PROJECT MANAGEMENT PLAN FOR HYBRID AND ELECTRIC CAR PROTOTYPES DEVELOPMENT

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Abstract

This article presents a proposal for a project management plan for a two-seater vehicle development with two engines (electric and hybrid). The automobile industry innovates by novel projects for electric, hybrid, and/or green hydrogen-powered vehicles. In this scenario, the project management area has in the PMBOK Guide (PMI) one of the options to help, with several practices and different approaches, to increase the chance of project success and, consequently, the return on investment and increase the competitiveness of the automobile industry. This proposal aims to contribute to the development of vehicle prototypes that reduce pollution levels and fuel consumption.

Keywords: Automotive Industry, Project Management, Product Development, Electric Car.

PROPOSTA DE PLANO DE GERENCIAMENTO DE PROJETO PARA DESENVOLVIMENTO DE PROTÓTIPOS DE CARRO ELÉTRICO E HÍBRIDO.

Resumo

O presente artigo traz uma proposta de plano de gerenciamento de projeto para o desenvolvimento de um veículo de dois lugares com duas motorizações (elétrico e híbrido). A indústria automobilística tem buscado inovar constantemente através de novos projetos de desenvolvimentos de veículos elétricos, híbridos e / ou movidos a hidrogênio verde, em um contexto de alta competitividade. Nesse cenário, o gerenciamento de projetos tem no Guia PMBOK (PMI) uma das opções para auxiliar, com diversas práticas e diferentes abordagens aplicadas, para aumentar a chance de sucesso dos projetos e, consequentemente, o retorno do investimento e aumento da competitividade da indústria automobilística. Busca-se com esta proposta contribuir, para benefício futuro com a sua implementação, para o desenvolvimento de protótipos de veículos que impactem na redução dos níveis de poluição e de consumo de combustíveis.

Palavras-chave: Indústria Automobilística, Gestão de Projetos, Desenvolvimento de Produto, Carro Elétrico.

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1. INTRODUCTION

The national automotive industry has been challenged to increase the business environment and improve our competitiveness due to mitigating CO2 emissions. Most sources of greenhouse gas emissions come from cars [1].

Based on this competitive scenario, the main numbers of the automotive industry in Brazil [2] have reported a growing fleet of electric vehicles observed in the licensing of new vehicles since 2003..

Table 1. Registration of new vehicles by fuel type – from 2003 to 2020

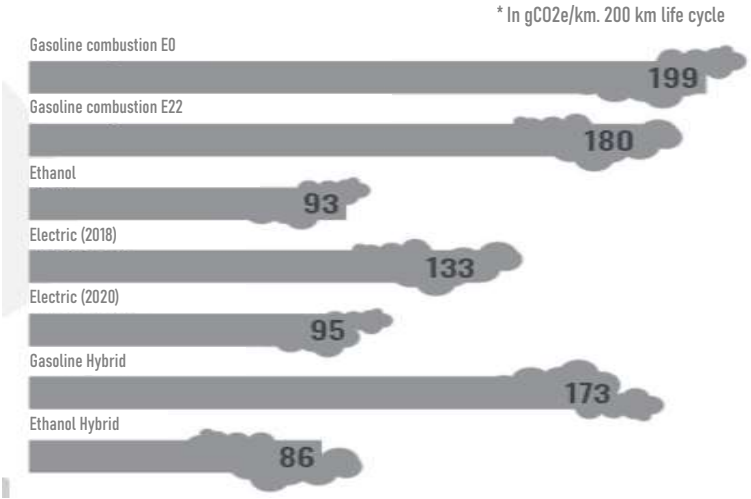
Unidades / *Units*

ANO *Year*	AUTOMÓVEIS *Cars*					COMERCIAIS LEVES *Light Commercials*				
	GASOLINA *Gasoline*	ETANOL *Ethanol*	FLEX FUEL *Flex Fuel*	ELÉTRICO *Eletric*	DIESEL *Diesel*	GASOLINA *Gasoline*	ETANOL *Ethanol*	FLEX FUEL *Flex Fuel*	ELÉTRICO *Eletric*	DIESEL *Diesel*
2003	1.046.474	33.034	39.095	-	-	105.989	3.346	9.083	-	54.729
2004	967.235	49.801	278.764	-	-	110.710	1.149	49.615	-	66.247
2005	646.659	30.904	752.597	-	9.662	50.347	1.453	59.507	-	68.713
2006	283.240	1.651	1.334.342	1	13.713	33.319	212	95.992	2	69.813
2007	233.440	90	1.834.259	2	17.915	12.211	17	168.821	1	74.467
2008	206.815	70	2.113.289	8	21.122	10.201	14	215.962	1	103.711
2009	210.281	61	2.416.111	21	17.388	11.407	9	236.187	1	117.401
2010	264.330	44	2.570.578	24	21.564	16.347	6	305.595	5	150.536
2011	350.848	44	2.524.402	200	26.153	25.956	7	323.669	-	174.552
2012	258.950	46	2.834.334	117	21.776	14.965	6	328.488	-	175.501
2013	182.046	29	2.833.091	484	25.133	7.063	5	335.989	7	196.049
2014	180.561	10	2.588.367	842	24.907	4.280	4	352.127	13	182.372
2015	133.922	13	1.959.868	843	28.363	2.228	3	234.136	3	121.153
2016	79.490	12	1.572.798	1.085	34.904	1.005	4	177.934	6	121.358
2017	68.144	26	1.739.014	3.278	46.118	758	4	188.177	18	130.447
2018	81.493	20	1.969.672	3.965	46.964	442	1	198.480	5	174.296
2019	73.425	26	2.123.841	11.844	52.933	429	2	204.780	14	198.289
2020	58.330	18	1.490.480	19.687	47.427	600	3	174.498	58	163.727

FONTES / *SOURCES:* ABEIFA, ANFAVEA. NOTAS / *NOTES:* 1. Em comerciais leves, na coluna Gasolina, estão incluídas 85 unidades movidas a eletricidade produzidas e vendidas no período 1981-1985. *In light commercials, the column Gasoline includes 85 battery- powered units produced and sold between 1981-1985.* 2. Os dados de caminhões e ônibus a partir de 2005 não estão disponíveis por combustíveis. Os volumes totais de licenciamentos estão concentrados nas colunas "Diesel" / *The numbers of trucks and buses since 2005 are not available by fuel. The total volumes of registration are concentrate on "Diesel" columns.*

Figure 1 illustrates a comparison of the amount of CO_2 emissions per kilometer between the different energy sources. The technology of the electric car has been evolving to reduce the rate of CO_2 emission, considering recharge and battery production due to the energy matrix used.

Figure 1. CO_2 Emission: Vehicles Lifecycle



Source: Autodata Magazine, p.31. August/2021

Currently, a car has a capacity for 4 or 5 passengers, where the average is one car for every 3.6 inhabitants, considering the Brazilian economy of 211 million [3] and a fleet with 58 million cars [4].

Many users walk alone, or at most with a passenger, underusing the capacity of seats available in cars. On the other hand, this scenario has brought several opportunities for improvement through new technologies and the research and application of other fuel sources in motor vehicles,

such as electricity-powered vehicles and hybrid vehicles. The Toyota Prius, launched on the Japanese market in 1997, was the first hybrid vehicle produced in series and became the best-selling hybrid car worldwide [5].

Tesla was founded in 2003 by a group of engineers who wanted to prove that people do not need to compromise to drive electric – that electric vehicles can be better, quicker, and more fun to drive than gasoline cars. Today, Tesla builds not only all-electric vehicles but also infinitely scalable clean energy generation and storage products. Tesla believes the faster the world stops relying on fossil fuels and moves towards a zero-emission future, the better [6].

According to the International Energy Agency's "Global EV Outlook," the electric passenger car sales climbed by approximately 3 million units to a total global stock of 10.2 million despite all automobile industry contracting by 16%. We expect these trends to drive further M&A activity in the EV space — from manufacturers (including last-mile commercial vehicles) to battery producers and other players in the EV ecosystem [7].

The automotive industry has sought to prioritize new projects for developing electric, hybrid, and green hydrogen-powered vehicles in a context of high competitiveness. In this scenario, the project management area can assist with several practices and distinct approaches, which might increase the chance of success and, consequently, the return on investment.

So, one of the research questions that stands out is: how can a project develop a model of an electric car and a hybrid vehicle be managed? This study sought to bring together the current literature in the large industry in this segment, with a set of best practices in project management based on the international standard Project Management Body of Knowledge (PMBOK®), published by the Project Management Institute (PMI), a non-profit institute, which aims to disseminate the best practices in project management and brings together more than 300,000 experts from all over the world.

This study proposes a project management plan for the two-seater vehicle development with two engines (electric and hybrid). This article thus contemplates the major planning artifacts for the pre-production batch development of 30 (thirty) vehicles with 2 (two) seats, 15 (fifteen) electric and 15 (fifteen) hybrids, tested, approved, and certified to meet the needs of users, as well as regulations, emission, and safety laws.

The principal benefits are in the management area, with a greater chance the project succeeded through good management practices. In the project product, the benefits of vehicle prototypes are reduction of pollution levels; decrease in fuel consumption (for hybrid vehicles), among others, as in the ease of parking in malls and buildings, where spaces are increasingly smaller, and in the facility of mobility in large centers and capitals, in addition to the positive impact competitiveness of the industry with the launch of vehicles.

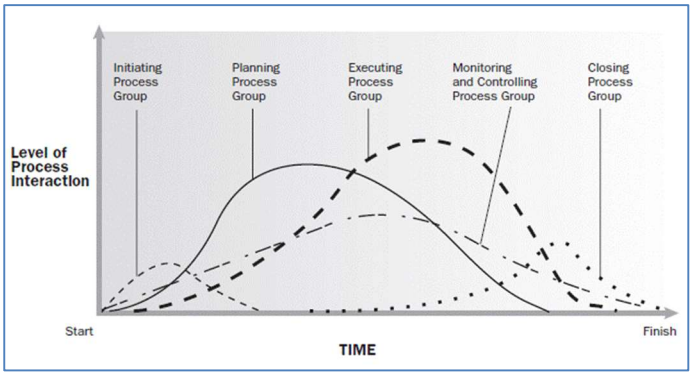
2. METHODOLOGY

This work is based on a literature review and was developed during the year 2020, through exploratory research on the topic of project management and on electric and hybrid cars, and for the development of the proposal, was used a project management methodology by SENAI CIMATEC, based on the PMBOK Guide (PMI), applied to the

Executive MBA in Project Management. Also added is the professional experience of three of the authors, mechanical engineers with expertise in the large industry in the automotive area, in addition to experts in project management.

The methodology used was based on the best practices of the PMBOK Guide, from the initiation phase to the end, with principles, processes, techniques, and tools distributed in 10 (ten) areas of knowledge in project management [8] and covers the following areas: integration management, schema, time, costs, risks, quality, human resources, communications, procurement, and stakeholders, which were integrated into a project lifecycle consisting of 5 phases: Initiation, Planning, Execution, Control, and Closing (Figure 2).

Figure 2. Project Lifecycle



Source: PMBOK Guide, 6ª ed. (2018)

These phases overlap and create an interactive and progressive flow of processes in the areas throughout the project life cycle, with different levels of resource and cost allocation and considering assumptions and constraints imposed on the project.

3. RESULTS AND DISCUSSION

Project development started with the use of PMCANVAS and the SMART methodology to facilitate project scope definition and thus advance to other areas of project management.

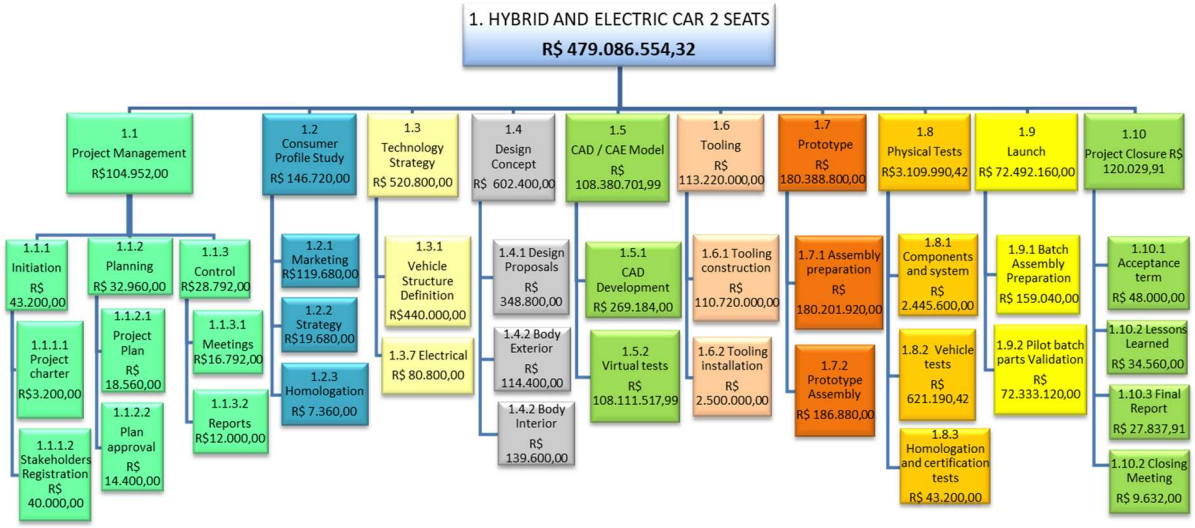
Figure 3. Goal Smart

Once defined the Scope of developing a 2-seater vehicle, with two types of engine, one in the electric version and the other hybrid, delivering a pre-production

batch of 30 vehicles (15 electric and 15 hybrid), with the launch in June 2022, the following phases followed the PMBOK [8], input and output tools as the creation of the WBS (Figure 4) with the identification of 10 phases due to the size and complexity of the project.

WBS breakdown and project team meetings made management clean when it was possible to identify project costs by phases and packages.

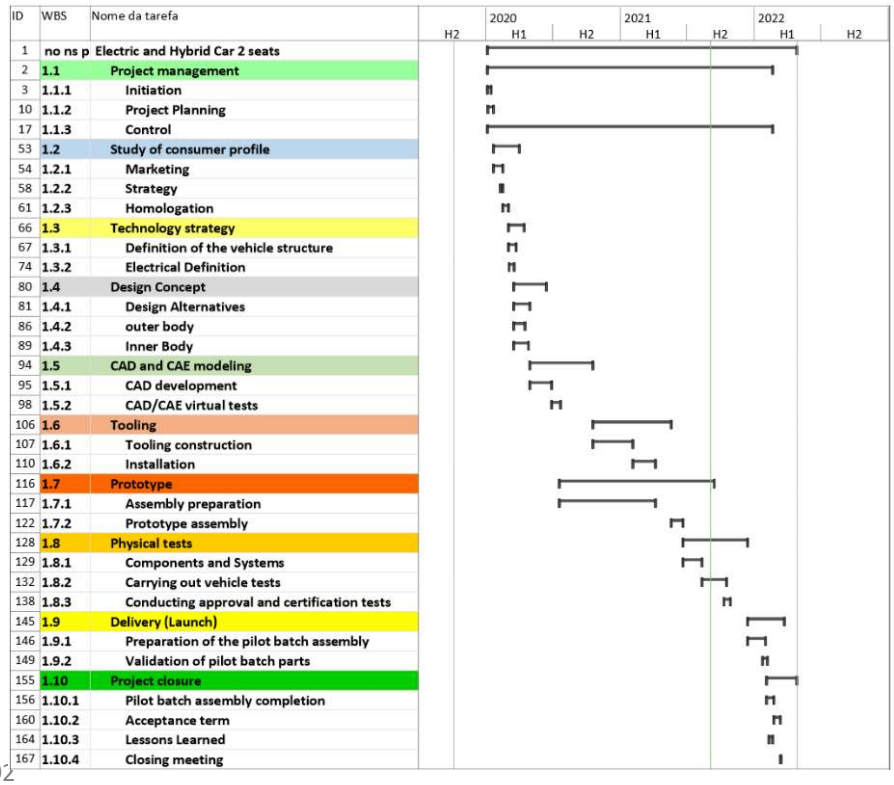
Figure 4. Work Breakdown Structure



For scope control, changes will be through management meetings, using the decision matrix and competitor benchmarking for approval.

The MS Project Management tool, scope statement, WBS, and expert opinion were used to determine the sequencing of activities in package deliveries within the phases in schedule management (Figure 5).

Figure 5. Project Schedule



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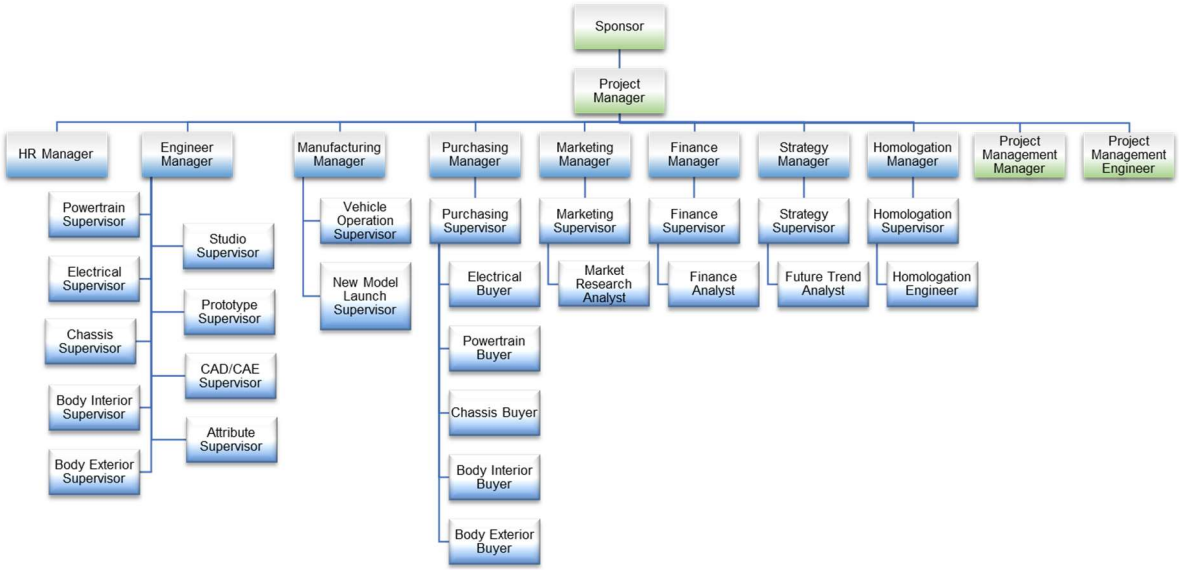
The project phases in the time intervals were interrelated according to the project needs, allowing the monitoring in the Gantt chart, evaluating the project deadlines weekly (546 days).

The project's organizational chart was developed based on the good practices of the PMBOK Guide, consisting of the Sponsor, Project Manager, and Project Management engineers and the functional managers, supervisors, engineers, and analysts in product development (Figure 6).

Figure 6. Team Organization chart



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The management structure was divided into sections: HR, Engineering, Manufacturing, Purchasing, Marketing, Finance, Strategy, and Approvals, facilitating interaction between teams with the responsibility matrix (RACI).

Project Risk management was carried out based on the PMBOK Guide, and the Risk Analytical Framework was made up of 4 pillars: Technical, External, Organizational, and Project Management (Figure 7).

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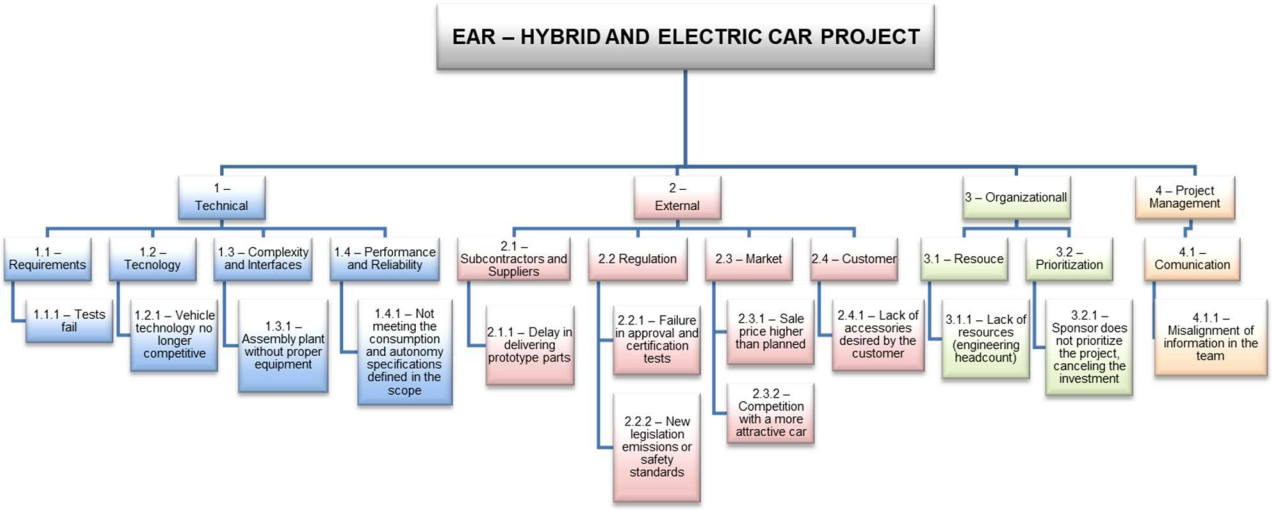
Figure 7. Risk Breakdown Structure



Based on some previous projects, on the know-how of the managers, and the risk map, 13 (thirteen) potential risks were raised (shown above), which we may face during the project.

For risk control, we prioritized contingency in the action strategy, using the Planned Risk Responses matrix since we established qualitative x quantitative ranking

Figure 8. Planned Risk Responses Matrix example

ITEM	RISK	PROBABILITY	SEVERITY	IMPACT	ACTION	DESCRIPTION	RESPONSIBLE	COST
1.1.1	Tests Fail	0.3	0.4	0.12	Mitigate	Hire "Specialized Company" to improve correlation of virtual analytics with physical tests.	Project Manager and Product Engineering Manager	R$ 1.500.000
1.2.1	Vehicle technology no longer competitive	0.5	0.8	0.4	Escalate	Due to the lack of AUTONOMY, the PROJECT MANAGER must hold a meeting to SCALE RISK (which was identified by the Marketing and Strategy teams) for the SPONSOR.	Project Manager	-
1.3.1	Assembly plant without proper equipment	0.3	0.2	0.06	Accept	Allocate a prototype assembly specialist to adapt the available equipment.	Project Manager	-

4. CONCLUSION

This study presented an answer to the research question: How can a project develop a model of an electric car and a hybrid vehicle be managed? It can be developed through the detailed planning of the project for prototypes of an electric and hybrid vehicle. Project management following PMBOK® practices promotes better integration and monitoring of the team in the development of phases, maintaining engagement and meeting the stakeholder expectations.

The detailing of the project management plan allowed the vehicle development processes to be traced and all activities specified and described through several management artifacts, contemplating a set of practices and measures necessary for the project's success. In practical terms, the main contributions of this research are Project Scope, Schedule, and Risk Management Model.

The limitations of the research are at the same time opportunities for future development and refer to the impossibility of implementing the proposal due to the impacts on the automobile sector, especially in the local scenario resulting from the difficulties imposed by the new coronavirus pandemic. We recommend the pilot project implementation as the future work that reinforces the potential contribution in terms of theoretical advances. For example, in comparative studies of the results obtained with the different project management approaches adopted by the automobile industry.

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