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PROJECT QUALITY MANAGEMENT CONTRIBUTIONS IN AUTOMOTIVE INDUSTRY

-PhD Thesis Summary-

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CONTENT

PhD Thesis Summary

The current context of development of the products requires very precise objectives: short deadline releases, low costs of development and production and the ensuring of a high level of quality, safety and security of products. As time passed, the projects become more complex, due to the strategy of car manufacturers in order to reduce the number of architectures and to increase the number of models and options. As a result of this tendency, components produced by the suppliers are common, configurable and adaptable to the specific customer requirements, enabling *mass customization/individualization*. This leads to a high complexity of the software and hardware components in an automobile, has as impact more complex projects in the development and production process.

The general problem that justifies the approach of the research thematic refers to the quality of the product development projects.

From the general problem, some secondary problems were identified, that have a negative impact on the quality, cost and time and require:

- evaluation of quality requirements;
- risk analysis of the product concept phase;
- handling the customer complaints or resolving internal problems with improved methods in analyzing problems.

After problem forming, the primary objective and secondary objectives are proposed, objectives that lead to problem solving.

Primary objective of the PhD thesis is represented by the analyzing and solving of current and extremely sensitive problems about the quality of the product development project, for its improvement.

Secondary objectives, derived from this primary objective, are:

- optimizing and improving the quality requirements analysis;
- improving the risk analysis in the concept phase of the product;
- improving corrective actions in the case of quality complaints.

Research methodology proposed is based on the approach used in the Theory of Inventive Problem Solving (Teorija Reshenija Izobretateliskih Zadatch - TRIZ). Starting from the general design approach (problem forming - problem solving), the problem-solving approach, adapted from the TRIZ process of conceptualization, comprising the following steps: identify the specific problem, generic problem formulation, development of generic concepts, evaluation (interpretation of generic solutions) and implementation (finding specific solution). The approach lends itself very well, considering the application of research in the automotive industry, for solving the quality problems and for meeting customer requirements. The proposed methodology in project development is based on TRIZ in combination with other methods.

Secondary objectives of the research are specific problems. They represent the directions of research addressed in the main chapters of the thesis.

In order to solve the specific problem of the first secondary objective an approach based on anticipation regarding analysis of customer requirements is proposed, the focus being on quality requirements; the problem is approached from the perspective of reducing the time and increasing quality of requirements analysis (particularly those of quality) by creating a new model, using TRIZ in combination with other methods of analyzing requirements (e.g. QFD - Quality Function Deployment).

In order to solve the specific problem of the second secondary objective product FMEA is used, in combination with TRIZ, from which a new risk assessment model results.

In order to solve the specific problem of the third secondary objective the complaints process is addressed. For this purpose, the current methodologies are evaluated and a set of basic tools used to solve quality problems are defined, that are combined with TRIZ. Also a transition from the classic to the modern model or a transition from prevention and detection to anticipation or a transition from the possible causes of the problem to strong technical contradictions of the problem is proposed.

The thesis is divided into six chapters.

In **Chapter 1** (5 pg.), GENERAL INTRODUCTION, presents the issues and research objectives, the methodology adopted and the structure of the thesis. It follows the opportunity and importance of research aimed at solving quality problems that occur in different phases of project development and production launching.

In **Chapter 2** (21 pg.), the STATE-OF-THE-ART OF THE PROJECT MANAGEMENT OF THE PRODUCT DEVELOPMENT is presented.

After presenting the basic concepts, an analysis of the project management of product development is done, referring to the most common processes, methods used, types of management, the aim being to identify issues that constitute research goals.

They are studied and analyzed three current approaches of project management: (1) PMBOK Guide realized by PMI (Project Management Institute); (2) PRINCE2 (Projects In a Controlled Environment) developed by the Central Computer and Telecommunications Agency in the UK; (3) IPMA (International Project Management Association). Conclusions of the study are:

- PMBOK refers to a generic structure of the life cycle of the project and presents an interaction of the domains, areas of knowledge and groups management process design being clearly defined, but it is quite difficult to use in small projects because it depends very much on the scope of applicability and other specific constraints of the project;
- PRINCE2 is a process-based approach, which addresses not only knowledge areas, but also topics of project management; it treats summarily quality management, only the aspect of quality planning and control being proposed;
- IPMA focuses on elements of contextual, behavioral and technical competence, quality is not structured in a process, description and information is quite poorly documented.

Based on the performed study that main objective of the research was decided: analyzing and solving of actual and extremely sensitive problems related to the quality of a product development project in order to improve it. Derived from this main objective, three secondary objectives of the research were defined. These are specific issues and are research directions addressed in the following chapters of the thesis, related to the problem triangle: requirements-risks-complaints.

In **Chapter 3** (27 pg.), CONTRIBUTIONS ON QUALITY SPECIFIC REQUIREMENTS EVALUATION, the first issue of the research is addressed, named evaluation of specific quality requirements, while aiming the first secondary objective: optimizing and improving quality requirements analysis. For this the usage of QFD method is proposed, integrated with TRIZ methodology, by going through the following steps:

- adapting the QFD method to project life cycle;
- adapting TRIZ method to project life cycle;

- integrating QFD and TRIZ for analyzing of specific quality requirements, generating an applicable model in product development phase and monitored during production phase.

Validation of the proposed model was done by simulating on a product in the development phase. For the analysis of the requirements a new format was used, in which elements of QFD and TRIZ are found.

Chapter 4 (55 pg.), CONTRIBUTION ON RISK ANALYSIS, is focused on the second secondary research objective: improving risk analysis in the concept phase of the product.

So far the analysis of interaction effects of components and the risk assessment composed in system were not addressed, because current methodologies are not robust enough regarding this. Therefore, a methodology, in a simplified form, based on FMEA combined with TRIZ is proposed, in order to help in the identification, evaluation, reduction and validation of composed risks of the interacting components and following is taken into account:

- a generic approach of FMEA also in relation to the directions of the automotive industry;
- analysis of the three types of FMEA: Product (Design) FMEA, Process FMEA and System FMEA;
- integration of customer specific requirements of FMEA;
- integration in Lessons Learned and solving the quality problems using TRIZ in order to validate actions.

Validation of the proposed methodology was done through simulation in a project under development, on the same product as in chapter 3, but with D-FMEA complete, parts of it were used to validate the feasibility of integrating TRIZ methodology to the next generation of product. The new application of TRIZ method is carried out in dedicated software or Excel format for D-FMEA.

In **Chapter 5** (35 pg.), CONTRIBUTIONS TO THE VALIDATION OF CORRECTIVE ACTIONS AFTER Quality COMPLAINTS are presented.

The proposed target is to make improvements to the analysis process of the quality claims, by reducing the analysis time and by anticipating the technical validation of the corrective actions. To fulfill the third objective of the research, claim management was approached.

The review process has been shown in the flow chart for a complaint, then an example of response time in case of complaints to the OEM. Tools and ways of analysis and quality problem solving were reviewed and a set of basic tools for dealing with problems and identifying root cause were selected and proposed. This includes: Brainstorming, 5 Why, cause–effect diagram (Ishikawa), Pareto analysis, FTA (Fault Tree Analysis), TRIZ (Theory of Inventive Problem Solving), DoE (Design of Experiments). Another aspect studied was related to the current issues of quality that are found by the car manufacturers. These were researched and proposed for analysis in different market studies, certifying that currently major changes are required in the approach of solving and anticipation of quality problems.

The proposed model for the validation of the corrective actions before the implementation demonstrates the advantages of applying TRIZ in the claim process. The case study refers to the same product in development phase presented in chapter 3 and 4.

In **Chapter 6** (6 pg.) the FINAL CONCLUSIONS, PERSONAL CONTRIBUTIONS AND PROSPECTS FOR RESEARCH are summarized, by showing the advantages of using the new models and how to apply them in. Also in this section the personal contributions of the author and proposed new research

directions are presented.

The research was completed by developing new models for quality management of project and by application of new concepts in developing projects within a company in the automotive industry.

Thereby it is considered that the research main goal, quality improvement of the quality product development projects, and secondary goals: quality methods improved in different project phases, risk management improved during product concept phase, improvement of quality requirements analysis, complaint management process of corrective actions validation improved, have been met.

Personal contributions in the quality project management in automotive industry are structured in three main sections:

1. State of the art of the project quality management
   - A knowledge synthesis regarding project management of the product development;
   - A knowledge synthesis regarding project management approaching most important guidelines in automotive industry;
   - Analysis of the actual methodologies applied in different phases in the projects;
2. Theoretical contributions:
   - Adapting of the TRIZ conceptualization process for problem solving addressed within the research scope;
   - Proposal of new quality models;
   - Proposal of a new requirements analysis model based on a combination of QFD – TRIZ;
   - A new risk matrix proposal based on TRIZ and impact versus probability;
   - New concept developed for risk analysis RA-IS (Risk Assessment-Innovative Solutions), with TRIZ integrated in D-FMEA, with causes definition, failure modes and effects standardized through allocation for these of technical parameters according to TRIZ, in this way were eliminated generic effect, causes or failure modes;
   - Proposal of a new concept for problem solving based on passing from prevention and detection to anticipation of the problem;
3. Applicative contributions

- Highlighting quality principles which are focused on the proposed objective with clear and structural highlight on quality assurance elements;
- Highlighting most FMEA types used in the projects;
- A classic FMEA format proposed (table form) with TRIZ included;
- D-FMEA risk analysis performed in different projects;
- Actions validation in D-FMEA with TRIZ;
- Establishing a clear link between requirements-risks-claims, in order to determine how the elements are defined;
- Using 8D-Report in combination with TRIZ and a new step introduced for contradiction validation before implementation of the corrective actions;
- New D-FMEA's developed using APIS IQ-RM for products in development phases;
- Conflict parameters implemented in the APIS IQ-RM software and simulated in the project.

The thesis ends with a bibliography which contains 180 cited titles.