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Appliances' New Product Development: Exploring the Influence of Fuzzy Front End Phase on Time to Market

By Marcos Vinicius De Barros, Osmar Possamai,
Luiz Veriano Oliveira Dalla Valentina & Marco Aurelio De Oliveira
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Abstract- The purpose of this study was to identify the main uncertainties involved in the fuzzy front end phase of a new product development and to determine the weight of factors that define the time to market a product. The focus of this study has emerged from the need to explain the complexity of the fuzzy front end of a project and to understand and establish a treatment for the variables involved. Although literature covers the existence of difficulties in managing the fuzzy front end of projects, there is no reference to the identification of those variables and to the determination of their influence on the time to market. The interest in the fuzzy front end is justified due to the doubts that occur at that point of the development process of a new product. The fuzzy front end mentioned by some authors covers project management difficulties that occur at the very beginning of a project due to the lack of more precise data and to the possibility that the project team may face unknown situations and tasks. This paper proposes the use of systemic modeling tools in the fuzzy front end of a new product and the use of linear regression and variance analysis to determine the time to market. A study to be used as the database has been carried out with a home appliance company.

Keywords: *time to market; conceptual design; new product development; fuzzy front end.*

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Marcos Vinicius De Barros [α], Osmar Possamai [σ], Luiz Veriano Oliveira Dalla Valentina [ρ] & Marco Aurelio De Oliveira [ω]

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Keywords: time to market; conceptual design; new product development; fuzzy front end.

I. Introduction

The search for differentiated products and for better cost has accelerated the reduction of product life in the market, made people rethink product design and create platforms and strategies. That context creates a new challenge to companies, that is, to get competitive advantage generated by earlier launching of new products to the market. In this strategy, companies need to reduce the number of direct competitors and to avoid price erosion, traditional in a competitive market. Having that differentiation and using it by making products available to the market before competitors do is the strategically objective of most of the companies inserted in this context. Earlier availability of a product to the market may increase the profitability of a company due to the extension of its sales life, and also to the qualification of their product development (NPD) area to launch products within the timing required by the market. Fast development of a product leads to superior performance according to empirical studies (Mascitelli, 2006); (Bascle et al, 2012); (Shankar et al., 2013).

Time to market (TtM) expresses the speed a company moves from the concept of a product to initial market sales. The time to market (TtM) is defined as the total development time of a new product. It is obtained by adding the concept generation time (Tcet) to the conversion time (drawings/prototypes/tests) and to the execution time (moulds and tools execution) (Whirlpool, 2012). To Mascitelli (2006), in the past, the TtM was less important than innovation and the cost of new products. However, in the last decade, speed and efficiency have been considered to be at the same level of priority as price and cost. Actually, today, many companies clearly know the difference in the total profit generated by being the first to launch a product. Although many companies use the fast follower strategy for a product already launched in the market, one should observe that an excellent TtM usually offers profitability gains for having a differentiated product before their competitors. Given the above scenario, and looking for that strategic advantage, there is a concern that the development lead time of a new product may be affected in its initial concept generation phase due to the uncertainties experienced by the project team regarding the new product. One of the well known factors about the development process of a product is that the degree of uncertainty in the beginning of the process is very high, decreasing with time (see figure 1). However, most of the constructive solutions are chosen at the beginning. Decisions among alternatives at the beginning of the development cycle are responsible for 85% of the end product cost. Modification costs increase along the development cycle as every change may invalidate a greater number of decisions already made (Rozenfeld et al, 2006).

This work uses the new product development model called C2C to demonstrate the uncertainty level along the stagedgates (Whirlpool, 2012). The figure 1 shows the project phases and the uncertainty level associated. The conceptualization phase is the momentum of the project that the uncertainties are in the highest level. This is the phase that the project team is selecting the concept for a new product. Also picture 1 show the tollgates: IST or *Idea Selection tollgate* when the general idea of a new product is approved; CET or

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Concept Evaluation tollgate when the final concept of the new product is defined and locked, BET or *Business Evaluation tollgate* when the investments are approved for tooling execution and finally LCT or *Launching Tollgate* when the product is approved to produce and commercialize.

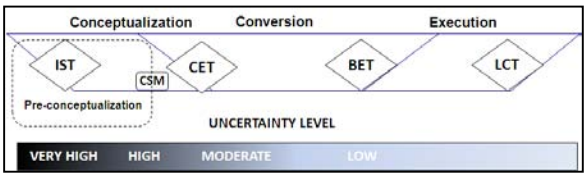

Figure 1 : Uncertainty level along the project phases

Smith and Reinertsen (1997) calls fuzzy front end the initial development phase or the new product concept generation phase, mentioning the lack of attention of managers to that initial phase as it does not have the traditional management control, that is, neither time scale nor established goals. Therefore, it is not possible to detect whether actions are deviating from the plan in the fuzzy front end. Also, the lack of controlling mechanisms is aggravated by the fact that most managers only pay partial attention to that phase. As managers are more involved with finances, they tend to ignore that phase as it seems to have a fuzzy financial impact. In view of what has been exposed, the present paper proposes to identify the main uncertainties within the fuzzy front end, and to determine the weight of factors that define the product concept generation time during the fuzzy front end and the time to market, that is, which variables shall be early identified to avoid delays to the concept generation time (Tcet) and to the time to market (TtM).

The article is divided into five sections. The *second section,* which follows this introduction, is devoted to a literature review on TtM. The *third section* describes the proposed model. This section begins by addressing the conceptualization of a new product as the focus of this study. A research within the NPD of a home appliance industry is made to identify the main critical factors (uncertainties) in the fuzzy front end phase. The critical factors identified help to create the theoretical construct. This section ends with the presentation of the proposed model. In the *fourth section,* a case study is made inside the same NPD with two purposes: to validate the critical factors identified in the previous research and to understand the influence of the uncertainties on the TtM of the projects developed in these NPD. Also empiric data are analyzed through the use of linear regression to probabilistically determine concept generation times (Tcet) and the time tomarket (TtM). The *fifth section* of the study shows the results, limitations and implications.

II. Product Development (PD) Models and Their Approach to the Fuzzy Front End

Some authors (Montoya-Weiss and Tatikonda, 2001, Eisenhardt and Tabrizi, 1995; Song and Montoya - Weiss, 2001, Kerzner, 2003) reported in their study, concerns with excessive changes during the development of a product as well as the impact of new developments in technology and marketing and its effect on the design of a new product. Crawford (1994) highlighted that imperceptible costs may be generated due to acceleration in NPD to ensure rapid development. These costs include errors resulting from unfulfilled milestones, risks related to non-dominated technology and marketing uncertainties on the designing of the product to be developed on account of the pressure regarding speed in development. Datar et al. (1996) reports that the excess of information on consumers may create confusion and subsequent duplication of effort by the project team that may cause impairment of TtM. Cooper and Kleinschmidt (1995) recommend attention in the pre-development activities, especially in the conduct of technical studies of the market and feasibility analysis, which contributes to the reduction of uncertainties of the initial phase. According to Chen et al. (2012) high levels of uncertainty may limit the technological availability and the absorption capacity of the NPD team. Among the success factors for achieving TtM are the distinguished studies of Lynn et al. (1996) which identified 10 key success factors for NPD. The factors include (1) having a structured NPD process, (2) a clear and shared vision of team work, (3) develop and launch products within an appropriate period, (4) refine the product after launch and gain insight in the long term, (5) have great team skills, (6) understand the market and its dynamics; (7) support from top management to the development team and vision of the development team; (8) applying lessons learned from previous projects; (9) ensure good relationships within the project team, and (10) retain the members of the project team who have relevant experience. Another contribution for a good TtM is highlighted by Griffin (1997) when he emphasizes the need for quality in the activities of generation and analysis of ideas, technical development and introduction to the market. Chen et al. (2012) argues that low levels of uncertainty in understanding the available technology, help the NPD team reduce the time and use of speed as a linear and direct benefit in developing a new product. In line with Chen et al (2012) are Whirlpool (2008) and Mascitelli (2006) when describing the management of the introduction of a new product innovation through the development of concepts prior to the project, as an opportunity for assertiveness in the development and speed to launch a new product. Within the success factors, Cooper and Kleinschmidt (1995) also cite that the

skill levels of the areas involved in NPD have been correlated with the success and failure of new products, associating this to technical training of the teams involved in the project. For Brown and Eisenhardt (1995) the main factors affecting the performance of the PDP are: the project team, the project leader, the role of the managers and the involvement of suppliers and customers during project execution. In the research made about which approach is given by product development reference models to the fuzzy front end of a new project showed that the main decisions and commitments are made in the initial stage, when the concept of a new product is generated. Future corrections to a decision made may imply in launching delays due to reprocesses.

III. Proposed Model

The identification of the variables of research starts by examining the product development process as shown in Figure 2.

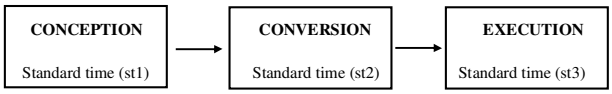

Figure 2 : Summarized flowchart on the development of new product

Summarizing, TtM is the sum of the time of conception or conceptualization (the product being developed) with the time of conversion (realization of designs, prototypes and tests) and the execution time (production of molds and tools for the manufacture of this product). For this study we will be considering only the design or conception stage for the formulation of the forecasting model. The conversion and execution phases of this study will be considered as dependent on the design phase and predictabilities. That is, it is understood that the expected results for these two phases depend more on the excellence of its execution and standardization of procedures. This is on the principle that the critical factors are inherent in the early stages of conception, since this is the stage where there is a greater lack of accurate information for the project team, therefore this phase becomes critical for defining TtM. Since TtM (ideal or standard) = st1 + st2 + st3, but taking into account the actual time we can write the equation as follows:

$$TtM\ real\ (TtM + \triangle\ TtM) = (st1 + \triangle\ st1) + (st2 + \triangle\ st2) + (st3 \triangle\ st3) \quad (1)$$

Each Δ has its own characteristics depending on the activity to be performed within the project phases within the NPD. As mentioned earlier in this chapter only the variations inherent in the design phase or t1 will be considered in this study. It is understood that the definition, knowledge and management of critical success factors of the project in the early stages of new product conceptualization will assist the project team in meeting the deadlines. Failure to comply with the schedule or delay in launching a new product is linked to the lack of knowledge of critical success factors.

Below some examples of traditional delays and impact on TM described by Smith and Reinertsen (1997), Chen et al. (2012) and Griffin (1997) are cited:

- *Delays due to the understanding of the project problem, or level of complexity of the project.* In this case the project team does not have the usual experience in developing tasks.
- *Delays due to unknown mental processes of generating or creating solution.* In this case there is training in order to solve problems related to the activities.
- *Delays in decision making, the need to* "hit the gavel" for the delivery of results. The latter can be defined in two ways, the first being when the information requested or required for a definition does not reach the project team, and the second when the information arriving to the project team is incomplete or inaccurate.

a) Identification of project uncertainties in the fuzzy frontend of home appliance sector

As a continuation of this study we propose a complementary study to identify the critical success factors in the new product project performance. This research aims at identifying specific critical factors on the particulars of a given NPD. To better understand the reality existing in a project environment subjected to the pressures of a competitive market, we chose to interview a group of people who work in the NDP of a large multinational company leader in the sector of household appliances in Brazil. The target of the research consists solely of experts and project leaders with extensive experience in new product development. Therefore, in this study, we used intentional sampling, by selecting a group of 15 professionals having a cumulative experience of 10 to 25 years on projects. The objective was to identify the main insights of these experts regarding the causes and factors causing delays in the project (for refrigerators, washer machines, free standing ranges, room air conditioners and micro-wave ovens) that are compromising TtM on the last 10 years. This is on the assumption that the public interviewed has enough skill and competence to perform a specific task of the project within the stipulated time, as long as provided with the adequate means for its execution.

The questions asked were:

- What does the word "doubt" represent at the beginning of a project?
- What is your view on the complexity involved at the beginning of a project?
- What does being assertive in the conception of a new project mean?

– What are the main uncertainties involved at the beginning of a project?
– What affects the speed of development of a project conception?

The first part of this research involved collecting data through survey sent over the Internet where we obtained the answers (written). With the answers provided by the project leaders (experts), we synthesized and classified them by clusters with common factors (see figure 3).

Figure 3 : Clusters generated by answers from survey

In the second stage, individual interviews were conducted with research participants (two hours with each participant) to validate the developed materials. The third stage of the study was to compare the material developed through field research with the literature review on TtM. The correlation of the two surveys provides the critical success factors in the industry of household appliances.

Listed below are the critical factors identified:

– Compromising of functional areas with the project objectives (FAC);
– Impact (time) in the development of a new technology within the project (TDI);
– Competence of the members of the project team (PMC);
– Competence of the leader in managing activities (LC); - Clarity and maintenance of project scope (SCM);
– Reconciling the demands of the project (marketing, cost,
– quality and legal requirements) (PDC);
– Availability of resources (people / investment / budget) (RA)

The definition of the critical success factors of a project in NPD is obtained from the correlation of data from field research conducted with the theoretical framework on TtM.

b) Theoretical Construct

To quantify the impact of the critical success factors of a project on project performance it is important to show the relationship between information, uncertainty and project performance (TtM). Figure 4 shows the theoretical construct proposed to solve the problem showing the relationship between input factors, middle factors (in this case the critical success factors) and output factors.

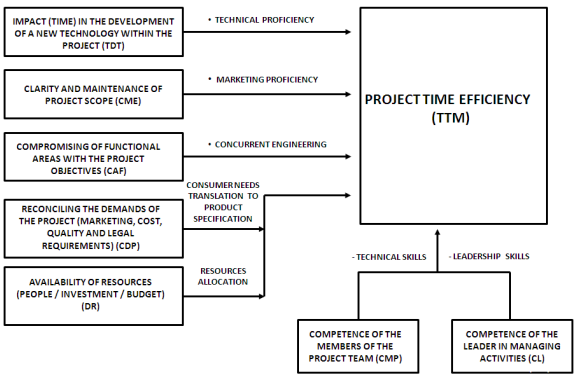

Figure 4 : Theoretical construct for the solution of the problem

c) Proposed model for TtM simulation

In the search to identify the degree of probability of reaching the foreseen TtM of a product scheduled for launching to the market is shown in the flowchart of Figure 5.

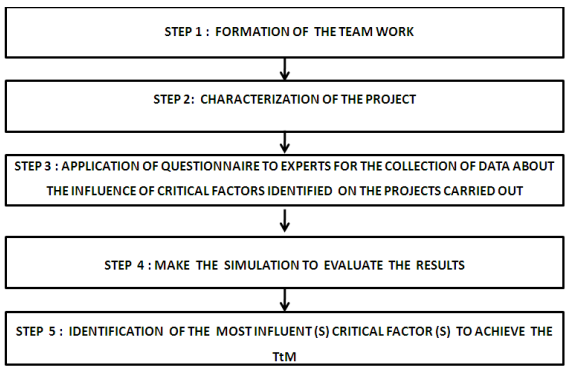

Figure 5 : Proposed model for TtM simulation

It presents a whole series of steps that should be implemented for the identification and formatting of data. This formatting is for the purpose of carrying out the simulation of TtM for a given project. This simulation will allow the project group an understanding of the likelihood of this project being launched within the estimated TtM. Step 1 begins with the formation of the team that will work throughout the process of determining TtM. It is desirable

that the composition of this team be with professionals experienced in leading projects. The later stages of the model for determining TtM require a proven experience of these professionals for a good reading and interpretation of data. In step 2 the characterization of the project being assessed is performed. The classification should be carried out so that you can identify the particularities of the project in relation to novelty and or the complexity demanded. In step 3 a survey is conducted through a questionnaire (see Appendix 1) administered to a group of experts for the assessment of projects undertaken by the NPD study. The goal of this step is to generate sample data for subsequent simulation. In step 4 is made the simulation using the software JMP/Anova (2011) software to identify the most influent critical factors to achieve TtM. In the step 5 are analyzed the results of simulation and also defined a plan to manage the most influent variables in order to guarantee that the TtM objective will be achieved.

d) Modeling Tools Employed

The linear regression analysis through software JMP/Anova (2011) is used to quantify the impact of each variable on the project development time, and then to obtain a general equation that represents the impact of a set of variables on the total time of product development. To check whether the result of the TtM simulation presented good adherence to the reality of the project environment, the simulation results were confronted with the actual data obtained from the projects already carried out by the researched company. Data and records of 15 projects carried out by the company were collected by means of workshops with project leaders (specialists). A set with the same leaders was also carried out to assess the impact of each variable (uncertainty) on the projects researched. The purpose was to check whether the simulated results were coherent with those found in the records of the finished projects, and to ensure the precision of the models chosen to estimate projects TtM.

IV. Empiric Study (Proposed Model Application)

The field study involved the NPD of the home appliance industry. In this study, a survey was conducted with the senior project leaders. They answered a questionnaire sent via internet with questions about projects already undertaken. The approach applied was to understand the influence of the critical success factors on projects delivered and also to validate the proposed model for new projects. The survey was conducted between February and March 2012. The sampling profile of the NPD is reported in Table 1.

COMPANY	COMPANY DESCRIPTION	PROJECTS (SAMPLE) EVALUATED	PROFILE OF EXPERTS
APPLIANCES	IT HAS 4 TECHNOLOGY CENTERS (NPD) IN BRAZIL WHERE REFRIGERATORS / FREEZERS / COOKERS / WASHING MACHINES / AIR CONDITIONERS AND MICROWAVES ARE DEVELOPED	18 MEGA PROJECTS (7 PROJECTS FOR NEW REFRIGERATORS AND FREEZERS, 5 PROJECTS FOR NEW STOVES, 5 PROJECTS FOR NEW WASHING MACHINES, 1 PROJECT FOR AN AIR CONDITIONER, 1 PROJECT FOR A WATER DISPENSER	18 PROJECT LEADERS HAVING 10 TO 25 YEARS OF EXPERIENCE

Table 1 : Company profile

a) Application of the model proposed to NPD of a home appliance company

To apply the linear regression, a study of the main projects carried out by the researched company, leader in the segment of home appliances, is suggested. This research resulted in a sample of 15 projects already carried out in the four main businesses of the researched company. The seven factors (uncertainties), present in the fuzzy front end of a project, identified by the specialists as those that impact the most the TtM, comprise the group of variables x knowing the uncertainties (x), a workshop with those specialists (project leaders) was carried out to individually attribute the degree of impact of each variable on the product concept generation phase (Tcet) and on the time to market TtM (Y) in each of the projects developed by the team. This paper used a more intuitive approach in the evaluation of the results over more objective variables. The critical factors were deployed through specific questions and where the final averages were obtained.

b) Results Found

The normal probability graph shown in figure 6 identifies the most significant uncertainties after the analysis of variance (ANOVA), that is, the uncertainties that are further away from the diagonal straight line, those that have the greatest significance or impact on Tcet and TtM. This analysis can be confirmed with the Pareto plot represented in figure 4, which shows the effects of factors TDI (impact of product and/or process new technology development time within project), SCM (project scope clearness and maintenance), and FAC (functional areas commitment with project objectives) as being the most influential on Tcet and TtM. It is important to point out that variable LC (leader competence as a manager ofactivities) stood out in the product concept generation phase (Tcet) graph. The same factor is not significant for TtM, suggesting that the leader capability at that point of the project is important to manage the project team.

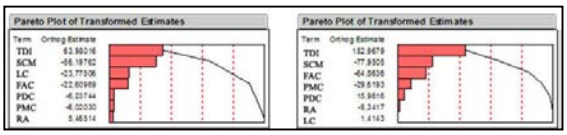

Figure 6 : Normal probability graph considering the orthogonal analysis of the variables (uncertainties)

The next step in the analysis of the results was to make a regression analysis with the most significant factors only, TDI and SCM, analyzing their residues and generating a model (equation). In the graphs shown in figure 7, the value of Rsquare adj shows that these factors (TDI and SCM) represent 78.21% of the variation found in the data, a value greater than when factor FAC is added (variation = 74.75%). The analysis of variance shows that the probability of such factors to happen at random is of 0.01%. As a result, it becomes clear that thetwo uncertainties (TDI and SCM) were the most significant to influence Tcet and TtM.

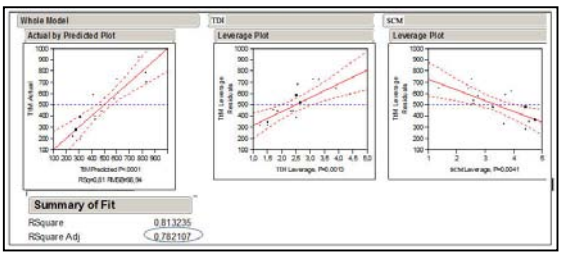

Figure 7 : Correlation of TDI and SCM variables with the TtM graph

c) Equations obtained with linear regression

Equations (2) obtained with linear regression and variance analysis, considering the variables that have the greatest impact TDI and SCM. These equations allow the calculation of the development time of a new product concept (Tcet), of the total development time and of the time to market (TtM).

$$Tcet = 287.80 + 41.56*TDI + (-60.34)*SCM$$

$$TtM = 515.08 + 123.21*TDI + (-96.66)*SCM$$

d) Prevision Model Validation

The validation of the model was done for 4 projects that were not involved on the case study. The table 2 shows the previewed TtM obtained through the use of the equation (1). The table 2 also shows the real TtM occurred by project. The comparison between previewed TtM and real TtM expresses the accuracy of the model. The score used to simulate TtM comes from an interview conduct with project team members. The project team members attributed scores to TDI and SCM in according with: not satisfactory (1) - little satisfactory (2) - satisfactory with minor restrictions (3) – satisfactory (4) - above expected (5).

SIMULATION				REAL TtM	
TDI	SCM	Tcet	TtM	Tcet	TtM
1	3	148,34	348,31	128	363 (Project 17)
1	5	27,66	154,99	35	165 (Project 16)
3	3	231,46	595,45	252	630 (Project 19)
5	3	314,58	841,15	350	890 (Project 18)

Table 2 : Methodology validation for new projects

V. Conclusion

The case study shows that the evaluated NPD should be concerned with prior identification, development and certification of new technologies to be introduced in their appliances (e.g.: Refrigerators, Washing Machines and Ranges) once the lack of know-how about those factors in terms of product and/or process has generated delays to the latest launchings. The NPD need to take care about product or process innovation for new products that are not tested and certified before the conceptualization phase in order to avoid delays on TtM. Another finding that caused delays on project launching is regarding the "non-maintenance" of the original proposal of the new product along the project. In other words, the briefing generated by marketing has not been consistent, being changed during the development of the project, leading to process re-loops and launching delays. Although, all uncertainty factors are present within (NPD), the simulation evidences shows greater concern with (TDI) and (SCM) in the projects to come as they have the most impact on the projects launched in the last years. The prevision model was validated with projects that not participated on the case study. The simulation presented results very near with the reality. The comparison between the simulated results with the practical results shows 5 to 10% of error. This level of error is quite acceptable with respect to TtM variation. It means that the prevision model is adequate to preview the TtM .The NPD participant in the sampling followed the boundary conditions or limitations of the model for this evaluation. As boundary conditions for this study we established that NPD assessed should possess: - a project leader appointed at the beginning of the project, managing the team project until the release of the product, - a reference model of product development with staged-gates defined, - the application of simultaneous engineering practices; -NPD maturity on new product development, - project team having previous experience of over 5 years - strong technological base.122 Finally the results of this study suggest that the development time performance of new products is linked with complex set of variables and the lack of understanding and management of these variables during the conceptualization of a new product may affect the development time performance of a new product. This research could be extended and expanded in several ways – for example by studying other models of NPD in companies of Different branches.

Finally, on identifying the factors that have influence on defining TtM we believe that we have contributed to future studies on performance improvement of NPD projects.

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Safety Management for Bangladeshi Ship Breaking Industries Perspective

By Ripon Kumar Saha , Md. Saiful Islam & Md. Mahbubur Rahman
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Abstract- Ship breaking is the process of dismantling an obsolete vessel's structure for scrapping or disposal conducted at a beach, recycling the ship's structure. It is a challenging process, due to the structural complexity of the ships and the involvement of many environmental, safety, and health issues. Six hundred end-of-life ships are broken annually without cleaning by the owner prior to export, and only a very few cleaned before scrapping. More than 3,000 ships with the toxic wastes have been exported over the last five years to Asian ship breaking yards and Bangladesh is the leading ship breaking country is south Asia. Although the steel is recycled, the toxic substances such as PCBs, metals, asbestos, lead, waste oil, TBT, etc enter into the environment and into the bodies of the workers. A new EU report on the phasing out and scrapping of single hull oil tankers concluded that 2,200 oil tankers would have to be scrapped after the end of their commercial life by the year 2012.Bangladesh is dependent on ship scrapping for fulfilling its domestic demands for steel and iron. Ship scrapping is not regulated by environmental law, nor is there care for the health and safety of the workers. Workers of Bangladesh break up European vessels with no protection from explosions, asbestos or a cocktail of toxic chemicals contained in the ship. Over the last 20 years more than 400 workers have been killed and about 6000 were seriously injured that indicates the highest accidents and casualties at the yards in the region. Workers cut down steel plates continuously without uniforms, protective gloves, boots and goggles. The Main objective of this paper is to Identifying hazards associated with ship breaking, to Calculate risk level according to those hazards and recommendation to ensure safety for the ship breaking workers.

Keywords: *risk, hazard, ship breaking industry, risk calculator, OSH (occupational safety and health), OSHA.*

GJRE-G Classification : *FOR Code: 290502*

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Ripon Kumar Saha [α] , Md. Saiful Islam [σ] & Md. Mahbubur Rahman [ρ]

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I. Introduction

There have been thousands of cases of death and injury at the Chittagong yards. Over the last twenty years more than 400 workers have been killed and 6,000 seriously injured, according to the estimates made by several NGOs and the Bangladeshi media. The explosion of the Iranian tanker TT Dena on 31May 2000 alone is said to have caused fifty deaths. To this toll must be added thousands of cases of irreversible disease which have occurred and will occur in future due to the toxic materials that are handled and inhaled without minimum precautions or protective gear. The recent 279th Session of the ILO's Governing Body (November 2000) endorsed a conclusion of the Tripartite Meeting on the Social and Labor Impact of Globalization in Manufacture of Transport Equipment (May 2000), stating that, as a first step, the ILO should draw up a compendium of best practice adapted to local conditions leading to the preparation of a comprehensive code on occupational safety and health in ship-breaking, and that governments should be encouraged to require ships to have an inventory of hazardous materials on board that is updated throughout the life of the vessel, and requested the Director-General to bear this in mind when drawing up proposals for the future work of the Office. The draft Program and Budget for 2002-03 also identifies the improvement of working conditions at Asian ship-breaking sites as a priority area for extra-budgetary activities.

II. Literature Riview

The OSH policy for the ship breaking facility should include, as a minimum, the following key principles and objectives to which the facility is committed:

a) Management commitment to, and leadership of, the occupational safety, health and environmental programs;

b) Recognizing OSH as an integral part of the overall management structure and OSH performance as an integral part of the facility's business performance;

c) Protecting the safety and health of all members of the facility by preventing work- related injuries and diseases, ill health and incidents;

d) Complying with relevant OSH national laws and regulations, voluntary programmers, collective agreements on OSH and other requirements to which the facility subscribes;

e) Ensuring that workers and their representatives are consulted and encouraged to participate actively in all elements of the OSH management system;

f) Continual improvement of the performance of the OSH management system.

Typically, an OSHA management system should contain the following main elements:

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- OSH policy
- Necessary conditions for the executing organization, i.e. establishment of responsibility and ccountability, competence and training, documentation, communication and information;
- Hazard and risk assessment, planning and implementation of OSH activities
- Evaluation of OSH performance and action for improvement.

III. Methodology

A hazard analysis is one of the most important elements of the safety management program. A hazard analysis is an organized & systematic effort to identify the significant of potential hazard in workplace. This analysis provides information that will help the employers & employees in making decisions for improving safety & reducing the consequences of unwanted & unplanned hazardous situations. The hazard analysis should focus on equipments instrumentations utilities human actions & external sectors that may impact the process. These considerations assist in determining the hazards and potential failure points or failure modes in a process.

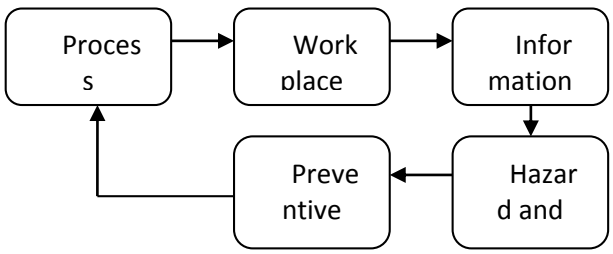

Figure 1 : Process flow diagram of the work

In this research work we have used different terms like Risk, Hazard, Hazard identification Check-list, and Risk calculator. Here the explanations of those terms are given below:

a) Risk

Risk is the potential that a chosen action or activity (including the choice of inaction) will lead to a loss. The notion implies that a choice having an influence on the outcome exists (or existed). Potential losses themselves may also be called "risks".

Risk = Probability of accident occurring* expected loss in case of the accident

b) Hazard

A hazard is a situation that poses a level of threat to life, health, property, or environment.

c) Hazard Identification Check List

This check list is used to identify different types of hazards associated with ship breaking. in this check list different types of hazards are grouped according their types. Source of those kinds of hazards are also shown in the list. Here who is exposed to the hazard & when he exposed are also shown.

d) The Risk Calculator

This is a tool to calculate risk. This calculator takes into account the frequency & duration of exposure of hazards. The risk calculator is primarily based on a Normogram introduced in the British Standard BS 5304:1988(machinery safety).

e) Elements of Risk Calculator

- Chance
- Frequency & duration of exposure
- Consequence

f) Categories of Risk Level

- High Risk A
- Moderate Risk B
- Low Risk C

g) Brief Explanation of Working Procedure

In our research work at first we have we have observed some ship breaking yards carefully. Then we have taken interview from ship breaking workers & we have documented the data collected from the interview. After that we have analyze those data very carefully. By analyzing we have identified different hazards associated with ship breaking. When various hazards are identified then we have used hazard identification check list to identify of potential hazards in workplace. In this checklist different types of hazards have been grouped according their types. Source of those kinds of hazards are also shown in the list. Here who is exposed to the hazard & when he exposed are also shown.

We have also identified risk level of different work activity which is done in ship breaking yards using risk calculator. We have categorized risk into high risk, moderate risk & low risk.

IV. Data and Result

a) Hazard Identification

Table 1 : List of hazards

No.	Activity	Cause	Consequence	Frequency of happening
01	Crushing in metal cutting machinery	Hand in running machine due to inattention, in appropriate protective equipment	Finger or hand injury	1 in 10
02	Crushing in material pulling machinery	Sleepy floor, in appropriate protective equipment	Finger or hand injury	1 in10
03	Being caught inside broken ship	Missing cover inattention	Significant body injury	1 in 1000
04	Fall from above	Inattention	Leg or hand injury	1 to 100
05	Damage from machinery splinter	Rupture during operations	Major wounds	1 in10
06	Knock from edge, metal part etc	Inattention	Wounds, cuts	1 in 10
07	Hair or cloths being caught in equipment	Inattention, inappropriate protective Cause	Significant body injury	1 in 1000
08	Bodily damaged from unobserved machinery start-up	Technical failure, Noise, inappropriate protective equipment	Significant body injury	1 in 100
09	Crushing when lifting material	Sleepy floor, inattention	Finger or hand injury	1 in 10
10	Damage due to roll coming loose	Rupture of spindle, carelessness	Sever injuries, fatalities	1 in 100
11	Damage due to dropping material	Failure of tackle, inappropriate fastening	Sever injuries, fatalities	1 in 10
12	Fire	Dust oil, smoking, sparks	Loss of machine, destruction of machines, injury to human body	1 in 10

From the table we have shown that event 01, 02, 05, 06,09,11,12 are occurred minimum 1 time among 10 incidents. Event 04, 08, 10 are occurred minimum 1 time among 100 incidents. Event 03, 07 are occurred minimum 1 time among 1000 incidents.

Those events are grouped together and named E1, E2, and E3 in the table below:

Frequency of occurring	Event No.	Name
1 in 10	01,02 ,05,06,09,11,12	E1
1 in 100	04,08,10	E2
1 in 1000	03,07	E3

Now we will be able to calculate risk for different hazardous events. Here E1 occur frequently, E2 occur less than E1, E3 occur less than E2. So E1>E2>E3.

b) Risk Calculation

Using the data of hazard identifications we shall calculate risk now. Here we have divided risk into three categories. These are:

a) High risk: This indicates that the level of risk is unacceptable.

b) Moderate risk: This indicates that the level of risk should be reduced to a level as low as reasonably practicable (ALARP).

c) Low risk: This indicates that the level of risk is broadly acceptable.

In this risk calculator probability level divided into six categories. These are:

- Frequent
- Probable
- Occasional
- Remote
- Improbable
- Extremely Remote

In risk calculator consequences are divided into six categories. These are:

- Multiple fatalities
- Fatalities
- Sever
- Major

- Minor
- Significant

d) Risk Calculation Diagram

With this diagram we shall calculate risk for event group E1, E2, E3. Here the calculation is given below:

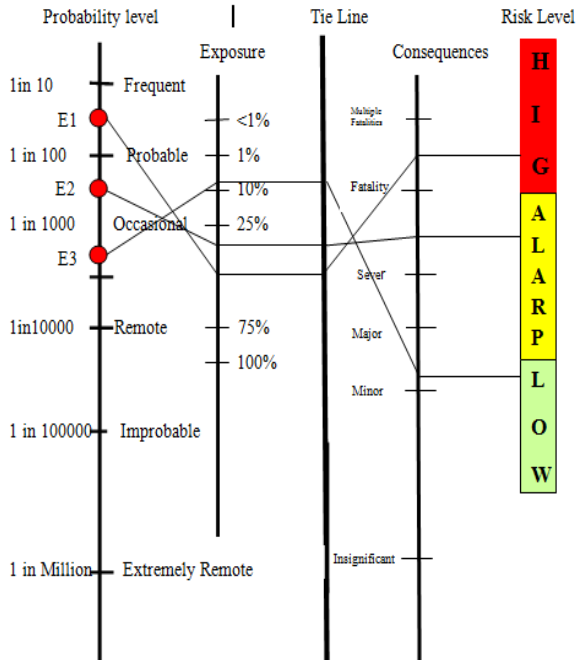

Figure 2 : Risk Calculation Diagram

Here we can see that event group E1 is in high risk level HIGH, event group E2 in risk level ALARP and event group E3 in risk level LOW.

V. Recommendation

a) Ensure that all workplaces are safe and without risk to the safety and health of workers.

b) Adequate and safe means of access and egress should be provided for all workplaces during all ship breaking operations. These means should be maintained in a safe condition.

c) Means of escape should be kept clear at all times. Escape routes should be frequently inspected and continuously modified on the ship according to the breaking progress.

d) Roadways, quays, yards, etc., where persons or vehicles move or are stationed should be so constructed and maintained as to be safe for the traffic that they have to carry.

e) A suitable housekeeping program should be established and continuously implemented on each ship breaking facility.

f) All openings through which workers are liable to fall should be kept effectively covered or fenced and clearly indicated in the most appropriate manner.

g) Adequate precautions should be taken, such as the provision of fencing, lookouts or barriers to protect any person who might be injured by the fall of materials, or tools or equipment being raised or lowered.

h) Fire Prevention and Fire-Fighting measures should be taken by the employer to ensure safety for ship breaking workers.

i) Signs and symbols are a very effective method for warning against hazards and for presenting information in a non-linguistic form. Safety signs and notices should conform in shape and color to the requirements of the competent authority.

j) Visitors should not be allowed access to ship breaking facilities or ships, as appropriate, unless accompanied by or authorized by a competent person and provided with the appropriate protective equipment.

k) As a basis for eliminating or controlling exposure to hazardous substances (including dusts, fumes and gases), the provisions of the ILO code of practice ambient factors in the workplace should be consulted.

VI. Conclustion

From our research work we have come to know that ship breaking is a very much dangerous process. A lot of unwanted death has been occurred from 2001 to 2012 due to ship breaking, many workers also get injured. This types of accidents happened because there are no safety rules for ship breaking workers. Worker do works without appropriate safety equipments so they easily expose to hazardous element. It increases the probability of accidents. So if we want to reduce the rate of accident we have to think about the safety issues of ship breaking worker. In our research work we have identified different hazardous work activities. We have also calculated the risk level of those work activities. With the help of the risk level we have given recommendations for different types of dangerous work. If we can implement those recommendations totally or partially it is sure that accident rate will be reduced to a acceptable level. In our research work we have shown an important thing that is the zoning of ship breaking area. This is a good idea to divide the ship breaking area into different parts. If we can ensure safety to every zone then total ship breaking area will be a safe place for the workers. If we can improve safety we shall get higher efficiency from the workers, we shall be able to break ship within a short time, as a result we shall be able to earn more money, and moreover worker satisfactions will be achieved. At last it can be said that our government should come forward to ensure the safety for the ship breakers. Owners of the ship breaking yard should think about the safety. If they can ensure

safety of their own ship breaking yards the workers will be benefited and the owners will be benefited as well.

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Theory of Pollution Certificates: Policy Developments and Industrial Applications

By Antônio Henriques de Araujo Junior, Marcus Vinicius Faria de Araujo, Francisco Santos Sabbadini, Rosinei Batista Ribeiro & José Glênio Medeiros de Barros

State University of Rio de Janeiro, Brazil

Abstract- A mathematical applicability test is carried out in this paper. The Pollution Certificate Theory is evaluated for an industrial cluster in Brazil. The purpose here is to discuss the contributions made by environmental agencies in controlling water pollutant emissions. This is considered by means of an instrument associated with economic regulatory instruments (as used in Brazil). A scenario is designed for an Industry Cluster with five industries and a potential to cause water pollution by the release of organic waste. In the test it is considered that the effluent is released in a Class II river, according to Brazilian CONAMA Resolution (no. 357). The marginal costs of abatement are arbitrated, whilst the reductions necessary to achieve the environmental targets were calculated. The control costs comparison and the use of standard emissions with the utilization of Pollution Certificates led to the conclusion that the Pollution Certificate Theory is a beneficial tool for water management issues, as it meets the environmental requirements at a lower abatement cost in industrial activities.

Keywords: *pollution certificates; pollution credits; pollution certificate.*

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I. Introduction

When considering the discussions promoted by the United Nations Climate Change Conference, 2009, in Denmark, we are able to produce the research question: "How to manage scarce environmental resources when our needs regarding consumption are growing at such a strong pace"?

We consider here the idea that the environmental problems of our planet are the result of synergies regarding local environmental problems. The global management of environmental problems will only have some success when resources are also properly managed locally. It is essential therefore, to take hold of our environmental "economato". This is the way forward considering the many layers of institutional arrangements: locally, regionally and globally (e.g. at *country level*, at a *regional-bloc level* and *internationally*). We may consider, for example: Brazil, Mercosul, and the United Nations (or USA-NAFTA-UN; and also Germany-European Community-UN).

If by one interpretation consumption stimulates production (creating jobs and improving the economy of countries), by another interpretation this same consumption generates higher levels of emissions and pollution (and also greater use of natural resources). It must be mentioned that the systems considering pollution abatements are not 100% efficient (and are also not 100% effective).

When considering for example, the use (exclusively) of regulatory instruments to control water pollution – there is the case of discharge patterns considered in pollutant concentrations [mg/L] – it is possible to observe that this criteria enhances environmental problems. This occurs as it considers only marginally, the volume of water being discharged.

Hahn and Stavins (1991) mentioned that "Some seventy years ago, Pigou (1920) suggested corrective taxes to discourage activities that generate externalities. A half century later, Dales (1968) showed how the introduction of transferable property rights could work to promote environmental protection at lower aggregate cost than conventional standards. From these two seminal ideas - corrective taxes and transferable property rights - a substantial body of research has developed".

Environmental Licenses are given, many times, without an accurate analysis of environmental matters. These matters may be related to private costs or also social costs (*externalities*). There is, therefore, a need for good management where the sustainability of decisions have to be understood under a perspective taking into account *costs* (industrial, commercial, institutional, etc.), and also *savings* (saving the "natural capital" of our planet).

Environmental Management (EM), as suggested here, must consider economic instruments that may make viable the instruments and tools used for this management. The solution, we consider, will be where the "optimum" cost is found (balancing resource needs and consumption with the needs relating to preservation and the limits of environmental degradation).

There is no doubt that management strategies have greater chances of succeeding when "subjectivities" are also reduced. This must be the "objectivity" when dealing with the environment. This objectivity may be found in the "Theory of Pollution Certificates" (Dales, 1968).

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Combining the ideas developed by Dales (1968) with modern-day mathematical applications and making use of Operational Research (OR), also helped by "Game Theory" as published by John von Neumann and Oskar Morgenstern in 1944, it is feasible to construct ways in which better environmental management is possible. In this case, EM takes mathematical arguments in order to reduce matters relating to "subjectivities" (including policy and political arrangements). This will promote clarity of objectives and hopefully reduce environmental costs and "*pay-offs*" (for all stakeholders).

This society, as above described, is represented here in this text by an "Industrial Cluster" having water emissions discharged in a "Class II" river (according to the CONAMA Resolution number 357 of 2005). This is our case for study: the actors, players, are respectively, the river, the environmental regulatory agency and the companies of our fictitious industrial cluster.

II. Literature Review

The *Economics of Natural Resources* (ENR) is a trans-disciplinary field of research. Its aim is to consider the interdependence between the human economy and natural ecosystems. Any economic system (within a modern-day perspective and taking into account a contemporary sustainability view), must operate within certain *ecological limits* (protecting the natural resources of our planet for future generations).

ENR connects different disciplines: "natural" (environmental) sciences, "pure sciences", social sciences, and humanities. ENR must consider Geology, Biology, Chemistry, Physics, Economics, Management, Law, Political Sciences (and Institutions), and even History and Philosophy. Only with this holistic view we will create ways in which the environment is better used and better protected ("humanizing" Nature and "naturalizing" the Economy).

The effectiveness of what is called "*cap-and-trade* approach" (a management approach for pollution control, based on economic concessions and incentives for those who reduce their emissions), was developed in 1967 (Burton and Sanjour, 1967). From 1967 up until 1970, the approach was developed by the *National Air Pollution Control Administration* (NAPCA), the predecessor of the American Agency for Environmental Air and Radiation Protection.

Gregório (2009) relates that a central authority, usually a national government or an international body, stipulates a limit (*cap*) to the emissions of pollutants. Credits are granted to enterprises and individuals; these enterprises and individuals must limit themselves to emit what corresponds to their credits. The total of credits must not exceed the limits of the agreed "cap".

The enterprises that need to enhance its emissions will have to buy credits form those who pollute less. There is, therefore, a "credit transfer" (a *trade*) between parts. The result, in theory (and that should reflect also in practice), is that companies needing to enhance their emissions will acquire (as an ordinary business) credits from the less polluting companies. The intended result would be one in which the more polluting companies will be motivated to reduce their negative impacts on the environment (investing in new technologies and promoting needed innovations).

According to the above quoted author, there are similar environmental programs all over the world. In the case of pollutants of the so-called green-house-effect (Carbon, Methane, Nitrogen), the main program is that of the European Union (EU). In the USA there is a national project for reducing acid rain (and there are also some regional programs). Another interesting (global) program is the "Clean Development Mechanism" (CDM), created by the Kyoto Protocol (dealing with reduction of Green-House Gases – GHG). These cases are all models for further development.

For those who adopt *cap-and-trade* practices, the major advantage is that taxes can be set in order to minimize pollution. The "cap" approach allows for a market-driven determination of emission costs (and legal costs).

Other benefits of "cap-and-trade" are:

a) Safety: There is little risk (different from taxation systems) of changes in aliquot (tax rates), which would alter economic conditions and stability.
b) Environmental Certainty: Considering a previously agreed "cap", what may change is the operational cost, but not the total emission. This would also avoid special treatment for "privileged sectors" (politically motivated problems).
c) Emission / Agent Incentives: Individuals and enterprises are stimulated to create new technologies and to find better equipped suppliers (with sound environmental policies).
d) The *cap-and-trade* system allows for economic shock absorption. In times of recession, prices for credit emissions would fall (due to a reduction in consumption, of production and demand for there credits).

North-American experience suggests, also, that quick changes within businesses, and well-developed environmental controls, may be helpful in producing technological innovations (reducing emissions and industrial costs in general).

Those defending taxation increases, on the other hand, argue that:

a) Taxes are simpler to put into practice (when compared to other "systems of commerce" which is dependent on extensive and complex regulation procedures).
b) Due to its complexity, the *cap-and-trade* system will run the risk of being corrupted by politics (lobbies)

and social pressure (litigation and lawsuits). Lawyers and other agents, when standing for this view, would find quicker ways to corrupt the system (being more efficient then regulatory bodies). The examples from North America demonstrate this vulnerability (in practice).

c) There is less consumption of what is (heavily) taxed. If the Government stipulates taxes for labor and capital, why not suspend these taxes in favor of pollution taxation?

d) Decisions regarding strategies for reducing costs of emissions is something that would be better done by individuals and enterprises; which would be better (and faster) than governments.

e) Although it is possible that individuals and enterprises would merely pay more taxes (and not pollute less), this seems highly improbable. The experience from the USA indicates that taxation mechanisms are quite efficient in order to change behavioral patters.

As a conclusion to this part of the text, it may be considered that a viable alternative to promote environmental protection would be by "setting limits" for the degradation of the environment. A *cap-and-trade* system could be adopted, together with two other mechanisms: (a) government monitoring (e.g. via a regulatory agency), and (b) taxation over pollutants and emissions.

Doing so, speculation over prices and emission titles would be avoided; this because the buying of credits in cases of low prices is economically accepted and stimulated. Another incentive would be to change habits (behavior changes), protecting the environment sooner (which is better than leaving things for "future correction").

Burton and Sanjour (1969) consider the use of mathematical models applied to different towns and sources of emission. Their study compares cost and effectiveness regarding different strategies for environmental control. These authors also consider that each individual strategy of pollution reduction was compared with the minimum cost solution. This minimum cost solution was produced by an "optimization" program, where the combination of minimum cost and reduction of polluting sources was identified (considering certain targets which should be met).

According to Helfand, Berck and Maull (2003), physically, pollution occurs because it is practically impossible to have a perfect (non polluting) productive process. Industrial processes are waste producers. Also, when it comes to economic analysis, pollution occurs because it is cheaper to pollute than to operate within a cleaner structure.

The characteristics of each pollutant performs an important role when considering the defining agents considered by environmental policy institutions and practices; this context "frames" what will be done regarding pollution control. Carbon Dioxide (CO_2), for example, presents what is called a "global action" (or global impact), and, therefore, this impact is considered to be similar in all parts of the planet. Pointing out where emissions are (specifically) produced, does not matter.

The political context, therefore, should produce different considerations when dealing, for example, with more "regional" pollutants (such as SO_2, NO_X, and even mercury). The effects of these cited *regional pollutants* are not the same everywhere. The same quantities of a so called *regional pollutant* may cause diverse (greater or smaller) effects within different parts of the planet. The reasons for this are many: water availability (and local hydrology), geological setting, soil and geochemical characteristics, etc. What really matters here is the pollutant itself (this is known as a "Hot Spot" problem).

A Lagrange method is usually applied to determine the minimum cost possible in order to reach the desired objectives (when it comes to total emission conditions). It is possible to use, in some cases, the Lagrange method of optimization to determine required reductions for different countries. These calculations are based on Abatement (reduction) marginal costs; so that the global cost of pollution reduction is minimized.

Under such a scenario, the *Lagrange multiplier* may represent the price taken by the market for a certain pollutant. This is the case in Europe and the USA, when many emissions are considered (institutionally speaking).

Each country will confront its own licensing system price-levels with other countries. This will enable them to make their individual (national / regional) decisions regarding licensing (*e.g.* laws, practices, taxes), in order to minimize their costs. By doing so, there will be more "regulatory conformity", which constitutes another view of the principle of "marginal equivalence" (used by economists in order to decide the most efficient solution for a problem).

III. Methodological Approach

The methodology used here (for this specific research) consisted as a simulation of an Industrial Cluster near a river margin (but outside of its marginal protection zone). The river is a "Class 2" river (according to Brazil´s CONAMA Resolution number 357; 17th March 2005). One of our objectives, therefore, will be to establish a discussion concerning potential polluting activities. The main pollution problem will be that of liquid effluents being discharged into the quoted class 2 river. The main problem is to understand how to reduce polluting discharges into the river.

The environmental control of liquid effluents is performed in accordance to regulatory instruments, considering each (different) industrial activity. The control of pollution sources is usually undertaken in relation to the "receptor body" (*i.e.* the river class 2 in this specific case).

By doing this, society is able to internalize all social costs (due to multiple emissions, not only industrial).

Once the simulation scenario is established, we may consider a control that is the reverse (opposite) to the one being considered: in other words, from the "receiving (affected) body" to the pollutant sources. By doing so, in order to allow a simulation, the quality of water parameter was elected (Biochemical Oxygen Demand – BOD) as our method of analysis. It was then considered that the "water body" under study could receive an excess of up to 5% downstream (from the emission source belonging to the Industrial Cluster).

It is important to know that the criteria allowing for a 5% excess (as quoted above), is only an illustration (taken as example). This percentage may be reconsidered according to different needs not compromising our research conclusions regarding cost-effectiveness between regulatory and economic instruments and conditions.

From data considered for outflow (discharges) and concentrations (measured in BOD´s), a simple model for mass balance was performed, in order to define concentration of discharges for the liquid effluent coming from the Industrial Cluster. The value obtained by such method was used as an environmental marker for the pool of polluting activities present in the Cluster.

When adopting these steps for our research, it was possible to define (for our simulation), uniform levels of control which may be required from each activity of the Cluster (knowing that there is a wide rage of activities). It is then possible to simulate (and apply) only the "standard" value (for regulatory purposes).

Deriving from the values (the targets) considered for the study of the effluents coming from the Industrial Cluster (our environmental goal), and also from individual targets (from each of the enterprises of the Cluster), it was possible to establish a system for comparing environmental cost-effectiveness. This was undertaken in order to compare the situation that can be found (in practice; in the field) with the "Pollution Certificate Theory".

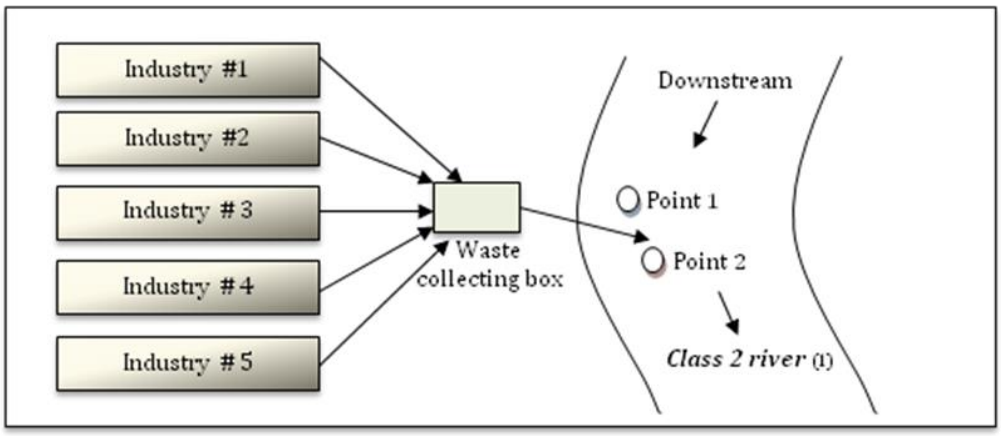
When using the *pollution certificate theory* it was considered that the environmental body (*e.g.* the regulatory agency) would file certificates in a quantity equivalent to the BOD capacity (the allowed limit of discharge for the Industrial Cluster). The distribution of certificates was performed so that each individual industry would be considered (in proportion to the total environment). This allows for negotiation between parts (among these individual enterprises).

The method for reaching the environmental target (at a minimum BOD cost level) allows for individual industries to buy and sell their certificates when convenient.

IV. Environmental Management: the Rules of the Game

Taking hydrological pollution as the "controlling issue" for environmental management practices, we may define, therefore, the strategy of the game. The main condition (main strategy) is to reach optimum levels of water pollution (at the lower possible cost) for those polluting and for those suffering from pollution. This model, when applied in practice, will need to consider *Command and Control (CAC)* regulatory instruments and requirements.

Our "game" constitutes itself by an Industrial Cluster with five individual enterprises or industries (all of them capable of polluting the environment). The pollution under consideration is water waste (hydrological pollution) originating from organic matter. The polluting sources are located on one side of a "river class II" (as already mentioned). See Figure 1.



- According to the Brazilian Environmental National Council (CONAMA), the Class 2 category refers to the river, whose waters may be intended to supply for human consumption.

Figure 1 : Representation of the proposed scenario

In order to allow for an interesting (useful) simulation, different polluting activities are considered. Emissions are of different types (being distinguished according to their industrial typology production factors and sources, and "size" or volume). These activities all present different costs in accordance to their "vocation" (or their possibilities) for pollution mitigation purposes. The marginal costs (for their mitigation), by these standards, as well as their discharge volumes and BOD concentrations (which was selected as tracing parameters), are represented in Table 1.

Table 1 : List of quantitative and qualitative characteristics for effluents derived from the Industrial Cluster; and marginal costs for mitigation purposes

Industry	Discharge [m³/day]	Effluent BOD [mg/L]	Weight [kg/day]	Mitigation Marginal Cost (US$/kg BOD)[1]
1	100	2500	250	1.60
2	200	2100	420	1.20
3	300	4300	387	1.00
4	400	1200	480	1.40
5	500	600	300	2.00
Total	1500	-	1837	-

[1]The mitigation marginal costs were considered constant.

At an imaginary point, upstream, and near the source of effluent discharge, the BOD concentration would be of 4.0 mg/L. The outflow of the river (at that point) was 2,400,000, m3/day. The BOD just after the place of junction (or confluence) should have a maximum value of 4.2 mg/L (around 5% more; considering the standard for the river-type under scrutiny of 5.0 mg/L). A simple calculation was undertaken to determine the reduction index to be applied to the organic material discharged by the Industrial Cluster.

Under the conditions described, the organic matter at "point number 1" (Figure 1) amounts to 9,600 kg/day. "Point number 2" would have (at most) some 10,086.3 kg/day. The total organic volume (discharge) permitted for the Cluster is 486.3 kg/day. This represents an 82.3% reduction in terms of organic matter – as the average effluent concentration for the Cluster would be 1,826.7 mg/L (while the environmental requirement for BOD discharges would be 324.2 mg/L).

Table 2 : Reductions necessary for achieving defined environmental targets

Industry	Total Discharge [kg/day]	Discharge after reduction index [kg/day]
1	250	44
2	420	74
3	387	69
4	480	85
5	300	53
Total	1.837	325

For managing industrial water emissions, the concept of "uniform and ample control" is applied, considering that reductions can be applied to each case (each industry) inside the Cluster. Table 2 presents results in terms of BOD reduction load (using the required 82.3% index, as mentioned above, for each industry of the Cluster).

V. Economic Analysis: the "GAME" with Regulatory Instruments

Judging the environmental effectiveness for applying regulatory instruments as "standard", it was possible to determine cost controls for each industry (of the Cluster). This is done in order to reach environmental goals (*e.g.* as required by the CONAMA Resolution).

In Table 3 we have the final result for each industry of the Cluster (considering a uniform reduction of 82.3% in BOD terms). It is useful to remember that the reduction being applied is that in concentration terms, and not in polluting "volume" (total discharge). This is how the environmental bodies tackle the matter under discussion. This must be further discussed and hence more research requires to be undertaken.

Table 3 : Organic load, BOD concentration of treated effluent, and total costs for mitigating the BOD´s

Industry	Load of treated effluent in 82.3% [kg/day][2]	BOD of treated effluent in 82.3 % [mg/L]	Mitigation costs for a reduction of 82.3% in BOD [US$/day]
1	44	442.5	204,10
2	74	371.7	257,11
3	69	761.1	196,92
4	85	212.4	342,44
5	53	106.2	305,90
Total	325	-	1306,47

[2] Rounded values. Conversion for US$ with exchange rate, as of May 19th, 2011.

At first glance it is noticeable that the use of standards as water pollution management instruments makes the cost for each industry proportional to their emissions (not considering the cost for controlling each polluting source).

It must be noticed that, once the defined pattern is reached (as defined by regulation and appropriate authorities), there is no reason for industries to pursue greater improvements. The next section will consider this issue.

VI. Economic Analysis Considering the use of the "Theory of Certificates": using Economic Instruments

To take advantage of *Pollution Certificate Theory* it was required to use "Nash equilibrium", or the strategic solution by Dunford and Schwartz (1988), where the final interest (and common to all) would be to reach a stipulated environmental target (level) at the lowest possible cost (for each industry). In mathematical terms, the strategic profile to be stimulated may be expressed as follows:

$s^* = (s1^*, \ldots, s(i-1)^*, si^*, s(i+1)^*, \ldots, Sn^*) \in S$, where "S" is a finite conjunct of strategies relating to an utility function "u", in order that "ui : S → R"; associating gain (payoff), ui(s*) of a certain industry (gi player), to each strategic profile $s^* \in S$.

For the trial analysis (the testing) of the applicability of the "Pollution Certificate Theory" to the Industrial Cluster, the following sequence was considered:

a) The environmental body (public or private) defines a target (environmental objectives) based on the main uses of water resources receiving polluting effluents.
b) The controlling environmental agency (be it public or private) certifies that it is possible to establish control at only one point of discharge.
c) The controlling body for the environment (public or private) will monitor the flow and the BOD of the effluent (for each industry of the Cluster), in order to define the maximum levels and conditions for organic discharge (for each industry).
d) The environmental agency (public or private) establishes a "maximum organic volume" permitted. Once this is done, the agency will then issue "pollution certificates" with "values" (1 certificate = 1 kg BOD/day), and distribute the "BOD credits" (in proportion to the level of pollution of each industry in the Cluster).
e) The agency (public or private) allows for trade between industries; the companies will trade their certificates (according to their needs). Resulting in a "optimum pollution level" which can be reached (allowing some industries not to reduce their pollution levels).
f) The agency (public or private) allows that the "pollution market" may work freely, not performing individual pollution checks, but only monitoring a single location (which represents total pollution output for the Cluster).

Taking into account Table 1 it is simple to infer that the certificates obtained for each industry (separately), according to marginal costs for BOD mitigation (for each activity), will acquire a value for this "pollution market". This value is an alternative for reaching environmental objectives (targets).

Knowing that the marginal costs for mitigating pollution and the value of BOD certificates are constant in time "t", instantaneous probability analysis may be performed in order to understand cooperation between industries. At another opportunity we intend to perform an analysis with broader time intervals (and with value fluctuations for the certificates, according to their scarcity).

For now the US$ 0,96/certificate value was used, and considering that one certificate is equivalent to 1kg BOD/day. In Table 4 some results immediately after the distribution of BOD certificates (provided by the official agency) are shown.

Table 4 : Initial configuration for the "pollution market" (immediately after distribution of certificates)

Industry	Total Mass [kg/day]	Mass after mitigation (kg/day)	Number of BOD certificates received[3]
1	250	44.3	44
2	420	74.3	74
3	387	68.5	69
4	480	85.0	85
5	300	53.1	53
Total	1,837	325.2	325

[3] Rounded values (the smallest unit for the certificates is 1).

As mentioned previously, one of the main elements used to achieve the objectives (the environmental targets), at a minimum cost (for all industries), is *strategic interdependence* (player g_i). This means that the optimum result is obtained when the "game" is "played" with cooperation between parts, aiming for a common objective (including industries and regulatory agency).

According to marginal costs for mitigation of BOD´s and the market value at an instant "t" (for the BOD certificates), both arbitrated, it is reasonable to advocate that industries number 2, 3 and 4 would have a greater vocation to reduce their pollution output. They would also have a greater vocation to buy certificates. There is a technological limit for BOD mitigation at the instant "t".

Knowing that there is no system for pollution reduction that is 100% efficient, it is also necessary admit an BOD mitigation performance rate (here considered to be 99%). By adopting these considerations we have a sort of "mathematical lock" that disallows a paradox where those industries with smaller marginal costs for BOD mitigation would try to reach zero emission levels (in order to maximize their gains with the certificate commerce). We must remember, therefore, that zero pollution is something impossible (this would only occur when industries ceased to exist).

- Mathematicaly we have

G = {Industry 1, Industry 2, Industry 3, Industry 4, Industry 5}

$s_{Industry1}$ = {buy certificates from Industry 2, buy certificates from Industry 3, buy from Industry 4}

$s_{Industry\ 2}$ = {sell certificates to Industry 1, sell certificates to Industry 5}

$s_{Industry\ 3}$ = {sell certificates to Industry 1, sell certificates to Industry 5}

$s_{Industry\ 4}$ = {sell certificates to Industry 1, sell certificates to Industry 5}

$s_{Industry\ 5}$ = {buy certificates from Industry 2, buy certificates from Industry 3, buy from Industry 4}

The space for pure strategy will be the Cartesian product (S) for the strategies of each of the 5 industries. The determinant of the payoff matrix will be obtained when industry 3 (having smaller mitigation marginal cost), maximizes its sales, initially to industry 5 and, on the sequence, to industry 1. After this (and under the condition that there still is a market for certificate commerce), would come industry 2; and after that, would come industry 4 (maximizing their sales to other industries).

Finally, in the case where there are no certificates available, industries still in need of certificates would have to reduce (to mitigate) their polluting levels (this, therefore, in a non-cooperative manner).

Table 5 and Table 6 present results for the emission and trade of certificates traded, total costs and gains for each industry (after negotiations have taken place and considering the levels imposed by the environmental agency).

Table 5 : Total costs with mitigation of pollution and certificate commerce

Industry	Total certificates received	BOD level to be reduced without commerce of certificates [kg/day]	Total cost with BOD mitigation [US$/day]	Total cost with trade of certificate [US$/day]
1	44	206	329.60	-
2	74	346	502.80	-
3	69	318	386.00	-
4	85	395	670.60	-
5	53	247	44.00	348.75
Total	325	1,512	1,933.00	348.75

Once the results from Table 6 are obtained, it can be noticed that the use of the "Theory of Certificates" for the control of BOD at the hypothetical Industrial Cluster presents greater cost-effectiveness than by simply waiting for the results of regulation.

With the assumptions in this research, the simulation of the sales of carbon credits, as shown in Table 6 the 5 industries cluster generated a total daily saving of US$ 215,96 and the issuance and sale of 325 certificates.

Table 6 : Initial state of the "pollution market" (immediately after the distribution of certificates)

Industry	Total gain with trade of certificate [US$/day]	Number of certificates after negotiations	Total cost after trade (US$/day)
1	-	44	204,10
2	70,07	1	241,28
3	65,27	1	173,76
4	80,62	1	334,63
5	-	278	243,20
Total	215,96	325	1196,97

With the assumptions in this research, the simulation of the sales of carbon credits, as shown in Table 6 the 5 industries cluster generated a total daily saving of US$ 215,96 and the issuance and sale of 325 certificates.

VII. Conclusion

From the research, and considering the implications of different economic and mathematical tools, it can be concluded that the regulatory instrument used nowadays in Brazil (and also in other places and countries), does not take into account (and does not take advantage of) economies of scale. This indicates that there is scope for using the Theory of Pollution Certificates (associated to Game Theory).

In this study, by considering a standard level for reduction of pollution (in BOD terms), total cost results for a Cluster (after negotiations) was shown. The results points to a saving of 5.54% of total costs.

With the exception of Industry 1 (which needed more certificates than those available, and, therefore stayed out of the "pollution market"), all other industries of the Cluster beneficiated with the economic instrument presented here. This indicates a stimulus for greater developments in the area of control technologies applied to broad environmental management.

It is obvious that our choice of Industrial Cluster made our research easier to present. The reason for this was simplicity of presentation. Once the basic framework is understood, other (more complicated) cases may be considered. There are limitations of course. For example: in cases of enterprises dealing with radioactive material, the use of negotiation instruments between industries have no sense (and is not recommended).

Legal and institutional considerations are very important to be discussed together with technical, economical and mathematical applications and methodologies.

Finally, our expectations point to more complicated cases. Cases where mathematical modeling (and simulations), may be performed with the aid of computerized processes. By doing this it will be possible to describe more complicated cases and environments, and, therefore, be more realistic. A reality where marginal control costs (and the value of certificates), may freely fluctuate according to market forces.

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Fuzzy-TOPSIS Analysis for Standard Alternative Selection: A Multiple Attribute Decision-Making Method and Application for Small and Medium Manufacturing Enterprises (SMEs)

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Abstract- In the era of industrialization small and medium enterprises (SMEs) play great role in world economy. The developed as well as developing countries are being benefited from SMEs which holds a strong position creating new employment and helping in the development and supporting in local production. The job creation element of SMEs enables many poor people to feel more secure, assuring that they have a stable job to survive .But the actual situation and overall working condition of SME's is very dreadful especially due to limitation of resources, facilities and techniques. This paper compares different performance criteria on three different SME and indicates a standard benchmark SME using fuzzy-TOPSIS analysis. The proposed method states optimum SME working condition among different performance variables with different values. Qualitative variables with multiple criteria problems have been analyzed here. As human assessment is uncertain and often subjective for qualitative characteristics, the alternatives' characteristics are expressed in linguistic terms. These linguistic terms are then evaluated through integrated fuzzy- TOPSIS method to produce numerical value which is the performance rating for each characteristic of SME alternatives. According to the fuzzy rule, the alternative with the highest value is chosen as the standard and other variables of alternatives are compared with the standard. The advantage of using fuzzy- TOPSIS is that it distinguishes benefit and cost category criteria and selects solution that is closed to the positive ideal solutions and far from the negative ideal solutions. Moreover, the paper offers a new method of identifying best SME using integrated fuzzy-TOPSIS and recommends optimum performance variables.

Keywords: *fuzzy, multi-criteria problem, TOPSIS.*

GJRE-G Classification : *FOR Code: 091005, 290502*

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I. Introduction

a) Purposes of SMEs

The small and medium manufacturing enterprises (SMEs) manufactures a great number of metal products every day. Manufacturing SME has a big contribution from repairing metal parts to manufacturing complex parts. There is wide range of activities behind the manufacturing system, from raw material to finished product until the product is used by customer or recycled. One of the most important roles of SMEs is poverty alleviation through job creation. The developed as well as developing countries are taking extreme benefits from SMEs and that are capable to accelerate the economy of any country. In developing countries, SMEs are major source of income. The following TABLE express importance of SMEs to the national economy.

Importance of SMEs on Economy of Asian Countries

country	SMEs as % of all enterprises	SMEs employees as % of total employees population
Japan	98.9	69.2
Singapore	99.7	57.0
Hong-Kong	98.0	60.0
Thailand	99.7	58.0
Taiwan	97.7	68.8
Philippines	99.6	70.0
Malaysia	96.1	45.0

b) Problems with SMEs

Small and medium enterprises in the manufacturing sector are faced with challenge of competition with established business. One of the major challenges that SMEs face in relation to adoption of maintain the standard that's why productivity is low and delicate.

According to Talha (2002) in order to compete effectively, companies must be capable of manufacturing high quality products at a low cost, and also provide a first class customer service. Customers' needs are changing as well as newly configured product is essential to manufacture while SMEs cannot keep pace with the performance needed. So it is very essential to change them to capable of. But they can't be changed having small investment, small budgeting, small technical support, hazardous environment and small opportunity due to economic and environmental lacking. So it is an

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important and necessary research, how the SMEs can be made enable without changing infrastructure, equipment, environment, budget, capacity and environment.

c) Previous Work

SMEs have received noticeable attention in the literature. Some examples of the literature on small and medium enterprises are given follows. Hudson et al. have examined the problems associated with PM for small to medium-sized enterprises (SMEs) and has proposed a procedural framework specifically tailored to their needs. They showed Improving control through effective performance measurement in SMEs. Tomomi et al. have focused on the adoption of green or sustainable practices in Small and Medium Enterprises (SMEs). Sarkis (2006) found that early adoption and increased investment in environment risk management did not increase performance for small firms in the metal finishing industry. Paying particular attention to the needs of small and medium sized enterprises (SMEs), Project Acorn by Gascoigne j. provides a framework for the systematic management of environmental issues within individual organizations and the supply chains to which they belong [1]. Toyli et al. (2008) analyzed the relationship between logistics performance and financial performance in Finnish small and medium-sized enterprises (SMEs). Several studies in South Africa (Mutezo, 2006; Maas and Herrington, 2006; Angela and Motsa, 2006; Herrington et al., 2008; Musara and Fatoki, 2011) have alluded to lack of access to financing as one of the major challenges impeding the survival and growth in the SME sector. Wagner, B. A. et al. (2003) worked on E-business and E-supply chain strategy in small and medium sized businesses (SMEs). In a study in India's machine tools SMEs, Pillai (2010) found that proper inventory management practices results in lower inventory costs. In another study, Lee (2006) revealed that many Chinese small manufacturing firms face size-related difficulties in implementing JIT. Lee suggested that Chinese small firms can achieve their goals by implementing only feasible elements of JIT without too much capital investment. Bayraktar, E. et al. (2009) made a causal analysis of the impact of information systems and supply chain management practices on operational performance having evidence from manufacturing SMEs in Turkey. Bhagwat, R., & Sharma, M. K. (2006) worked on Management and practice of information system in Indian SMEs. While it is acknowledged that large firms have an advantage for adopting sustainable practices more than SMEs and that SMEs adoption is necessary in the long run, studies found that the rate of return on early adoption is not encouraging. Banomyong, R., & Supatn, N. (2011) developed supply chain performance tool for SMEs in Thailand. There is also a vast literature on business success of small and medium enterprises (SMEs). Audretsch (2005) showed the relationship between ownership, decision making and employee deployment and the performances of the SMEs. In a research study on SME's in Indonesia (Robert, 2007) founded that SMEs operate on traditional lines in marketing. Strict reaction on account of competition should be responded proactively by SMEs by doing business development and research Information access it stands for the availability of business information is also important to initiate new enterprises and to run the existing enterprise profitably. Technology also plays an important role in this respect. Technology has a close relationship with improvement of production process. Different studies have also revealed the similar results that lack of new technology and equipment are hindrances of SME development (Swierczek & Ha, 2007). In Indonesian study it was revealed that business has no sufficient relation with the success of an SME (Huggins, 2007).

d) Contribution of This Paper

Works on SME were seen frequent formerly. While it is acknowledge that large firms have an advantage for adopting change discussed above where SMEs have no option but SMEs adoption is necessary. More research is thus needed on how SMEs should approach to a standard performance. In this paper standard alternative has been selected incorporation with TOPSIS and fuzzy analysis.

It is a common problem found in many cases of quantitative decision making the human assessments is uncertain and it is often difficult for decision makers to supply exact numerical values for specific criteria. In this regard most of the selection parameters can't be given precisely and the evaluation data of alternatives' characteristics is expressed in linguistic term by the decision makers. Moreover human judgment on qualitative attributes is always subjective and thus imprecise. For the sake of modeling this type of characteristics in case of human approach, fuzzy logic could be the best means.

There are many more operational tools for this type of analysis. Among those TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is applied to solve this type of multi-criteria problem. TOPSIS method is developed by Hwang and Yoon (1981) based on the concept that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution for solving a multi-criteria decision making problem. Briefly the positive ideal solution is made up of all the best values attainable of criteria, whereas the negative is composed of all worst values attainable of criteria.

The rest of the paper is organized as follows: Section 2 consists of briefly discussion on SME and fuzzy-TOPSIS. Methodology is discussed in section 3. Rest of the paper is comprised of calculation, result&

discussion and conclusion. There is also reference and appendix annexed at the last portion.

II. Fuzzy –Topsis

The fuzzy TOPSIS approach involves fuzzy assessments of criteria and alternatives in TOPSIS (Hwang and Yoon, 1981) [2]. The TOPSIS approach chooses alternative that is closest to the positive ideal solution and farthest from the negative ideal solution. A positive ideal solution is composed of the best performance values for each criterion whereas the negative ideal solution consists of the worst performance values. The various steps of fuzzy TOPSIS are presented as follows:

- *Step 1: Assignment of ratings to the criteria and the alternatives*

Let us assume there are J possible candidates called A = {A_1, A_2……. A_j} which are to evaluate against n criteria, C = {C_1, C_2…….C_i}. The criteria weights are denoted by w= (1, 2, 3,……m). The performance ratings of each decision maker D=(1,2,3……k) for each alternative A_j(j=1,2,3……n) with respect to criteria C_i(i=1,2,3……..m) are denoted by $R_k=X_{ijk}$(i=1,2,3…m; J=1,2,3…n; K=1,2,3……..k) with membership function $\mu_{rk}(x)$

- *Step 2 :* Compute aggregate fuzzy ratings for the criteria and the alternatives. If the fuzzy ratings of all decision makers is described as triangular fuzzy number $R_k=(a_k, b_k, c_k)$ K=1,2,3…….k; then the aggregated fuzzy rating is given by R=(a, b, c), K=1,2,3……k where

$$a=\min\{a_k\},\ b=\frac{1}{k}\sum_{k=1}^{k} b_k,\quad c=\max\{c_k\} \qquad (1)$$

If the fuzzy rating and importance weight of the k^{th} decision maker are $X_{ijk}=(a_{ijk},b_{ijk},cijk)$ and $Wi_{jk}=(w_{jk1},w_{jk2},w_{jk3})$; i=1,2,3…..m; j=1,2,3……n; respectively ,then the aggregated fuzzy ratings (X_{ij}) of alternatives with respect to each criteria are given by $X_{ji}=(a_{ij},b_{ij},c_{ij})$ where

$$a_{ij}=\min\{a_{ijk}\},\ b_{ij}=\frac{1}{k}\sum_{k=1}^{k} b_{ijk},\ ;\ c_{ij}=\max\{c_{ijk}\} \qquad (2)$$

The aggregated fuzzy weights (W_{ij}) of each criterion are calculated as $w_j=(w_{j1},w_{j2},w_{j3})$ where

$$W_{j1}=\min\{w_{jk1}\},\ b_{j2}=\frac{1}{k}\sum_{k=1}^{k} w_{jk2};\ w_{j3}=\max\{c_{jk3}\} \qquad (3)$$

- *Step 3 :* Compute the fuzzy decision matrix. The fuzzy decision matrix for the alternatives (D) and the criteria (W) is constructed as follows:

$$D=\begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad i=1, 2, 3…m;\ J=1, 2, 3…n;$$

W= (w_1, w_2, w_3……w_n)

- *Step 4 :* Normalize the fuzzy decision matrix. The raw data are normalized using linear scale transformation to bring the various criteria scales into a comparable scale. The normalized fuzzy decision matrix R is given by

$$R=[r_{ij}]_{mxn}\ i=1,2,3……m;\ j=1,2,3……..n$$

Where,

$$r_{ij}=\left(\frac{a_{ij}}{c_j^*},\frac{b_{ij}}{c_j^*},\frac{c_{ij}}{c_j^*}\right) \text{ and } c_j^*=\max c_{ij} \text{ (Benefit criteria)} \qquad (4)$$

$$r_{ij}=\left(\frac{a_j}{c_{ij}},\frac{a_j}{b_{ij}},\frac{a_j}{a_{ij}}\right) \text{ and } a_j=\min a_{ij} \text{ (cost criteria)} \qquad (5)$$

- *Step 5 :* Compute the weighted normalized matrix. The weighted normalized matrix V for criteria is computed by multiplying the weights (w_j) of evaluation criteria with the normalized fuzzy decision matrix.

$$v=[v_{ij}]_{mxn}\ ;\ i=1,2,3……..m;\ j=1,2,3……..n \text{ where } v_{ij}=r_{ij}(.)w_j \qquad (6)$$

$$A^*=(v^{1^*},v_2^*,v_3^*……..v_n^*) \text{ where } v^*_j=\max\{v_{ij3}\}\ ;\ i=1,2,3……..m;\ j=1,2,3…..n \qquad (7)$$

$$A=(v1,v2,v3……..v_n) \text{ where } v_j=\min\{v_{ij1}\};\ i=1,2,3……..m;\ j=1,2,3……..n \qquad (8)$$

- *Step 7 :* Compute the distance of each alternative from FPIS and FNIS. The distance (d_i^*, d_i^-) of each weighted alternative i=1, 2, 3……..m from the FPIS and the FNIS is computed as follows:

$$d^*_i=\sum_{j=1}^{n} d_v(v_{ij},v^*_j) \quad i=1,2,3……..m \qquad (9)$$

$$d^-_i=\sum_{j=1}^{n} d_v(v_{ij},v^-_j) \quad i=1,2,3……..m \qquad (10)$$

Where d_v (a, b) is the distance measurement between two fuzzy numbers a and b.

- *Step 8 :* Compute the closeness coefficient (CC_i) of each alternative. The closeness coefficient CC_i represents the distances to the fuzzy positive ideal solution (A^*) and the fuzzy negative ideal solution (A) simultaneously .The closeness coefficient of each alternative is calculated as

$$CC_i=\frac{dd_i}{d_i+d_i^*} \qquad i=1, 2, \qquad (11)$$

- *Step 9 :* Rank the alternatives. In step9, the different alternatives are ranked according to the closeness coefficient (CC_i) in decreasing order. The best alternative is closest to the FPIS and farthest from the FNIS.

III. Methodology

In order to identify the causes behind the production quality three SMEs were observed. Then some fundamental points were selected. The points were of two types: qualitative and quantitative. Even menial errors were tried to be overcome, so before taking the data they were checked and rechecked. There were some categorizations set for quantitative data analysis. Criteria weights are calculated as the triangular fuzzy numbers and then these fuzzy criteria weights are inserted to the fuzzy TOPSIS methodology to rank the alternatives.

The data were taken on the following points: Working space(in sq. ft.), light (in lumen), salary of workers, age of machines, cutting tool quality, maintenance of machines, waste disposal system, basement space, floor quality, welding rod, safety measures, handling equipment ,working conditions, amount of work per hour, amount of scrap material, quality of material used etc.

Then using fuzzy logic the qualitative and quantitative data analysis was performed.

The Process flow diagram is described below:

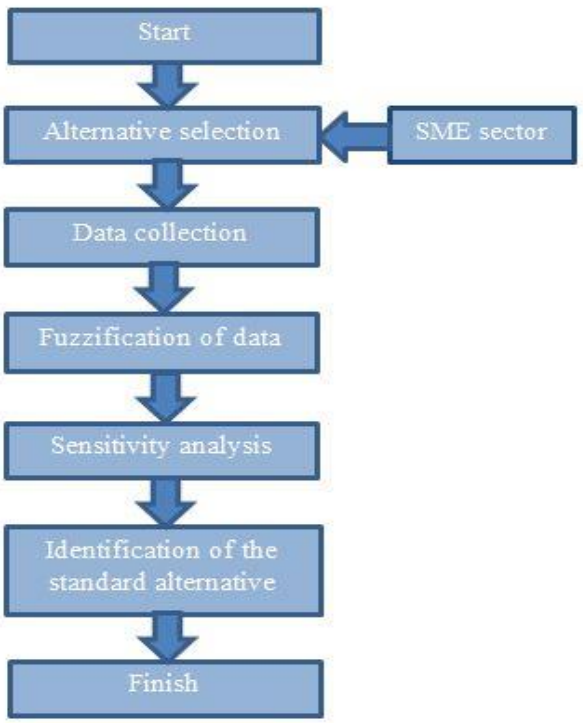

Figure 1 : process flow diagram of proposed methodology

Finding maximum (At table no.4)

Max=Max (Alternative1, Alternative 2, Alternative 3) [alternatives from table no. 3]

=Max (7, 9, 9, 3, 5, 7, 5, 7, 9)

=9

It is shown for the first element. Similarly others were calculated.

Finding minimum (At table no.4)

Min =Min (Alternative 1, Alternative 2, Alternative 3) [alternatives from table no. 3]

=Min (1, 3, 5, 1, 3, 5, 1, 3, 5)

=1

It is shown for the first element. Similarly others were calculated.

According to equation no. 4 normalized fuzzy was calculated represented in table 4.

For the Alternative 1;

a_{11}= 7/9 = 0.78

For the Alternative 2; (For Benefit Criteria)

a_{21}= 3/9 = 0.33

For the Alternative 3;

a_{31}= 5/9 = 0.56

It is shown for the first element. Similarly others were calculated.

According to equation no. 5

For Alternative 1;

a_{13}, 1= 1/5 =0.20

For Alternative 2; (For Cost criteria)

a_{13}, 2= 1/1 =1

For Alternative 3;

a_{13}, 3= 1/1 =1

It is shown for the first element. Similarly others were calculated.

At the Table no.5 the weighted normalized matrix was calculated from equation (6);

For alternative 1;

a_{11} =0.78*3=2.33

For alternative 2;

a_{21}=0.33*5=1.00

For alternative 3;

a_{31}=0.56*7=1.67

It is shown for the first element. Similarly others were calculated.

At the Table no.6

Fuzzy negative ideal solution (FNIS) was calculated by using equation (8).

Min (a_{11}) = Min (2.33, 5.00, 7.00, 1.00, 2.78, 5.44, 1.67, 3.89, 7.00)

=1.00;

It is shown for the first element. Similarly others were calculated.

The fuzzy positive ideal solution (FPIS) was Calculated by using equation (7).

Max (a_{11}) =Max (2.33, 5.00, 7.00, 1.00, 2.78, 5.44, 1.67, 3.89, 7.00)

=7.00;

It is shown for the first element. Similarly others were calculated.

The distance of each alternative from FPIS and FNIS was calculated using equation following equation.

$$d(a, b) = \sqrt{\frac{1}{3}[(a_1 - b_1)^2 + (a_1 - b_2)^2 + (a_1 - b_3)^2]} \quad (12)$$

For Alternative 1(D-), using equation 12.

$$d(a_{11}) = \sqrt{\frac{1}{3}[(1 - 2.33)^2 + (1 - 5)^2 + (1 - 7)^2]}$$

$$= \sqrt{17.93}$$

$$= 4.23$$

It is shown for the first element. Similarly others were calculated.

At table no.7

For Alternative 1(D+), using equation 12.

$$d(a_{11}) = \sqrt{\frac{1}{3}[(7 - 2.33)^2 + (7 - 5)^2 + (7 - 7)^2]}$$

$$= \sqrt{8.59}$$

$$= 2.93$$

It is shown for the first element. Similarly others were calculated.

At table no. 8

Calculation of the closeness coefficient (CC) of each alternative was performed by equation no. (11);

For Alternative 1 calculation of (cc); cc = 63.25/ (63.25+78.57) = 0.446 =44.60%.

It is shown for the first element. Similarly others were calculated.

IV. Result & Discussion

Table no. 8 shows the final result. There are three values for three alternatives. The alternative having highest value is the best, hereby standard among all. The analysis shows "alternative 1'' as the standard manufacturing SME (small and medium enterprise).So the best possible alternative is "alternative 1. It is said in previous section that, on qualitative characteristics human assessment is uncertain and often subjective so the alternative characteristics are expressed in linguistic terms. There were some characters tics which were qualitative, but due to simplicity they were also transferred to quantitative. And for the purpose of confidentiality the real name of the manufacturing SMEs were not disclosed.

V. Conclusion

For the selection of the best alternative the proposed method is a unique one. As the best is selected by the analysis then is can be said as standard. So changing the others comparing to it can make them well efficient in production. So drastically change is not needed for SMEs. The proposed method will help the SMEs to cope with the competition in the era of industrialization. To our knowledge no previous work investigated such a solution with TOPSIS and fuzzy analysis. As the proposed method is novel, it might be applied to other MADM problem.

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Appendix

Table 1 : Linguistic terms for performance variables

Linguistic term	Membership function
Very poor(VP)	(1,1,3)
Poor(P)	(1,3,5)
Fair(F)	(3,5,7)
Good(G)	(5,7,9)
Very Good(VG)	(7,9,9)

Table 2 : Data analysis

ID	Criteria	Definition	Alternative			
			1	2	3	criteri
V1	Working space	Space available for working.	(7,9,9)	(3,5,7)	(5,7,9)	B
V2	Light	Required brightness for working condition by electrical devices.	(3,5,7)	(7,9,9)	(5,7,9)	B
V3	Material quality	Level of material performance.	(7,9,9)	(3,5,7)	(3,5,7)	B
V4	Scrap material	Material that are useless after working.	(1,3,5)	(1,3,5)	(1,3,5)	C
V5	Waste disposal	An action process of waste disposing.	(7,9,9)	(7,9,9)	(7,9,9)	B
V6	Voltage of current	Available voltage from the power supply.	(1,3,5)	(1,3,5)	(3,5,7)	C
V7	Wire quality	Category of wire according to performance.	(5,7,9)	(3,5,7)	(3,5,7)	B
V8	Maintenance of machine	The process of maintaining of Machine.	(5,7,9)	(5,7,9)	(5,7,9)	B
V9	Gas welding quality	Distinctive attribute of gas welding	(1,3,5)	(1,3,5)	(1,1,3)	B
V10	Basement space of machine	Available space for the machine holding in basement	(1,3,5)	(1,3,5)	(1,3,5)	C
V11	Cutting fluid quality	The standard of cutting fluid against similar kind	(1,3,5)	(5,7,9)	(1,1,3)	B
V12	Output/hour	Amount of production hourly(kg)	(1,3,5)	(3,5,7)	(5,7,9)	B
V13	No. of worker	Quantity of worker appointed in working	(3,5,7)	(5,7,9)	(3,5,7)	C
V14	Temperature	The degree or intensity of heat present in working condition	(5,7,9)	(7,9,9)	(3,5,7)	C
V15	Worker's experience	Skill of worker	(3,5,7)	(1,3,5)	(5,7,9)	B
V16	Working environment	Conditions in which a worker operates machines	(1,1,3)	(3,5,7)	(1,1,3)	B
V17	Floor quality	Lower surface of the working room	(3,5,7)	(3,5,7)	(3,5,7)	B
V18	Welding rod	Distinctive attribute of welding rod	(3,5,7)	(3,5,7)	(3,5,7)	C
V19	Safety measure	Equipment that ensure safety like Googols, apron, Hand gloves, cades.	(1,1,3)	(1,3,5)	(1,1,3)	C
V20	Handling equipment	The equipment used for lifting, holding.	(1,1,3)	(1,1,3)	(1,1,3)	C
V21	Lubricant quality	Distinguishing performance level of lubricant used.	(5,7,9)	(5,7,9)	(5,7,9)	C
V22	Salary of worker	Payment of worker	(1,1,3)	(1,3,5)	(3,5,7)	C
V23	Age of machine	Length of time machine has been worked	(3,5,7)	(3,5,7)	(1,1,3)	C
V24	Belt quality	Categorization of belt basis of performance	(3,5,7)	(5,7,9)	(1,3,5)	C

*B is for Benefit criteria.

*C is for cost criteria.

Table 3 : Fuzzy direct matrices for alternatives

Weightage			Alternative 1			Alternative 2			Alternative 3		
3	5	7	7	9	9	3	5	7	5	7	9
7	9	9	3	5	7	7	9	9	5	7	9
5	7	9	7	9	9	3	5	7	3	5	7
5	7	9	7	9	9	7	9	9	7	9	9
3	5	7	5	7	9	3	5	7	3	5	7
5	7	9	5	7	9	5	7	9	5	7	9
3	5	7	1	3	5	1	1	3	1	1	3
3	5	7	1	3	5	5	7	9	1	1	3
5	7	9	1	3	5	3	5	7	5	7	9
5	7	9	3	5	7	1	3	5	5	7	9
7	9	9	1	1	3	3	5	7	1	1	3
3	5	7	3	5	7	3	5	7	3	5	7
5	7	9	1	3	5	1	3	5	1	3	5
3	5	7	1	3	5	1	3	5	3	5	7
3	5	7	1	3	5	1	3	5	1	3	5
5	7	9	3	5	7	5	7	9	3	5	7
3	5	7	5	7	9	7	9	9	3	5	7
3	5	7	3	5	7	3	5	7	3	5	7
7	9	9	1	1	3	1	3	5	1	1	3
5	7	9	1	1	3	1	1	3	1	1	3
3	5	7	5	7	9	5	7	9	5	7	9
7	9	9	1	1	3	1	3	5	3	5	7
5	7	9	3	5	7	3	5	7	1	1	3
3	5	7	3	5	7	5	7	9	1	3	5

Table 4 : Fuzzy normalized matrix for alternatives

	Normalized Fuzzy								
Max/Min	Alternative 1			Alternative 2			Alternative 3		
9	0.78	1.00	1.00	0.33	0.56	0.78	0.56	0.78	1.00
9	0.33	0.56	0.78	0.78	1.00	1.00	0.56	0.78	1.00
9	0.78	1.00	1.00	0.33	0.56	0.78	0.33	0.56	0.78
9	0.78	1.00	1.00	0.78	1.00	1.00	0.78	1.00	1.00
9	0.56	0.78	1.00	0.33	0.56	0.78	0.33	0.56	0.78
9	0.56	0.78	1.00	0.56	0.78	1.00	0.56	0.78	1.00
5	0.20	0.60	1.00	0.20	0.20	0.60	0.20	0.20	0.60
9	0.11	0.33	0.56	0.56	0.78	1.00	0.11	0.11	0.33
9	0.11	0.33	0.56	0.33	0.56	0.78	0.56	0.78	1.00
9	0.33	0.56	0.78	0.11	0.33	0.56	0.56	0.78	1.00
7	0.14	0.14	0.43	0.43	0.71	1.00	0.14	0.14	0.43
7	0.43	0.71	1.00	0.43	0.71	1.00	0.43	0.71	1.00
1	1.00	0.33	0.20	1.00	0.33	0.20	1.00	0.33	0.20
1	1.00	0.33	0.20	1.00	0.33	0.20	0.33	0.20	0.14
1	1.00	0.33	0.20	1.00	0.33	0.20	1.00	0.33	0.20
3	1.00	0.60	0.43	0.60	0.43	0.33	1.00	0.60	0.43
3	0.60	0.43	0.33	0.43	0.33	0.33	1.00	0.60	0.43
3	1.00	0.60	0.43	1.00	0.60	0.43	1.00	0.60	0.43
1	1.00	1.00	0.33	1.00	0.33	0.20	1.00	1.00	0.33
1	1.00	1.00	0.33	1.00	1.00	0.33	1.00	1.00	0.33

5	1.00	0.71	0.56	1.00	0.71	0.56	1.00	0.71	0.56
1	1.00	1.00	0.33	1.00	0.33	0.20	0.33	0.20	0.14
1	0.33	0.20	0.14	0.33	0.20	0.14	1.00	1.00	0.33
1	0.33	0.20	0.14	0.20	0.14	0.11	1.00	0.33	0.20

Table 5 : Weighted matrices for alternatives

Weighted Fuzzy								
Alternative 1			Alternative 2			Alternative 3		
2.33	5.00	7.00	1.00	2.78	5.44	1.67	3.89	7.00
2.33	5.00	7.00	5.44	9.00	9.00	3.89	7.00	9.00
3.89	7.00	9.00	1.67	3.89	7.00	1.67	3.89	7.00
3.89	7.00	9.00	3.89	7.00	9.00	3.89	7.00	9.00
1.67	3.89	7.00	1.00	2.78	5.44	1.00	2.78	5.44
2.78	5.44	9.00	2.78	5.44	9.00	2.78	5.44	9.00
0.60	3.00	7.00	0.60	1.00	4.20	0.60	1.00	4.20
0.33	1.67	3.89	1.67	3.89	7.00	0.33	0.56	2.33
0.56	2.33	5.00	1.67	3.89	7.00	2.78	5.44	9.00
1.67	3.89	7.00	0.56	2.33	5.00	2.78	5.44	9.00
1.00	1.29	3.86	3.00	6.43	9.00	1.00	1.29	3.86
1.29	3.57	7.00	1.29	3.57	7.00	1.29	3.57	7.00
5.00	2.33	1.80	5.00	2.33	1.80	5.00	2.33	1.80
3.00	1.67	1.40	3.00	1.67	1.40	1.00	1.00	1.00
3.00	1.67	1.40	3.00	1.67	1.40	3.00	1.67	1.40
5.00	4.20	3.86	3.00	3.00	3.00	5.00	4.20	3.86
1.80	2.14	2.33	1.29	1.67	2.33	3.00	3.00	3.00
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
7.00	9.00	3.00	7.00	3.00	1.80	7.00	9.00	3.00
5.00	7.00	3.00	5.00	7.00	3.00	5.00	7.00	3.00
3.00	3.57	3.89	3.00	3.57	3.89	3.00	3.57	3.89
7.00	9.00	3.00	7.00	3.00	1.80	2.33	1.80	1.29
1.67	1.40	1.29	1.67	1.40	1.29	5.00	7.00	3.00
1.00	1.00	1.00	0.60	0.71	0.78	3.00	1.67	1.40

Table 6 : Negative distances of alternatives

FNIS	FPIS	D-					
MIN	MAX	Alternative 1		Alternative 2		Alternative 3	
1.00	7.00	17.93	4.23	7.64	2.76	14.93	3.86
2.33	9.00	9.63	3.10	32.86	5.73	22.88	4.78
1.67	9.00	29.05	5.39	11.13	3.34	11.13	3.34
3.89	9.00	11.93	3.45	11.93	3.45	11.93	3.45
1.00	7.00	14.93	3.86	7.64	2.76	7.64	2.76
2.78	9.00	15.28	3.91	15.28	3.91	15.28	3.91
0.60	7.00	15.57	3.95	4.37	2.09	4.37	2.09
0.33	7.00	4.81	2.19	19.62	4.43	1.35	1.16
0.56	9.00	7.64	2.76	17.96	4.24	33.38	5.78
0.56	9.00	17.96	4.24	7.64	2.76	33.38	5.78
1.00	9.00	2.75	1.66	32.49	5.70	2.75	1.66
1.29	7.00	12.63	3.55	12.63	3.55	12.63	3.55
1.80	5.00	3.51	1.87	3.51	1.87	3.51	1.87
1.00	3.00	1.53	1.24	1.53	1.24	0.00	0.00
1.40	3.00	0.88	0.94	0.88	0.94	0.88	0.94

3.00	5.00	2.06	1.43	0.00	0.00	2.06	1.43
1.29	3.00	0.70	0.84	0.41	0.64	2.94	1.71
3.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00
1.80	9.00	26.77	5.17	9.49	3.08	26.77	5.17
3.00	7.00	6.67	2.58	6.67	2.58	6.67	2.58
3.00	3.89	0.37	0.61	0.37	0.61	0.37	0.61
1.29	9.00	31.70	5.63	11.95	3.46	0.45	0.67
1.29	7.00	0.05	0.23	0.05	0.23	16.46	4.06
0.60	3.00	0.16	0.40	0.01	0.12	2.51	1.59
			63.25		59.51		62.77

Table 7 : Positive distances of alternatives

D+					
Alternative 1		Alternative 2		Alternative 3	
8.59	2.93	18.75	4.33	12.71	3.56
21.48	4.63	4.21	2.05	10.04	3.17
10.04	3.17	27.97	5.29	27.97	5.29
10.04	3.17	10.04	3.17	10.04	3.17
12.71	3.56	18.75	4.33	18.75	4.33
17.12	4.14	17.12	4.14	17.12	4.14
18.99	4.36	28.27	5.32	28.27	5.32
27.52	5.25	12.71	3.56	35.92	5.99
43.92	6.63	27.97	5.29	17.12	4.14
27.97	5.29	43.92	6.63	17.12	4.14
49.99	7.07	14.20	3.77	49.99	7.07
14.80	3.85	14.80	3.85	14.80	3.85
5.78	2.40	5.78	2.40	5.78	2.40
1.45	1.20	1.45	1.20	4.00	2.00
1.45	1.20	1.45	1.20	1.45	1.20
0.65	0.81	4.00	2.00	0.65	0.81
0.87	0.93	1.72	1.31	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00
13.33	3.65	30.61	5.53	13.33	3.65
6.67	2.58	6.67	2.58	6.67	2.58
0.30	0.54	0.30	0.54	0.30	0.54
13.33	3.65	30.61	5.53	51.93	7.21
30.82	5.55	30.82	5.55	6.67	2.58
4.00	2.00	5.31	2.30	1.45	1.20
	78.57		**81.89**		**78.34**

Table 8 : Final performance of alternatives

	CC		
	Alternative 1	Alternative 2	Alternative 3
	0.45	0.42	0.44
Percentage=	**44.60**	**42.09**	**44.48**

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Technological Applications of the New Theory of Dynamic Interactions

By Gabriel Barceló

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The method utilized in the development of this theory, and its applications, consists of a scientific analysis of the dynamic fields that are generated in bodies subjected to simultaneous non-coaxial rotations.

The results obtained in the development of this dynamic theory allow an innovative approach to significant scientific and technological applications, for example, in orbital dynamics, orbit determination, and orbit control.

As a conclusion, under the Theory of Dynamic Interactions various new assumptions have been elaborated based on the analysis of inertial fields generated. A new criteria has been found applicable in the understanding of the coupling of velocity fields. The innovative dynamic theory that has been developed, based on new concepts such as rotational inertia or field's coupling, has numerous technological applications in accelerated rotation systems.

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Technological Applications of the New Theory of Dynamic Interactions

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I. Theoretical Background

We have been involved in a research project on the behaviour of bodies with intrinsic angular momentum[1], when are exposed to new rotational non-coaxial accelerations. As a result of this investigation, we have proposed a new theory in order to explain the dynamic behaviour of these bodies, insisting in the need of extending our studies on non-Newtonian dynamics.

On the analysis of the fields generated within rigid solid bodies equipped with rotational movement, it is necessary to take into account inertial reactions. We understand to date that the inertial behaviour of the rigid body mass, when exposed to these rotational accelerations, has not been studied sufficiently.

It is possible to find new fields of research in new rotational dynamics of non-inertial systems. The foundations of rotational dynamics might be relevant to unsolved significant problems in physics.

Systems in the universe are in motion, in constant dynamic equilibrium. In the real universe, the general dynamic behaviour of rigid solids is characterized by its dynamic equilibrium. Through time, orbitation coexists with the intrinsic rotation. This aporia, and also the professor Miguel A. Catalán conjectures[2] were our initial speculation.[3]

We conducted experimental tests that confirmed our hypothesis. These tests were video recorded and can be accessed in different Internet portals[4]. Additional experimental tests have been carried out by other investigators. These other tests and experiments have been published[5] and also video recorded. The video with this other evidence can be accessed online[6].

As a result of all these tests, we arrived the following conclusion*: These experimental references, and many others which can be suggested, infer the existence of a different non-Newtonian rotational dynamics, which is necessary for identifying the behaviour of rotating bodies, when they are exposed to new non-coaxial stimulations, and the behaviour of which is nowadays often interpreted as anomalous, paradoxical or chaotic, as the laws at our disposal do not allow to identify and predetermine it. [7]*

II. Motion Equation

On the basis of the principle of conservation of motion[8], we have obtained the motion equation which is described in other texts[9].This motion equation finally can be written:

$$\vec{v} = \vec{\vec{\Psi}}\ \vec{V}_0 = \begin{pmatrix} \cos M' t/ I\omega & -sen\, M' t/ I\omega & 0 \\ sen\, M' t/I\omega & \cos M' t/I\omega & 0 \\ 0 & 0 & 1 \end{pmatrix} \vec{V}_0 . \qquad (1)$$

In a single rotation, the rotational operator $\vec{\vec{\Psi}}$ *transforms the initial velocity* $\vec{V}_0$ *into the velocity* $\vec{v}$ *, both situated in the same plane. We find that the rotational operator* $\vec{\vec{\Psi}}$ *is a function of sine or cosine of* $\vec{\Omega}$ *t, which clearly indicates the relation between the angular velocity* $\vec{\Omega}$ *of the orbit and the torque* M′ *and the initial angular velocity* $\vec{\omega}$ *Thus, I have derived a simple mathematical*

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relation between the angular velocity $\vec{\omega}$ *of the body and its translational velocity* $\vec{v}$ *. Equation (1) is a general equation of motion for bodies with angular momentum that are subjected to successive non coaxial torques. For this equation, the rotational operator* $\vec{\Psi}$ *serves as a matrix that transforms the initial velocity, by means of rotation, into the velocity that corresponds to each successive dynamic state*[10].

Based on this principle of conservation of motion, and establishing certain axioms, we obtain the equation of motion referred to bodies subjected to simultaneous non-coaxial rotations. This equation and the aforementioned axioms give rise to a series of laws for dynamic behavior of bodies under these assumptions rotational accelerations.

III. Field Analysis

By analyzing the dynamic fields created, we deduced that does not apply the discriminating Poinsot hypothesis[11], admitted in classical mechanics, which supposes that the angular momentums were coupled between each other and separate from the linear dynamic momentums. For example, in case that the body has a translational velocity $\vec{v}$ *, we propose a new dynamic hypothesis which states that the field of translation speeds couples to the anisotropic field of inertial speeds generated by the second non-coaxial momentum acting, forcing that the center of masses of the mobile modifies its path, without an external force having being applied in this direction*[12]. As such, we obtain an orbiting movement, which is simultaneous with the constant intrinsic rotation of the moving body $\vec{\omega}$.

We can observe in nature many examples of bodies which behave according to the equation of motion. For example, in the case of a coin rolling on a flat surface, one can observe that a non-homogeneous field of speeds is generated as a result of the overturn momentum created by the weight and the fulcrum: when falling, the variations of the non-homogeneous field of speeds also generate an anisotropic field of accelerations, which we can be identified by the inertial forces that are generated (Figure 1). The figure shows the drop velocities distribution generated in the perimeter of the coin. But it has to be stressed that, according to the proposed theory, the non-homogeneous field of speeds couples to the field of translation speeds, generating a new trajectory of the mass centre.

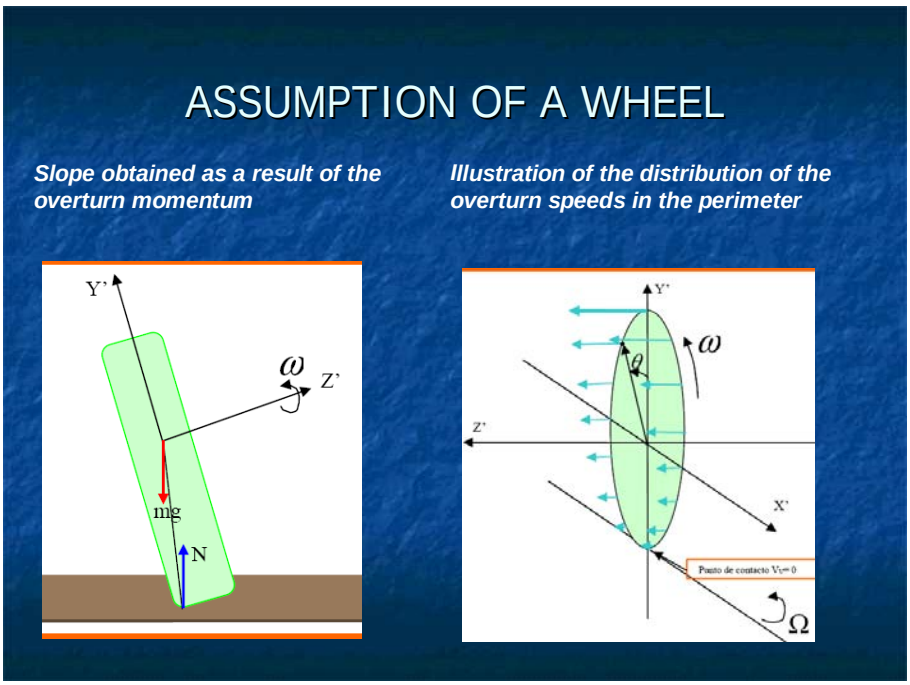

Figure 1 : Example of the dynamic behaviour of a wheel turns

This example can be applied to many other cases, like the hoop or the wheel. Also occurs in the case of balls with spin effect. In sports where balls are used, this phenomenon can be observed when the ball acquires an intrinsic rotation: the ball takes a curved path and fails to maintain its linear path. In these cases, in our opinion, non-homogenous speed and acceleration distributions are generated, which can be represented in a section of the mobile body. In the assumption of a football with intrinsic rotation, when being kicked eccentrically, a new non-coaxial momentum with the existent rotation can be generated, the speeds' distribution of which couples, according to our

hypotheses, to the field of transfer speeds, causing a curvilinear trajectory (Figure 2).

The figure 2 shows as it generates a homogeneous distribution of velocities and accelerations in a section of the ball, with rotation, transforming its linear path in another orbital.

In our opinion, the curvilinear trajectory of the ball is not caused by aerodynamic Magnus effect, however, and according to the *Theory of Dynamic Interactions*, the real cause is the coupling of dynamic fields that occur. In this way the ball can change its trajectory, without an external force. It is only necessary that the ball has intrinsic rotation and be subjected to a new torque that is not coaxial with intrinsic rotation.

Another example of the theory is the feared Roll Coupling of the planes. It happens when a plane, which is flying a screw or any other kind of air acrobatics which implies, for example, a turn around its main inertia axe, starts a new steering manoeuvre with curved trajectory.

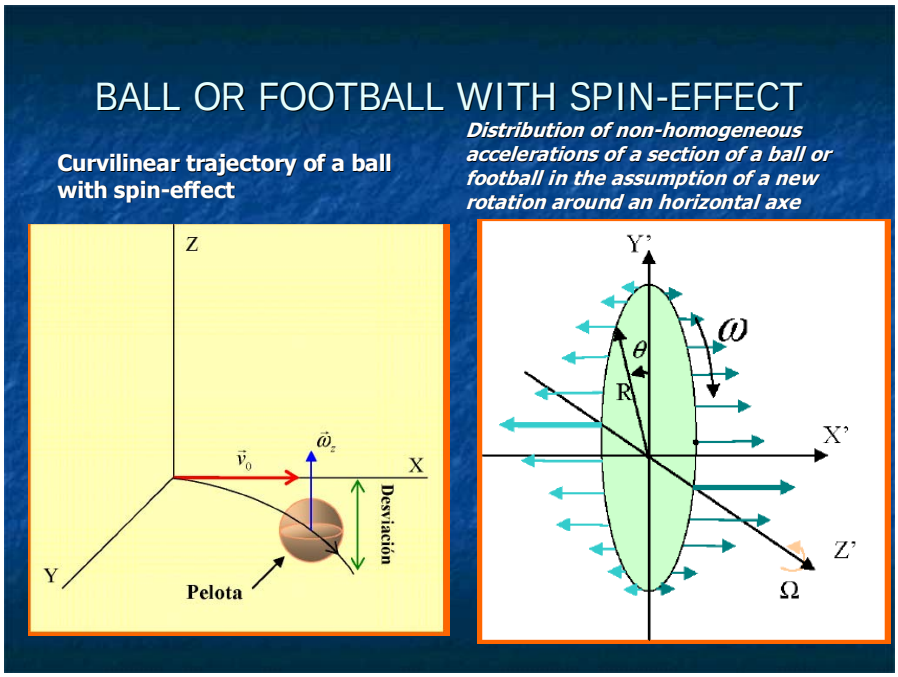

Figure 2 : Example of the dynamic behaviour of a rotating ball

It is also another example of the theory the feared Roll Coupling of the planes. This occurs when an aircraft is flying a screw or any other type of aerial acrobatics involving, for example, a rotation about its principal axis of inertia, if its begins a new steering maneuver with curved path. In this case, the pilot can lose control of the plane.

Again we can apply the proposed dynamic hypothesis. Thus, the inhomogeneous distribution of resultant speeds generated by the new rotation around a new non-coaxial axis, couples with the field of transfer speed, causing an unintentional deflection of the trajectory, as well as a possible loss of control of the aircraft.

The figure 3 shows the inhomogeneous distribution of velocities generated in the new rotation of the plane. In our opinion, the *Theory of Dynamic Interactions* can justify the dynamic behavior of many other examples.

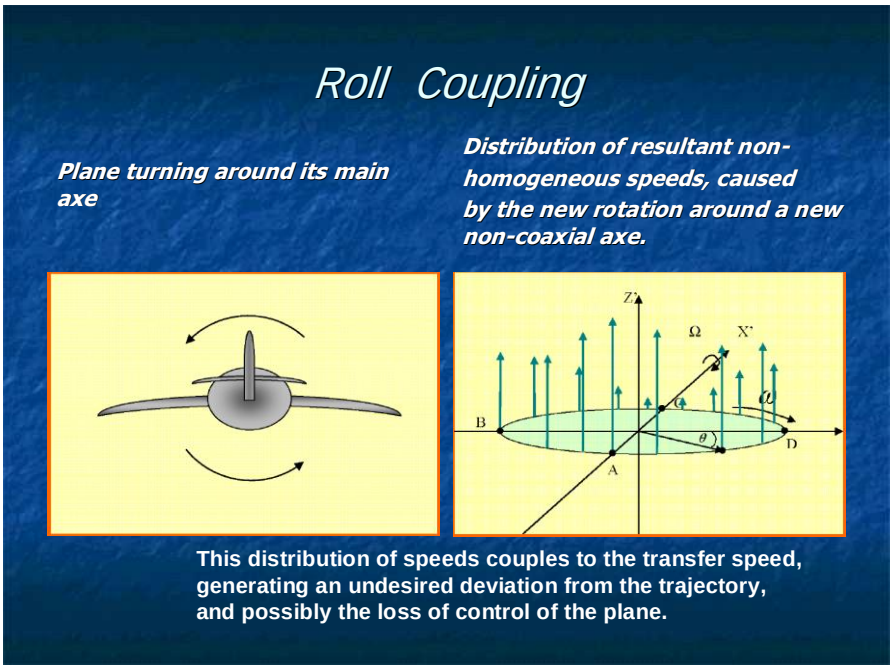

Figure 3 : Dynamic analysis of roll coupling in Planes

IV. Mathematical Model

This new rotational dynamics develops a mathematical model, from which we have performed simulations of dynamic behavior through computer.

This model incorporates inertial phenomena within a unified structure of a new rotational dynamics. Its backgrounds and fundamentals have already been exposed in a book[13]. This text is an essay on physics, which incorporates a portion of "inquisitive thinking". The work concentrates on the dynamics of rotations. It starts describing the main milestones in the evolution of scientific concepts which deal with, or are related to, the study of rotations. It then presents the historical evolution of the theories of the rotational dynamics and continues with a critical analysis of the different formulations of these problems during the consecutive development stages of what we usually call *rational mechanics*. In these two parts the peculiar nature of the dynamics of rotations is focused on, which certainly shows peculiar behaviours, not always coinciding with ordinary intuition, or even not always well understood.

The final part of the book is an essay which presents an alternative proposal invoking the freedom of "inquisitive thinking". This essay contains proposals of new dynamic hypotheses which would allow something like an "imaginary nature", as a suggestion of a new path for interpreting nature from a new point of view, for what could be interpreted as the keys for a new physics.

This proposal of "*imaginary nature",* has led to a new physical theory in the course of time, once the initial dynamic hypotheses were sufficiently checked by means of experimental tests, and once the designed computer simulation model qualitatively coincided with numerous examples in nature. This was the way how the *Theory of Dynamic Interactions* was designed, which helps us to understand the cosmos in constant dynamic equilibrium; in a universe in which the celestial bodies simultaneously rotate on its axis and orbit.

V. Simulation Models

Simulation studies have been carried out, obtaining traces equivalent to the trajectories of real bodies in space, open or closed. We can compare results and confirm this similarity, as for the case of the boomerang, or the dynamics of the galaxies (Figure 4). Hence we can propose that, in the assumption of dynamic systems in which simultaneous movements of intrinsic rotation and orbitation can be observed, one can infer the possibility of the existence of *dynamic interactions* and a mathematical model composed of that new and simple motion equation (1).

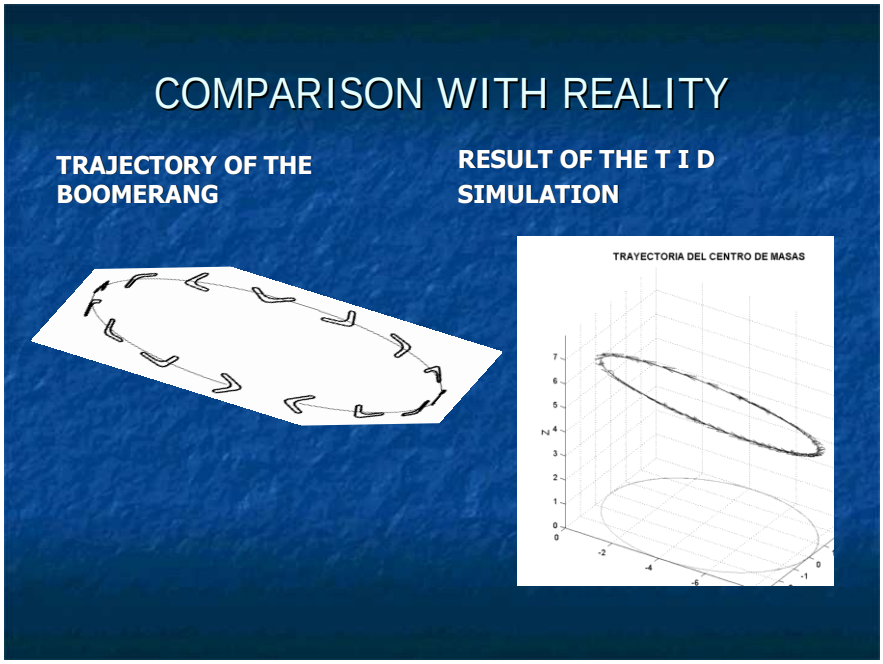

Figure 4 : Comparison between the flight trajectory of a boomerang and the path obtained by computer simulation model

The proposed theory generalizes dynamics concepts which remained unstructured within the classical mechanics. Apart from allowing us a better understanding of the equilibrium of the universe, it makes it possible to conceive the dynamics of the galaxies, and to explain the ecliptic or the rings of Saturn. According to the tenth law proposed in chapter eleven of the book, and its third corollary, the vectors of the speed and of the acting momentum determine a plane, which has to contain the described orbits. So we deduce that the rings may respond to the effect of a constant external momentum, within the scope of this theory.

Through multiple experiments the text proves the supported hypotheses of rotational dynamics of the theory, and proposes numerous behaviours as tangible examples of the theory, arguing that the laws of classical mechanics, fully valid and tested, exclusively refer to assumptions of translation movements in inertial systems, non-accelerated, when in the universe and in nature the movement occurs with accelerations, especially in the assumptions of rotational dynamics.

The theory also allows to give an answer to an initial aporia: allows us to be aware and come to understand the *physical and mathematical correlation between orbitation and intrinsic rotation,* and therefore, the rational casualty that we have day and night on earth, as our theory reflects a clear correlation between the intrinsic turn of earth and the route within its orbit.

VI. Technological Applications

There are numerous possible technological applications, especially in orbital dynamics, orbit determination and orbit control; one application would be to be able to calculate the trajectory of any solid in space, with intrinsic angular momentum.

Within the technological scope, the theory allows to propos a new steering system independent from a rudder or any other external element. Also, many innovating hypotheses, as for example the analysis of internal strains in moving bodies, due to internal efforts. The concept of dynamic coupling suggests the possibility of performing a power conversion between the terms coupled and in both directions. We can assume that the rotational kinetic energy can be converted into translational kinetic energy, or vice versa, which leads, for example, to conceive the concept of dynamic lever.

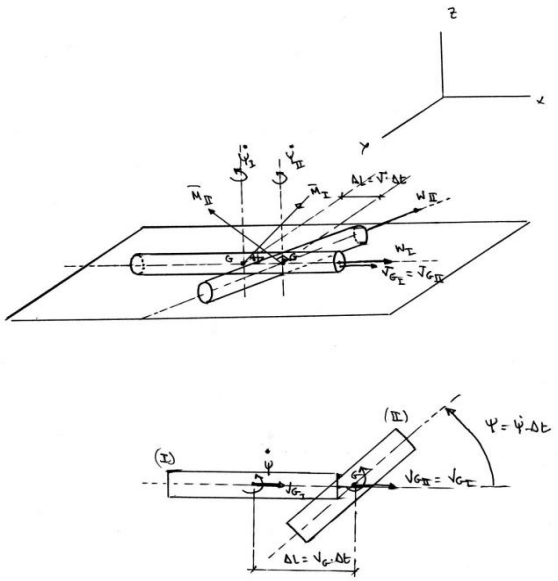

Figure 5 : Coupling speed of a body, in space with translational velocity V_G, with angular momentum about its vertical axis, and subjected to an external no-coaxial torque

As a result, one application would be a *dynamic lever* with technological uses and practical effects. This *dynamic lever* would allow to design mechanisms in which the result of its action could be obtained without any energy consumption, thus the provided energy being recoverable. As the example, in Figure 5 shows the dynamic lever can be applied in a dynamic rocket catapult.

The pitcher would have as its primary mission to give to the aircraft or rocket the initial thrust to overcome the attractive field, reducing the amount of fuel carried. The launching mechanism would consist of a fixed structure and tractor train supported on earth. Using an electromagnetic system, the spacecraft levitates with its longitudinal axis parallel to the ground. This initially is submitted to pairs of action and would generate a rotational movement about its longitudinal axis. Finding the rocket in the catapult rotating and with magnetic levitation will be subject to a strong initial impetus, imposed by the recoverable drive train. The aircraft, powered with the initial velocity in the direction of its longitudinal axis, is subject to a new electromagnetic torque, in this case a vertical axis perpendicular to the initial (Figure 5).

The action of a second torque, electromagnetic or mechanical, will maintain the time required for the rocket to initiate a curved path, describing a circumference arc (Figure 6). This trend will continue until it turns its longitudinal axis 90 °.In this way, the mobile has changed its relative position in 90 °, remaining standing with its longitudinal axis perpendicular to the ground.

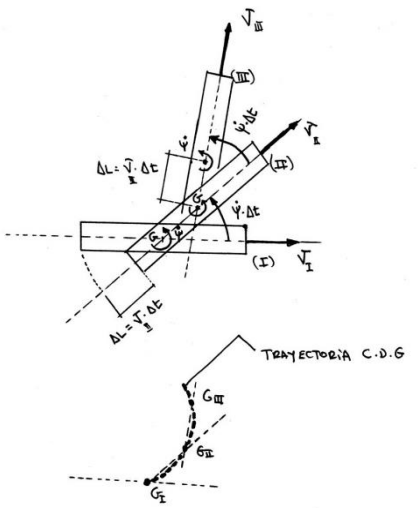

Figure 6 : The position of the center of mass varies depending on the coupling between the field of the linear velocity and the velocity field caused by the non-coaxial torque

Through this system, the mobile will have reached an initial boost due to the effect of Dynamic Lever, proportional to its rotational speed, to its moment of inertia, and the final pair received. This initial momentum will allow you to overcome the gravitational pull, and rise, using their own engines only to maintain the initial velocity. The system will allow significant energy savings. There is no necessary to carry the fuel needed to overcome the gravitational field.

Apart from designing a dynamic lever or energy conservation devices, this theory gives way to applications in the steering of mobiles in space, e.g. aircrafts, ships or submarines. A dynamic steering system for navigating a craft, comprising means to provide within the vessel with an intrinsic rotational movement around a principal axis of inertia of the craft. This is characterized by the fact that it also comprises a device for displacing the relative position of the centre of gravity of the craft, along a path that is substantially parallel to said principal axis of inertia. So that, the vessel is provided with angular momentum, that is substantially orthogonal to said principal axis of inertia, whereby it is induced to follow a curvilinear path. The dynamic steering applicable for vessels government proposed replaces traditional rudder by incorporating dynamic device.

The technological development of this theory allows also, in our opinion, the determination of the devastating effect of hurricanes. The theory will be applicable for predictions and control of dynamic systems which nowadays might be understood as chaotic, but the trajectories and behaviour of which can be determined with the Theory of Dynamic Interactions.

VII. Conclusions

We have developed a new dynamic theory applicable to accelerated rotation systems, based on new concepts such as rotational inertia or field's coupling. Various assumptions have been elaborated based on the analysis of the inertial field's generated and new criteria on the coupling of these velocity fields.

Our hypotheses have been confirmed by experimental tests made by ourselves and by independent third parties. A clear correlation between the initial speculations, the starting hypotheses, the mathematical simulation model, the deduced behaviour laws, the realized experimental tests and the mathematical model corresponding to the movement equations resultant of the proposed dynamic laws, has been obtained.[14]

The results obtained allow us to propose a new vision of the dynamics, based on the analysis fields for bodies subjected to rotational accelerations.

To end, we can remember Isaac Newton: *We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances*[15].

Anyone interested in cooperating with this independent investigation project is invited to ask for additional information from Advanced Dynamics S.A. or to look up at www.advanceddynamics.net

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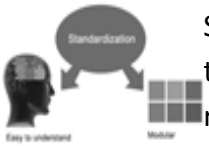

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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