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Review article

A survey on electrical cars advantages

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Abstract: The production of electric cars dates back to 1900 AD, at that time, on the one hand, due to the problems that electric motors had. And on the other hand, the discovery of oil and its abundant production were not taken into account in the remarkable development of internal combustion engines for the construction of these cars. But with the emergence of world wars and conflicts over oil, this material gained more value and more attention was attracted to electric cars, and that was that since 1990, the production of electric cars was taken more seriously, as well. In electric cars, the power supply system includes an electric motor, controller, batteries, and its charger. The electric drive system of the electric car has the task of converting the direct current produced by the battery into mechanical energy, which means the drive assembly of all parts, which convert the direct current of the batteries into the traction force and torque necessary for the movement of the wheels. One of the most important features of an electric car is the range and power of movement (acceleration, speed, incline, loading and flexibility), charging time and the high price of batteries in most existing electric cars. In this research, after the introduction and definition of the electric car and a description of the history of the electric car, the advantages of this type of car have been examined.

Keywords: electric car; advantage of electric car; range and driving power; charging time; battery price; car industry

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1. Introduction

The electric vehicle (EV) is not a new invention. The early years of production and construction of electric cars go back to 1900 AD, at that time, on the one hand, due to the problems that electric motors had. And on the other hand, the new discovery of oil and its abundant production were not taken into account in the remarkable progress of the internal combustion engines of these cars. But with the emergence of world wars and conflicts over oil, this substance gained more value and attracted more attention to electric cars. And it was that since 1990, the production of electric cars was more seriously considered. In electric cars, the power supply system includes an electric motor, controller, batteries and charger. The electric drive system of an electric car has the task of converting the direct current produced by the battery into mechanical energy, which means all the parts that convert the direct current of the batteries into traction force and torque necessary for the wheels to move. One of the most important features of an electric car is the range and power of movement (acceleration, speed, incline, loading and flexibility), charging time and the high price of batteries in most existing electric cars. Due to the increasing development of the automobile industry and the mass production of internal combustion vehicles, which causes various problems such as air pollution. Also, due to the limited and expensive fossil fuel reserves, research and design of electric vehicles has become one of the main programs of the automobile industry, especially in advanced European and American countries. In Iran, research has been done in this field in the last few years. The most important features of electric cars are: range and power of movement (acceleration, speed, incline and loading and flexibility), and charging time and high price of batteries, in most existing electric cars, the driving set consists of a controller (regulating member), motor electric, gearbox with reducing ratio on the axles and distribution box for two or four wheels, other solutions are also used. For example, two engines with or without a gearbox. The stimulus set must satisfy many and varied demands, which are used as criteria for evaluating and comparing different solutions. For example, some of the most important criteria are: easy to use, high efficiency, low cost, high reliability, no need for service and maintenance, low weight, low construction volume. It should be noted that all these criteria cannot be gathered well in one stimulus set, so that generally high efficiency is opposed to low cost. In this research, the performance characteristics of the electric vehicle as well as the power transmission system and the calculation of the required power have been discussed, which includes the preparation of optimal values, the design and completion of a vehicle for conversion.

2. Electric car

In an electric car, the electric drive set has the duty of converting the direct current produced by the battery into mechanical energy. The drive assembly refers to all the parts that convert the direct current of the batteries into the traction force and torque necessary to move the wheels. The most important features of electric cars are: range and power of movement (acceleration, speed, incline and loading and flexibility) and charging time and high price of batteries. Electric motor, gearbox with reducing ratio on the axles and distribution box for two or four wheels, other solutions are also used. For example, two engines with or without a gearbox. The stimulus set must satisfy multiple and diverse demands which are used as criteria for evaluating and comparing different solutions, for example, some of the most important criteria are: simple use, high efficiency, low cost, high reliability, no need for service and maintenance, light weight, small building volume. It should be noted that all these criteria cannot be gathered well in one stimulus set, so that generally high efficiency is opposed to low cost. In addition, it should be noted that different types of cars define the centers of demands, for example, in the electric cargo car, the building volume plays a less important role.

3. A review of research history

Taghipour et al.[1] studied "Risk analysis in the management of urban construction projects from the perspective of the employer and the contractor."

Mahboobi et al.[2] discussed "Assessing ergonomic risk factors using combined data envelopment analysis and conventional methods for an auto parts manufacturer." occupational injuries are currently a major contributor to job loss around the world.

Taghipour et al.[3] studied "The impact of ICT on knowledge sharing obstacles in knowledge management process (including case study)."

Khalilpour et al.[4] studied "The impact of accountant's ethical approaches on the disclosure quality of corporate social responsibility information an Islamic in Iran."

Mirzaie et al.[5] studied "The relationship between social bearing capacities with conflict as a result, in the perception of the visiting historical sites."

Alamdar Khoolaki et al.[6] studied "Effect of integrated marketing communication on brand value with the role of agencys reputation (including case study)."

Taghipouret et al.[7] studied "A survey of BPL technology and feasibility of its application in Iran (Gilan province).”

Seddigh Marvasti et al.[8] studied “Assessing the effect of the FRP system on compressive and shear bending strength of concrete elements.”

Jalili et al.[9] studied “Utopia is considered to be the physical form of an ideal human society where the goals are met.”

Taghipour et al.[10] studied “Insurance performance evaluation using BSC-AHP combined technique.”

Rezvani Befrouie et al.[11] discussed “The design of high-rise building with ecological approach in Iran (Alborz province).”

Taghipour et al.[12] studied “The identification and prioritization of effective indices on optimal implementation of customer relationship management using TOPSIS, AHP methods.”

Taghipour and Yazdi[13] studied “Seismic analysis (non-linear static analysis (pushover) and nonlinear dynamic) on cable-stayed bridge.”

Taghipour et al.[14] studied “Investigating the relationship between competitive strategies and corporates performance (case study: Parsian Banks of Tehran).”

Taghipour and Moosavi[15] studied “A look at gas turbine vibration condition monitoring in region 3 of gas transmission operation.”

Rahmani et al.[16] studied “Providing health, safety and environmental management (HSE) program in metal mining industry (including case study).”

Taghipour and Vaezi[17] studied “Safe power outlet.”

Tarverdizadehet et al.[18] studied “Predicting students’ academic achievement based on emotional intelligence, personality and demographic characteristics, attitudes toward education and career prospects through the mediation of academic resilience.”

Azarian and Taghipour[19] studied “The impact of implementing inclusive quality management on organizational trust (case study: Educatin).”

Jalali et al.[20] studied “Explain the relationship between intellectual capital, organizational learning and employee performance of parsian bank branches in Gilan province.”

Mohammadi et al.[21] studied “Investigating the role and impact of using ICT tools on evaluating the performance of service organizations.”

Abdi Hevelayi et al.[22] studied “Predicting entrepreneurial marketing through strategic planning (including case study).”

Arsalani et al.[23] studied “Investigating the effect of social media marketing activities on brand awareness.”

Khorasani and Taghipour[24] studied “The location of industrial complex using combined model of fuzzy multiple criteria decision making (including case study).”

Hoseinpour et al.[25] studied “The problem solving of bi-objective hybrid production with the possibility of production outsourcing through Imperialist Algorithm, NSGA-II, GAPSO Hybid Algorithms.”

Taghipour et al.[26] studied “Study of the application of risk management in the operation and maintenance of power plant projects.”

Taghipour et al.[27] studied “Risk assessment and analysis of the state DAM construction projects using

FMEA technique.”

Baghipour Saramiet et al.[28] studied “Modeling of nurses’ shift work schedules according to ergonomics: a case study in Imam Sajjad(As) Hospital of Ramsar.”

Taghipour et al.[29] studied “Identification and modeling of radio wave propagation channel in industrial environments.”

Taghipour et al.[30] studied “Implementation of software-efficient DES Algorithm.”

Sedaghatmanesh and Taghipour[31] studied “Reduction of losses and capacity release of distribution system by distributed production systems of combined heat and power by graph methods.”

4. History of electric car production

The history of electric car production and its advantages compared to combustion cars, electric cars have been produced since around 1900 AD and until 1915, the production process has increased relatively well. Due to the problems that electric motors had, the production of electric cars was not welcomed. The new discoveries of oil and its abundant production, as well as the remarkable progress of internal combustion engines from 1915 to 1990, made cars with combustion engines the monopoly. The occurrence of world wars, wars and conflicts in which oil was the main subject or used in them caused the real value of this material to be realized. And its price should increase now that new and significant sources of oil have not been discovered and it is predicted that oil reserves will be exhausted, industrialized countries have been encouraged to use other sources of energy such as solar energy, wind, hydro dams and nuclear energy sources. New energy supply and they are easily converted into electric energy. Since 1990, the production of electric cars has been given attention because cars, which are one of the main sources of energy consumption, can be used for energy consumption, can be converted into electricity consumers, with the advancement of the technology of making electric motors. Electric cars have a relative advantage over normal cars. In electric cars, the power supply system includes an electric motor, controller, batteries, and its charger. All these equipments have made significant progress so that repairs are minimized. A normal car includes an internal combustion with engine. It is a complex system and equipment is added to it. As smoke extraction and purification equipment including warehouse, exhaust, etc. Engine cooling system including radiator, water pump, cooling chamber, thermostat and sensors. The spark production system includes delco, spark plugs, etc. The fuel system includes the carburetor, fuel pump, injection system, fuel inside the cylinder, air and fuel filters. Engine mechanical system includes crankshaft, pistons, sealing rings, oil pump, chain wheel, sealing washers and starter. This equipment need constant service and repairs, while there are no complicated equipment in an electric car. Types of electric motors and their comparison, electric motors have a stator or stationary part and a rotor or moving part. Electric motors have only one moving part, while combustion engines have many moving parts, the efficiency of these engines is high and is often more than 90%. All types of electric motors can be designed in a wide range of power and in different sizes and shapes of DC or AC type. An electric motor is a mechanical device that converts mechanical energy into motion. And this movement can be used to produce work, pull, push, lift, shake or create oscillation. The electric motor uses classical laws and magnets, each type of motor has specific speed, torque and electrical characteristics. And for use in electric cars, they have advantages and disadvantages. The types of electric motors suitable for use in mass-produced electric vehicles are briefly introduced.

4.1. Direct current electric motors

In this type of motors, the main current passes through the core coils, and causes the core to rotate and create a torque in it. The stator includes magnetic poles, the core includes the main shaft of the motor and several coils, each coil is connected to the next coil. And the current exists in all of them, of course, the type of connection of the coils to each other creates different properties that create different types of DC motors. Direct current motors generally have a simple and cheap inverter circuit with very high capability. And the speed of the motor can be controlled easily, high weight and volume, high price, complexity of construction, high repair and maintenance cost, low efficiency and the presence of a vacuum cleaner are some of the disadvantages of these motors. In engines without high maintenance, low efficiency and the existence of a brush are among the disadvantages of these engines. In the type of brushless motor where there is no brush, speed control is done easily and the motor has a high-power density, this type of motor is used at high speeds, the volume of the motor is small and the noise is less compared to other motors.

4.2. Alternating current electric motors

AC current has good features, such as it can be easily transmitted at high voltages and with the presence of a transformer, the voltage value can be converted easily. The most important and most used AC motor is a rack motor. In this type of motor, the basis of which is like a moving transformer, the presence of current in the stator coil induces current in the core coil, so the forces resulting from the current field in the core cause it to rotate and Torque is produced. The most important features of the rack induction motor are as follows: there is no need for a sweeper, it has the least necessary repairs; it is suitable for the workload in dirty environments; it has high reliability; it has high efficiency; it has high hardness and life; it has low cost, weight, volume and moment of inertia. Below, more explanations are given about the three types of alternating current motors that are considered for use in electric vehicles.

4.2.1. Synchronous or permanent magnet motors

In this type of motor, the power density is high, due to the control of the current and the stator field, more torque can be produced, there is no brush, and it can be used at high speeds and a wide range of speeds.

4.2.2. Three-phase induction motors

The construction of the motor is simple, this motor is light, resistant, compact, cheap and has high efficiency and does not need a brush.

4.2.3. Axial flux motors

Recently, Axial flux motors (Afm) or axial flux motors have also been made, which have two models of using the motor inside the car wheel (whell motor) or motors with two rotors and one stator in such a way that the motor is installed instead of the car differential. Of course, the last two motors require higher technology to make and use and have a higher price, but their efficiency and performance are better than induction and normal PMSM motors.

4.3. Batteries that can be used in electric cars

Capacity and amount of current are two characteristic factors of batteries. Capacity is the amount of energy stored in the battery and they depend on many factors, the most important of which are: the surface or physical size of the plates covered by the electrolyte, the weight and amount of material in the plates, the number of plates and the type of separator between them, the amount of electrolyte and its specific mass, battery age, cell conditions—the amount of sediment at the bottom of the cell, temperature, limit low voltage, discharge rate. The capacity of the battery is determined in terms of ampere-hours, the current is another characteristic of the battery. And it is in amperes, the amount of current determines the rate of energy when charging or discharging. For example, for a 100-ampere-hour battery with a current of one ampere, the discharge time is 100 hours, and this battery is characterized by a current of 100/C. Perhaps the only weakness of the electric car is its batteries, due to the low energy density stored in the battery, a large number of batteries must be used, which increases its weight, and extra energy is consumed to carry this weight. And the mileage is less compared to combustion cars. Also, the charger of these batteries will take time. A high cost will also be spent on buying batteries. If suitable batteries are made for cars that do not have the current problems, of course, cars with internal combustion engines are left out. All kinds of chemical batteries are made, including lead-acid, nickel-cadmium, nickel-iron, nickel-manganese, sodium-sulfur and zinc-bromine batteries. Sodium-sulfur batteries have the highest energy density of about 150 kg. But they are explosive Lead-acid batteries have the lowest energy density of about 35 kg. But due to the good performance life of about 750 charging cycles, high reliability and reasonable price, they are used the most.

4.4. Electric energy storage system

Chemical batteries are usually used in electric cars, which are given below the general parameters and specifications of the batteries used in electric cars.

4.5. Full charge time

The charging time for different batteries is not the same and it depends on the type of battery and the way of charging. For lead-acid batteries it is 4–8 hours, li-ion is about 5 hours, Nimh is about 6–8 hours.

4.6. Charge type

Charging can be done by two methods, Inductive or Conductive, also the feeding power can be one phase or three isolated phases, the power is about 6 kW, the maximum output voltage is 388 V, and the output current can be up to 15 A.

4.7. Power consumption per battery charger

This amount can have different values depending on the capacity of the batteries and their number, the range of the vehicle, the loss of the vehicle, etc.

4.8. Battery life

Depending on the type of battery used in the car and the specifications provided by the manufacturer, the battery life is different. For example, in the case of coated lead-acid batteries, if they are discharged and re-charged up to half of their allowed capacity, they can be charged and discharged up to 1000 times, and if the entire capacity of the battery is used, they can be charged and discharged up to 500 times.

4.9. Battery type

Choosing the type of battery depends on various factors such as the amount of space in the car, the price of the car, the range of the car and the expected life of the car, etc. Because the technology of lead-acid batteries is available in Iran, and their finished price is much lower than other batteries, lead-acid batteries are used, of course, to prevent additional maintenance and repair, gel batteries can be used. Power generation and transmission systems for mass-produced electric vehicles.

4.10. Electric vehicle with direct current DC motor

Based on the experiences gained over many years by Chloride Group and Lucas Industries, which was established in England. And it was invested with the financial assistance of the Ministry of Experience and Industry of England. The specific goal was to build a series of electric cars with high efficiency and with the cooperation of normal car manufacturers. Both parent companies have followed DC power transmission systems that were separately excited. And both companies have had experiences in brushless power transmission systems. The power transmission systems that were followed by each of these companies used separate excitation DC motors for similar reasons. And it included a better reaction of the separate excitation system in fault conditions, the presence of a more flexible force-speed characteristic, and more efficiency and ability to work under DC current conditions. Most of the effort was focused on improving the existing system, which led to the production of a two-transistor control system, and a four-transistor system (output 216 V, 40 kW). The transmission system must be able to be installed on the vehicle in the production line of the manufacturer's factory. The system must have sufficient reliability, and it must be able to meet the working needs of the car manufacturer, which is built at the desired rate and fully developed before being presented to car manufacturers has shown practical experience. A DC traction motor, if it is properly designed and manufactured, is a highly reliable product. The improvement of the system capability by replacing the brushless motor instead of the DC motor is small. And the choice of the engine for the next generation transmission system will be based on the cost of the engine and the cost of connecting the engine and the control system. The complete analysis of the car price will also show the things that can be improved. And we summarize the most specific features of this economic analysis as follows.

- Mechanical integration of electronic equipment, DC/DC converter, state of charge measurement device, battery insulation, pedal magnetic converters and charger.
- Removal of electromagnetic parts such as relays, contactors and contactor testers as active parts in the transmission system.
- Minimizing electrical connections.
- Minimizing electronic parts.
- Eliminating dependence on 12 V car power supply.

5. The effect of weight in an electric car

The issue of weight should be examined before choosing a car that should be converted and to what extent weight reduction is possible, and also when converting a car to an electric car: the weight of the car should be reduced as much as possible after removing unnecessary weights. Therefore, a beautiful and light weight body is desired, no drilling should be done to install new parts on the frame and chassis of the car.

5.1. Weight distribution

Table 1 shows the distribution of weight on the rear and front axle of a car before and after converting to an electric car.

Table 1. Weight distribution in the car.

	Weight (lbs)	Weight on the front axle	Weight on the rear axle	Load capacity
Before conversion	3000	1800	1200	1200
Internal combustion engine and its components	−600	−500	−100	-
Sum before conversion	2400	1300	1100	-
The weight of electric motor and batteries and...	1400	400	1000	-
Weight after conversion	3800	1700	2100	400
Weight of batteries	1200	-	-	-
Battery weight ratio to car weight	3270	-	-	-

5.2. Air resistance force

In order to reduce the air resistance force, the resistance coefficient of the car or the front surface of the car should be reduced. **Table 2** shows different parts of the car.

Table 2. Cd coefficient for different parts of the car.

The desired level of the car	Amount	% of total
The rear body of the car	0.14	33.3
Wheels	0.09	21.4
Under the car body	0.06	14.3
In front of the car	0.05	11.9
Protrusions and indentations	0.03	7.1
Body surface friction	0.025	6.0
Total air resistance coefficient	0.42	100

The value for the car body has been reduced to 0.32, although this value is in normal mode and if the windows are open, it increases to 0.06. **Table 2** shows how much different surfaces contribute to this coefficient. About 31% of the air resistance coefficient is related to the wheels. This value can be reduced by using thin tires. The front surface of a car is 18–24 square feet. The front surface of the car cannot be changed, but it should be considered when buying a car for conversion. The air resistance force has been measured under standard conditions of 60 and 30 pressure, and normally they are sufficient for the calculations of hypotheses, but several other issues interfere in the calculations, for example, the relative speed of the wind interferes in the calculation of the air resistance force. The relative wind is involved in the calculation of the air resistance force, the coefficient is proportional to the wind. Crw is the relative wind coefficient, which is approximately 1.4 for normal cars, 1.2 for aerodynamic cars, and 1.6 for non-aerodynamic cars or cars with an open window. Crw is calculated for seven different car speeds and average speed. The wind is 5.7 mph and three different modes of Crw are shown in **Table 3**.

Table 3. Relative wind coefficient.

For average wind speed 7.5 mph	Crw	V = 5 mph	V = 10	V = 20	V = 30	V = 60	V = 75
12	3.180	0.929	0.299	0.163	0.159	0.063	0.047
1.4	3.810	1.133	0.374	0.206	0.185	0.082	0.062
1.6	4.440	1.338	0.449	0.250	0.212	0.016	0.016

Table 4 presents the values for a real car and calculates for seven different speeds. Note that the air resistance force is less for a small car and larger for a car and a van, but a small car does not have enough space for batteries.

Table 4. Values for the real car.

Car type		A	V = 5	V = 10	V = 20	V = 30	V = 45	V = 60	V = 75
Small ride	0.3	18	0.35	1.38	5.52	12.43	27.97	49.72	77.69
Big ride	0.32	22	0.45	1.80	7.20	16.20	36.46	64.82	101.28
Van	0.34	26	0.51	2.26	9.04	20.35	45.78	81.39	17.17
Pickup truck	0.45	24	0.069	2.76	11.05	24.86	55.93	99.44	155.37
Old models	0.6	18	0.69	2.76	11.05	24.86	55.93	66.44	155.37

5.3. Driving on the road

Car tires are wide and have ivory and have low rolling resistance. It is not possible, instead, they are made for more adhesion. In an electric car, if we use tires without teeth and thin, we will have driving problems.

5.4. Attention to car tires

Tires are important in an electric car, they bear the weight of the car, the batteries with the resulting vibrations, as well as bear the backward or forward forces during acceleration or braking, and side forces when turning. In terms of rolling resistance, the ideal motorcycle tire is the best because it is thin and has a small contact surface with the road and is hard, so it will have little friction and the large tar makes it make fewer rounds per personal distance.

5.5. Power transmission equipment

The transmission equipment includes all the parts that transfer the production power to the wheels and tires. When we talk about power transmission equipment, this equipment and their performance should be examined separately in an electric car and an internal combustion engine. In this section, we discuss the main parts including differences in the electric motor and the internal combustion engine. We discuss about the choice of transmission gear and the advantage of using manual automatic transmission, old or new transmission and light or heavy fluid for lubrication and smoothness of power transmission.

5.6. Power transmission systems

We start with the issue of what is the function of the power transmission system in a car with a combustion engine. In practice, the power obtained from the engine must be equal to the work of the resistance and friction forces that are calculated for each speed. Using the power of the engine to turn the wheels and tires with the least losses and the most efficiency is the clear task of the power transmission system, and in general, the power transmission system must meet the following requirements.

- Conversion and change of torque and speed from the engine to the movement of the vehicle-traction.
- Changing the direction of the output round to ensure the forward and backward movement of the car.
- Provision of different rotation speeds in the drive wheels and in the screws-differential.
- Overcoming the slope of the road.
- Maximum fuel economy.

A simple view of the power transmission system in internal combustion vehicles can be described as follows:

- The internal combustion engine (or electric engine) is responsible for providing the power and pushing torque of the car.

- Clutch: For a combustion engine, cutting off the power transmission from the engine to the tires: therefore, the transmission gears can be changed and the car can reach high speed from a standstill.

- Manual gearbox: Providing the ratio of gears that the car needs for maximum torque or maximum speed and normal speed for movement or maximum efficiency and economy.

- Drive shaft: Connecting the drive wheels to the gearbox is not useful in cars with rear-wheel drive and in cars with front-wheel drive.

- Differential: The duty of the differential is to accommodate the problem that the outer wheel travels a greater distance than the inner wheel when turning, and the transfer of the 90-degree power to the rear wheels of the car is done with the help of the differential.

- Driving axles: To transfer power from the differential to the driving wheels.

5.7. The difference between electric motor and combustion engine

In the comparison of the electric motor and the combustion engine with the same production power, the electric motor is preferable. The electric motor produces maximum torque at the moment of starting, while the combustion engine does not provide any torque until the revolution is sufficient. A fundamental difference between these two types of engines is the rate of production power. The rated power of an electric motor produces a higher maximum power, while combustion engines have maximum torque and maximum power in a certain range of revolutions. The maximum power output rate of a combustion engine is obtained under laboratory conditions. Electric motors are such that they can be used at less than their maximum, and the consumption of these motors is also reduced, the production power can be used continuously for an hour or more without causing the motor to heat up. In an electric motor, the production power is much lower than the maximum output power. It is almost two to three times smaller, and therefore we will have a considerable maximum power. Another of the main differences between these two types of motors is the amount of torque produced.

The electric motor can be directly connected to the driving wheels without the need for clutches, gearboxes and torque converters that are used in the combustion engine. The speed of the electric motor can be selected and controlled by the consumption current of the controller. In the combustion engine, the maximum torque is provided only in a certain range of revolutions. In order to provide the maximum torque in a wider range of vehicle speed, a gearbox with different gear ratios is needed. With the above explanations, we conclude that most of the electric motor is used on the power transmission system of a combustion engine, less loads are applied to its components. Therefore, a special lighter power transmission system should be designed in the mass production of electric vehicles. The clutch is also an intermediary between the engine and other components, including the gearbox, and it eliminates the need for us to build a connecting device between the electric motor and the wheels. In the future, AC motors and controllers will be used for the mass production of electric cars. It is not a complete mechanical gearbox. In this case, the electric motor can be directly connected to a simple, light, one-way gearbox with a maximum of two gear ratios, and therefore there is no need for a clutch. In an electric car, the presence of a gear box creates diversity in the choice of electric motor, it creates backward movement and we don’t have to use a two-way motor with the corresponding controller, and the work becomes simple. In the future, the existence of AC motor and controllers will ensure backward movement and the gearbox will be very simple. Drive shaft, differential and driving axles—these equipments are always used and must be present in an electric car. Of course, in mass production, if two electric motors installed on the driving wheels are used, these components are removed, but the use of a simple motor will be more.

5.8. Checking the gears

The gear ratio of the box is combined with the ratio obtained from the differential, and the power of the torque produced by the combustion engine is adjusted, as well as the maximum torque for climbing the slopes and the lowest cost for moving with high efficiency are provided.

5.9. Automatic and manual gearbox

The first thing that can be consciously avoided is the automatic gearbox because high efficiency is needed in an electric car, while the automatic gearbox has a low efficiency of about 80%. The better reason is that when converting the car to an electric car, the torque transmission system and design in the gearbox. It is automatic in such a way that we cannot have the desired gear ratio and this gearbox will not be compatible with the characteristics of the electric motor. The best way to convert an electric car is to use a manual gearbox and clutch.

5.10. Power transmission systems and light or heavy fluids for lubrication

The need to use high efficiency in an electric car rejects the use of an automatic gearbox. Also, this demand makes the design of the power transmission parts not to impose unnecessary weight on the system, such as the heaviness of the axis or driver, gearbox, clutch or anything else, which adds weight and reduces efficiency. Even a manual gearbox designed for maximum torque causes losses when working at a lower load. Low load electric vehicle results in lower efficiency of the system, so it is better to convert a combustion engine car with a light engine, the selection of lubricating fluid is also very important. The use of low-viscosity fluid in the differential makes the parts rotate more easily. Of course, the rules of lubrication do not play a role in an electric car during normal movement, approximately 10% of the maximum torque. A combustion engine is used, so it is better to use a power transmission system designed to transmit a lower maximum torque. As a result, the electric motor covers smaller loads entering the system and a maximum of 50% of the designed capacity of the vehicle power transmission system is used with a combustion engine. Therefore, less pressure on the gears makes it possible to use a lubricant with less viscosity and the final efficiency of the system increases.

6. Specifications of electric cars

Before turning the car into an electric car, it should be determined what our main demand is from the electric car, is a high speed and proper acceleration necessary, with a long distance of travel in mind? Or there are other demands, the weight of the electric car is the most important factor in any design. But the acceleration of the car requires a special design. In this section, the connection of the electric motor and the power transmission system to the selected body is discussed and it includes the following steps.

- Estimation of consumed power and torque.
- Review of calculations done.
- Calculate the necessary torque for the selected car.

Estimating the usable power of the selected electric motor and the torque of the open power transmission system, the design defined here can be used to buy, build or convert an electric car with a little change.

6.1. Power and torque

The basic formula used in this section is as follows:

$$P = F \times V \tag{1}$$

P = (kW) power. F: (KN) propulsion force. V: (m/s) speed.

HP = FV/375 and in the English system. HP = (hp) power. F: (ib) propulsion force. V: (mph) vehicle speed.

Therefore, the power is the product of the force or the torque in the speed. This force provides the propulsion of the car on a level surface or the rising of the car on an inclined surface. For example, the required driving force for a car is 3800 ib at a speed of 50 mph from the calculation of drag force and rolling friction.

$$HP = 146 \times 50.375 = 19.49 \text{ hp}$$

Therefore, it is 19.49 hp and a 20 hp electric motor will be the answer to this purpose. It is interesting that the electric motor in question will replace a 90–120 hp combustion engine. Before calculating the power, the driving force must be measured at different speeds, then the values of the load of the engine and the power transmission system are calculated based on the normal operating speed. For example, if the final speed of a car is 100 mph and the cost-effective speed is 20 mph, the normal operating speed of the car is 50 mph and it should be the basis of the designs. In other words, the speed should be selected, then an electric motor should be selected for that speed. And according to the rotation speed that the motor provides the required power, the gear ratio will be determined. Then let's see if the motor has the desired torque to move and climb the slopes. Does it provide? You can draw the results on the graph and by using the graph you can compare the torque obtained from the engine and the power transmission system with the required torque at different speeds. The propulsion force includes the following components:

resistance force in the movement of the car = rolling friction + movement on the slope + acceleration+ wind resistance + air resistance

Wheel torque and vehicle speed are calculated as follows:

$$V(\text{km}) = \text{engine PRM} \times 60(g \times R) \tag{2}$$

the number of wheel revolutions in one kilometer = R, the gear ratio of the power transmission system = g.

Now we will have some useful curves of torque according to speed for different gears of the gearbox. Finally, a diagram including the curve of the required torque and usable torque will be drawn.

6.2. Calculation of the necessary torque of the car

In this part, the required torque of the car is calculated for different slopes. The calculation of the torque for different slopes is equivalent to the calculation of the torque for different accelerations on the road without slope. The desired information for the electric arrow is provided in the design section of the power transmission system.

6.3. Engine output torque

The output torque of the engine depends on the speed and the amount of current consumed by the engine. First, the power of the engine must be calculated. For this, the torque of the wheels is calculated at the operating speed. Then, after calculating the power and choosing the engine, the engine speed at the desired torque is obtained from the torque curve and according to the engine speed provided by the manufacturer.

6.4. Comparison of required torque curves and engine output torque

By using the necessary torque curve for each gear, we can have the lowest current consumption of the motor. As a result, we will have the most energy savings and the longest distance traveled by the car without charging the batteries.

7. Conclusion

The main areas on which research should continue, and one of the problems and obstacles of making an ideal electric car is: durability and price of batteries, electric motors, auxiliary devices—chargers and converters, heating and ventilation. In the case of electric motors, it is worth mentioning that in industrial motors, parameters such as weight, structural volume, efficiency in half-load mode, torque trend, ability to adjust and control, and other such characteristics do not play an important role. And while they are very important in electric cars, it means that industrial engines are very heavy and too big for electric cars. And their efficiency is inappropriate, especially in half-load mode, and these engines are very expensive.

Author contributions

Conceptualization, AM and MT; methodology, AM and MT; software, AM and MT; validation, AM and MT; formal analysis, AM and MT; investigation, AM and MT; resources, AM and MT; data curation, AM and MT; writing—original draft preparation, AM and MT; writing—review and editing, AM and MT; visualization, AM and MT; supervision, AM and MT; project administration, AM and MT. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

References

1. Taghipour M, Seraj F, Hassani MA, Kheirabad SF. Risk analysis in the management of urban construction projects from the perspective of the employer and the contractor. *International Journal of Organization Leadership* 2015; 4(4): 356–373. doi: 10.33844/ijol.2015.60284
2. Mahboobi M, Taghipour M, Azadeh MA. Assessing ergonomic risk factors using combined data envelopment analysis and conventional methods for an auto parts manufacturer. *Work* 2020; 67(1): 113–128. doi: 10.3233/WOR-203257
3. Taghipour M, Mahboobi M, Gharagozlou H. The impact of ICT on knowledge sharing obstacles in knowledge management process (including case-study). *Iranian Journal of Information Processing and Management* 2016; 31(4): 1049–1074. doi: 10.35050/JIPM010.2016.003
4. Khalilpour M, Kamyabi Y, Nabavi Chshmi SA, Taghipour M. The impact of accountant's ethical approaches on the disclosure quality of corporate social responsibility information an Islamic perspective in Iran. *National Academy of Managerial Staff of Culture and Arts Herald* 2018; 1: 1173–1181. doi: 10.32461/2226-3209.1.2018.178689
5. Mirzaie F, Nazari AA, Zargham Boroujeni H, Taghipour M. The relationship between social bearing capacities with conflict as a result, in the perception of the visiting historical sites. *Journal of Investment and Management* 2015; 4(6): 403–408.
6. Alamdar Khoolaki M, Naami A, Taghipour M. Effect of integrated marketing communication on brand value with the role of agencys reputation (including case study). *Journal of Process Engineering* 2019; 5(11): 30–44.
7. Taghipour M, Safari M, Bagheri H. A survey of BPL technology and feasibility of its application in Iran (Gilan province). *Science Journal of Circuites, Systems and Signal Processing* 2015; 4(5): 30–40. doi: 10.11648/j.cssp.20150405.11
8. Seddigh Marvasti SMA, Beheshti B, Chegini H, Taghipour M. Assessing the effect of FRP system on compressive and shear bending strength of concrete elements. *International Journal of Innovative Research in Science. Engineering and Technology* 2015; 4(11): 11511–11524. doi: 10.15680/IJIRSET.2015.0411119
9. Jalili L, Ghafourian M, Toopal T, Taghipour M. Utopia is considered to be the physical form of an ideal human society where the goals are met. *Journal International Journal of Archaeology* 2015; 3(5): 39–47.
10. Taghipour M, Vosough A, Azizi D, Abdi J. Insurance performance evaluation using BSC-AHP combined technique. *Journal National Academy of Managerial Staff of Culture and Arts Herald* 2018; 4: 112–120. doi: 10.32461/2226-3209.1.2018.178687
11. Rezvani Befrouie A, Ghobadian V, Taghipour M. The design of high-rise building with ecological approach in Iran (Alborz province). *International Journal of Modern Trends in Engineering and Research* 2015; 2(10): 455–464.
12. Taghipour M, Ganji F, Zolfagharijoo A, et al. The identification and prioritization of effective indices on optimal implementation of customer relationship management using TOPSIS, AHP methods (case study: Pasargad bank). *Management, International Technology and Science Publications (ITS)* 2020; 3(4): 43–60. doi: 10.31058/j.mana.2020.34004
13. Taghipour M, Yazdi H. Seismic analysis (non-linear static analysis (pushover) and nonlinear dynamic) on cable-stayed bridge. *American Journal of Civil Engineering* 2015; 3(5): 129–139. doi: 10.11648/j.ajce.20150305.11
14. Taghipour M, Barzegar P, Mahboobi M, Mohammadi S. Investigating the relationship between competitive strategies and corporates performance (case study: Parsian Banks of Tehran). *Management, International Technology and Science Publications (ITS)* 2020; 3(4): 13–28. doi: 10.31058/j.mana.2020.34002
15. Taghipour M, Moosavi SA. A look at gas turbine vibration condition monitoring in region 3 of gas transmission operation. *Journal of Environmental Science Computer Science and Engineering & Technology(JECET)* 2020;

9(3): 423–432. doi: 10.24214/jecet.C.9.3.42332
16. Rahmani M, Shams SV, Abedi V, Taghipour M. Providing health, safety and environmental management (HSE) program in metal mining industry (including case study). *International Technology and Science Publications (ITS)* 2021; 4(3): 14–35. doi: 10.31058/j.mana.2021.43002
17. Taghipour M, Vaezi M. Safe power outlet. *Electrical Science & Engineering* 2020; 2(4): 5–10.
18. Tarverdizadeh H, Taghipour M, Nezamivad S. Predicting students' academic achievement based on emotional intelligence, personality and demographic characteristics, attitudes toward education and career prospects through the mediation of academic resilience. *Scientific Journal of Education Research* 2021; 16(65): 171–186.
19. Azarian R, Taghipour M. The Impact of implementing inclusive quality management on organizational trust (case study: Educatin). *Journal of Multidisciplinary Engineering Science Studies(JMESS)* 2020; 6(7): 3376–3383.
20. Jalali GA, Habibi Machiani H, Taghipour M, Moshtaghi S. Explain the relationship between intellectual capital, organizational learning and employee performance of parsian bank branches in Gilan province. *Educational Administration Research Quarterly* 2020; 10(2): 127–142.
21. Mohammadi S, Taghipour M, Mahboobi M. Investigating the role and impact of using ICT tools on evaluating the performance of service organizations. *Iranian Journal of Information Processing and Management* 2021; 37(1): 1–26. doi: 10.52547/JIPM.37.1.1
22. Abdi Hevelayi A, Hamedani SS, Saeed Abadi RY, Taghipour M. Predicting entrepreneurial marketing through strategic planning (including case study). *Educational Administration Research Quarterly* 2019; 10(2): 127–142.
23. Arsalani M, Esmaeilkhoo H, Taghipour M. Investigating the effect of social media marketing activities on brand awareness. *International Technology and Science Publications (ITS)* 2021; 4(2): 18–31. doi: 10.31058/j.mana.2021.42002
24. Khorasani Z, Taghipour M. The location of industrial complex using combined model of fuzzy multiple criteria decision making (including case study). *International Journal of Innovation Scientific Research and Review (IJISRR)* 2020; 2(7): 268–280.
25. Hoseinpour Z, Taghipour M, Hassan Beigi J, Mahboobi M. The problem solving of bi-objective hybrid production with the possibility of production outsourcing through Imperialist Algorithm, NSGA-II, GAPSO Hybid Algorithms. *Turkish Journal of Computer and Mathematics Education* 2021; 12(13): 8090–8111.
26. Taghipour M, Vosough A, Kazemi N, Ahitabar P. Study of the application of risk management in the operation and maintenance of power plant projects. *International Journal of Business Management* 2018; 3(3): 98–110.
27. Taghipour M, Sharifzadeh S, Seraj F. Risk assessment and analysis of the state DAM construction projects using FMEA technique. *Trends in Life Sciences an International Peer-Reviewed Journal* 2015; 4(2).
28. Baghipour Sarami F, Bozorgiamiri A, Mououdi MA, Taghipour M. Modeling of nurses' shift work schedules according to ergonomics: A case study in Imam Sajjad (As) Hospital of Ramsar. *Journal of Ergonomics* 2016; 4(1): 1–12. doi: 10.20286/joe-04011
29. Taghipour M, Sedaghatmanesh P, Safari M, Hekmati N. Identification and modeling of radio wave propagation channel in industrial environments. *International Journal of Innovative Research in Science, Engineering and Technology* 2015; 4(9): 9260–9271. doi: :10.15680/IJIRSET.2015.0409142
30. Taghipour M, Moghadam A, Shekardasht MNB. Implementation of software-efficient DES Algorithm. *Science Publishing Group* 2015; 3(1): 7–22. doi: 10.11648/j.net.s.2015030301.12
31. Sedaghatmanesh P, Taghipour M. Reduction of losses and capacity release of distribution system by distributed production systems of combined heat and power by graph methods. *American Journal of Electrical Power and Energy Systems* 2015; 4(6): 84–99. doi: 10.11648/j.epes.20150406.12