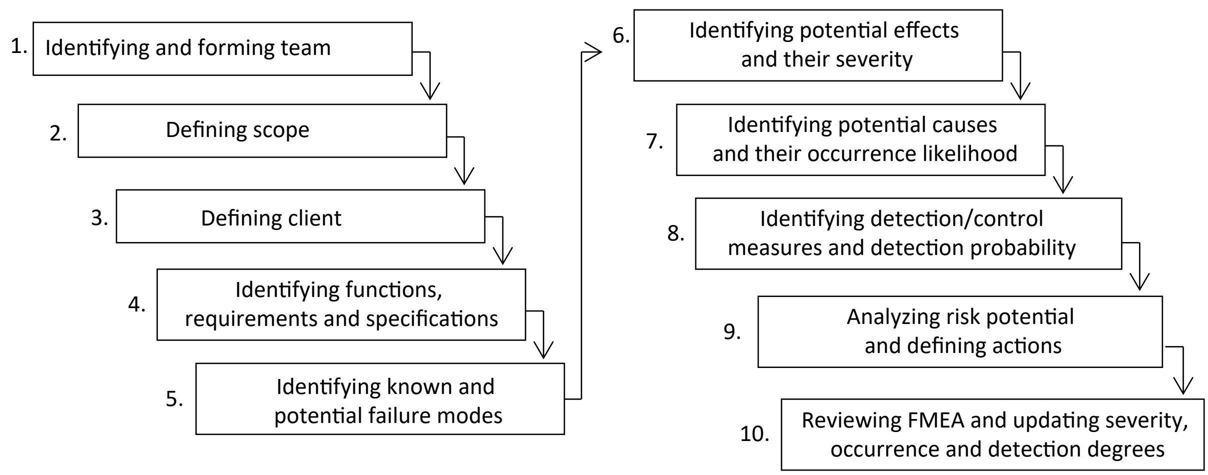

Figure 1. Steps for FMEA implementation
Source: Authors' research (2016)

9) Risk assessment. We performed this step by multiplying the three indices defined in the previous ones (severity x occurrence x detection). Each company evaluates, based on the requirements of its clients, the minimum value for the risk, and they must propose actions in an attempt to reduce the overall risk and the likelihood that the failure mode will occur for analyzes where the risk value is equal to or greater than the defined minimum. The present company defined as minimum risk the value of 115, by observing that RPN greater than this score presents a value that can already be considered high and, consequently, critical. Therefore, failure modes with RPN greater than 115 should undergo immediate actions to decrease this value.

10) Updating severity, occurrence and detection degrees. Once all the actions are completed and the results achieved, this last step is done.

For a better understanding of the scores for the three FMEA indices (severity, occurrence and detection), it is important to make clear that we made use of some tables proposed in the FMEA manual by the Institute of Automotive Quality (IAQ, 2008), that will be presented in the next section.

It is also worth mentioning that, of the ten steps described above, only the tenth stage is still under development in the studied company.

4. CASE STUDY

In this section, we present some information about the company in which the study was carried out, followed by the presentation of the FMEA development process.

4.1. The Company studied

This research was developed in automobile company that produces off-road vehicles and is denominated here Company X. It is a large company which currently employs around 2400 employees and has been in the market for over 15 years.

The use of FMEA for risk management in projects was done for the first time in this company in Alfa Project, and is based on the Beta Project information. Both are considered similar projects because they are projects of vehicles that have the same platform.

As shown in Figure 2, the company developed the FMEA in its three areas. The object of study of this research is area 3, as previously stated in section 3.

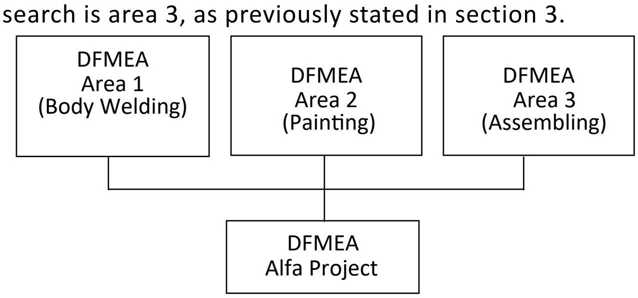

Figure 2. Project Alfa DFMEA
Source: Authors' Research (2016)

Electronic Journal of Management & System
Volume 11, Number 4, 2016, pp. 444-454
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It is noteworthy that, although only the development of FMEA in area 3 is described, the company also applied a very similar process in areas 1 and 2.

4.2. DFMEA development in company

In order to facilitate the collection of information during the execution of the DFMEA and ensure compliance with the deadlines established by management for the conclusion of the DFMEA, the company divided area 3 into two subareas as shown in Figure 3 as follows, and developed the FMEAs in these two lines in parallel. These subareas refer to the two assembly lines responsible for vehicle production.

A main operation was defined for each workstation. At the conclusion of the FMEA, each main operation had at least one failure mode identified. The effects of this mode of failure, the cause of nonconformity, its severity, occurrence and detection degrees, as well as the actions necessary to avoid the occurrence of this mode of failure, were then discriminated.

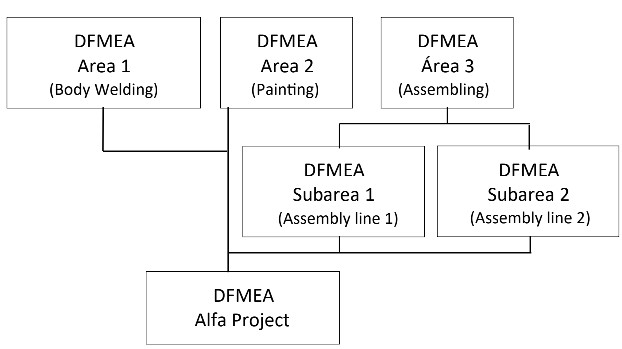

Figure 3. Subdivision of areas for DFMEA development in the Alpha Project
Source: Authors' Research (2016)

In addition to the sources of information used to carry out this FMEA, (existing database of previous projects, brainstorming with staff, experience obtained in similar projects as well as interviews with management personnel), we also used the FMEA outputs from the other areas of Company X, as can be seen in the following Figure 4.

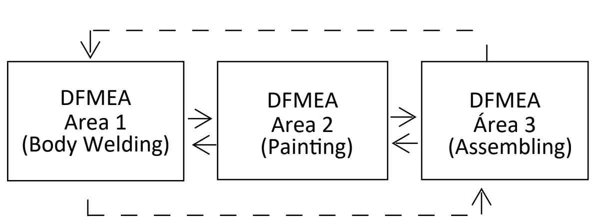

Figure 4. Information flow during FMEA execution in Area 3.
Source: Authors' Research (2016)

Through a macro view, we could observe that the FMEA developed in one of the areas is an input to the FMEA of the other areas, and an intense information feedback is necessary for FMEA to be executed in the best possible way. In this way, the FMEA developed in the assembly lines addresses failure modes with causes that may be directly or indirectly linked to some process failure in other areas, and, therefore, provides information of great relevance for continuous improvement in both processes. Likewise, the information obtained through FMEA in areas 1 and 2 may be of great importance for FMEA in area 3.

The inputs required to run the FMEA can be listed as information from other areas of the company such as supply engineering, dealer information, experimental engineering, component engineering, inspection/repair industry information, manufacturing engineering, Product quality and quality of suppliers.

Table 1 presents one of the 60 main operations that had their FMEA performed in Area 3, for a better understanding of their development process. For the operation of assembling the engine compartment harness, two failure modes have been identified: loss of functionality and incorrect routing.

We determined the potential effect of the failure for each mode, and then classified it in a degree of severity ranging from 1 to 10. Grade 1 of severity indicated that none of the potential effects generated was perceptible; while grade 10 severity indicated that the potential failure mode would affect the safe operation of the vehicle and/or involve non-compliance with governmental regulations (see Table 1, column 'SEV').

Severity is an index that can not be reduced or eliminated, because it depends only on the level of complications the effect of the fault would bring to the client and thus, the greater the degree of severity attributed to the effect, the greater is the complications generated. We defined the severity degree values presented in Table 1 based on the event logs of potential failures in the Beta Project as well as on the effect or severity of such failures.

For this, we took into account the severity degree classification defined by the company and the recommendations suggested by IAQ (2008). According to these, a grade 8 severity degree indicates that the failure will cause a loss of primary function from the perspective of the product function, and also indicates that 100% of the products can be discarded with the halt of production line or product shipping.

We proceeded then to list potential causes, also based on the experiences of the FMEA participants and Beta

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Volume 11, Number 4, 2016, pp. 444-454
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Project histories. Each potential cause had its degree of occurrence determined, ranging from 1 to 10 in the same previous way that, the greater the degree, the greater the chance of occurrence (see Table 1, column 'OCC'). We defined the scores for degree and occurrence presented in Table 1 were defined by comparing the occurrence of these flaws in a similar project (Beta Project) and taking into account the occurrence classifications determined by the company and considering the recommendations of the IAQ (2008).

The degrees of occurrence of a fault were categorized as very high (score 10), high (score 7-9), moderate (score 4-6), low (score 2 or 3) and very low (score 1). For example, a grade 3 occurrence indicates a less-than-frequent fault, pointing only to isolated failures, associated with a virtually identical design, or in design tests and simulation.

After that, FMEA team determined the control means to prevent the potential causes from occurring, as well as the existence of means to detect any failure should it occurs. These means do not always exist, and in this case, in Table 1, the abbreviation N.A (not applicable) is used. It is worth mentioning that an action can be taken to create such means.

FMAE development proceeded then determining the degree of detection which, as well as the degree of severity and occurrence, has a scale of 1 to 10 (see Table 1, column 'DET'). It should be noted that higher scores in detection degree implies the chance of a failure to occur without its detection in some part of the process, thus reaching the end customer.

The values obtained for the degree of detection were based on the records of failures occurred in a similar project that had some difficulty of detection and in the suggestions from IAQ (2008). Thus, an 8-degree of detection indicates that it occurs after the processing of the product and therefore, detection by the operator is difficult by visual, tactile or audible means.

At the end of this process we multiply the severity, occurrence and detection scores, thus generating a final value (RPN) that indicates the risk. For this developed FMEA, whenever the value of the risk is equal to or greater than 115, it is necessary to continue taking actions that will prevent the failure mode from happening, and a person from the organization or an area is pointed as responsible for the execution of this action. Such value was defined after the launching of the FMEA. Based on some RPN values obtained, we could observe actions were sometimes not necessary to achieve scores lower than 115. At the end of the FMEA implementation process in area 3 of the company under study, 500 actions were considered necessary to avoid the occurrence of identified failure modes.

4.3. Expected Outcomes

With the adoption of the FMEA during the execution of this new project, we hope to reduce the failures that occur during mass production of the new product, since the FMEA is a tool that allows to identify failure modes and, consequently, to take actions before their occurrence.

We also expect that, with the reduction of failures that were foreseen during the execution of the FMEA, there will be a considerable reduction in the rework done to correct such failures, and, consequently, a reduction of costs with wasted labor and time, breakdowns in parts and components of the vehicle during such rework and with the quality issues that might generate recalls.

As this is a tool focused on avoiding possible failures, in contrast with the well-known fault-correction reactive system, we expect that positive cultural impacts are generated in the company through practices that emphasize the importance of "making it right in the first run". It is also relevant to mention the possible positive aspects to be generated for the continuous improvement of the process and for the increase in the final product quality resulting from the use of the FMEA.

5. FINAL CONSIDERATIONS

The goal sought in this study was achieved. We applied the FMEA during the execution of a new project in an automobile company, in order to reduce the existing risks inherent to this project.

Responding to the research question, there was a method for conducting DFMEA, which enabled the identification of potential failure modes in the assembly process of a vehicle, considering the new project studied. In addition, actions have been proposed to improve this process, from labor training to preventive maintenance in equipment, as well as actions involving suppliers, which may be regarding of measure specs correction of a part supplied or the change of packaging in which such part is stored for delivery.

We suggest that during the execution of the FMEA in a process a team should be set up to closely follow the FMEA implementation in all areas, to facilitate access to information and feedback.

Electronic Journal of Management & System
Volume 11, Number 4, 2016, pp. 444-454
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Table 1 - FMEA development of an operation included in the analyzed project

FMEA – FAILURE MODE AND EFFECTS ANALYSIS											
Project FMEA	INVOLVED AREAS:	Production / Engineering / Manufacturing / Logistics Areas								First issue date: 10/ Aug/2015	
PROJECT/ PRO-GRAM: Alfa	PROCESS:	Alfa Product Assembly								Review Date: February / 2016	
PERSON IN CHAR-GE: FMEA Leader	TEAM:	Line Supervisor, Process Technician, Engineer 1, Engineer 2, Engineer 3, Operator 1, Operator 2, FMEA Leader.									
ACTIVITY:	Engine compartment harness Assembly										
Item, function name of Process Step	Potential Failure Mode	Failure Potential Effect(s)	SEV	Potential Causes	OCC	Current Pre-vention Controls	Current Detection Controls	DET	R P N	Recommended Actions	Key Person / Date
Engine compart-ment harness (Control harness)	Loss of functiona-lity	Vehicle malfunc-tion	8	Harness dis-connected	3	DVO Versatility Chart	Inspection (Buy Off)	8	192	Training related to new opera-tion	Ap-pointed person 1
			8	Bad connec-tion	3	DVO Versatility Chart	Inspection (Buy Off)	8	192	Training related to new opera-tion	Ap-pointed person 1
			8	Harness cut / crushed	2	N.A	Inspection (Incoming/ Buy Off)	8	128	Before Line Supply: Inco-ming Inspection	Ap-pointed person 2
			8	Terminal too far	2	N.A	Inspection (Incoming/ Buy Off)	8	128	Incoming Ins-pection	Ap-pointed person 2
			8	Bare wire	2	N.A	Inspection (Incoming/ Buy Off)	7	112	Incoming Ins-pection	Ap-pointed person 2
			8	Incorrect harness	5	DVO Versatility Chart	Inspection (Buy Off)	8	320	Evaluate possi-bility of sequen-cing the supply of harnesses for all the platforms in line	Ap-pointed person 3
			8	Harness out of measure specs	2	N.A	Inspection (Incoming/ Buy Off)	7	112	Incoming Ins-pection	Ap-pointed person 2
	Roteiro incorreto	Mal fixado/ Solto/ Ruído	6	Fixing hole out of measu-re specs	2	N.A	Visual check at assembly	7	84	Incoming Ins-pection	Ap-pointed person 2
			6	Fixing hole obstructed	5	N.A	Visual check at assembly	7	210	Incoming Ins-pection	Ap-pointed person 2
			6	Bracket mis-sing	2	N.A	Visual check at assembly	7	84	Incoming Ins-pection	Ap-pointed person 2
			6	Harness brac-ket / clamp out of measu-re specs	2	N.A	Visual check at assembly	7	84	Incoming Ins-pection	Ap-pointed person 2
			6	Bracket out of measure specs	2	N.A	Visual check at assembly	7	84	Incoming Ins-pection	Ap-pointed person 2

Source: Authors' Research (2016)

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This article contributed to a greater understanding and dissemination, both in the academic and business environments, of the FMEA tool and the possibility of using this tool to manage risks in new projects.

Much has been done about risk analysis techniques/tools. In Brazil, the Brazilian Association of Technical Standards (ABNT) addresses risk management through the ISO 31000 series of standards. We mention, as a suggestion of future research, an expanded discussion about the role of FMEA in the context of ISO 31000 applying also new principles and guidelines in the studied automobile company based on this risk management standard.

It is also possible to study the real impacts generated by the use of FMEA in the Alpha Project. Finally, we also suggest carrying out a survey in automobile companies to verify the types of FMEA used and ways of conducting the use and evaluation of this tool.

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