



STRATEGIC ROADMAP TO IMPROVE EV TECHNOLOGY

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INTRODUCTION

The EV market has been growing steadily and is forecasted for further growth. In India, range anxiety along with lack of sufficient charging infrastructure is still one of the biggest downsides of owning electric vehicles, and one of the major reasons as to why EV adoption rate is lower as compared to other bigger parts of the world. It is a challenge to incorporate higher energy density batteries and cut down on the weight at the same time, and due to this drawback, changes in HVAC (Heating, Ventilation and Air conditioning) systems of EVs is a solution. Tata Motors' initiative has already started to transform the Indian EV market as they manufacture passenger as well as commercial EVs. The Government of India has already defined the electrification roadmap until 2030 with the target of 30% EV penetration (Dada, 2021). This report addresses the transition that Tata Motors needs to make in the future to increase range by changing their HVAC systems, and also improvement plans in terms of driving forces and resistance to change.

TATA MOTORS

Tata Motors is India's largest automobile and original equipment manufacturer (OEM), leading the commercial vehicle industry with a market share of 45% (Dada, 2021), and is currently leading the megatrend of bringing e-mobility to India as it has more than 70% market share in the EV market (Dada, 2021). With heavy investments in their R&D sector (Figure 1), aim to increase driving range, and for high EV market penetration, Tata Motors is capable of adopting to new change.

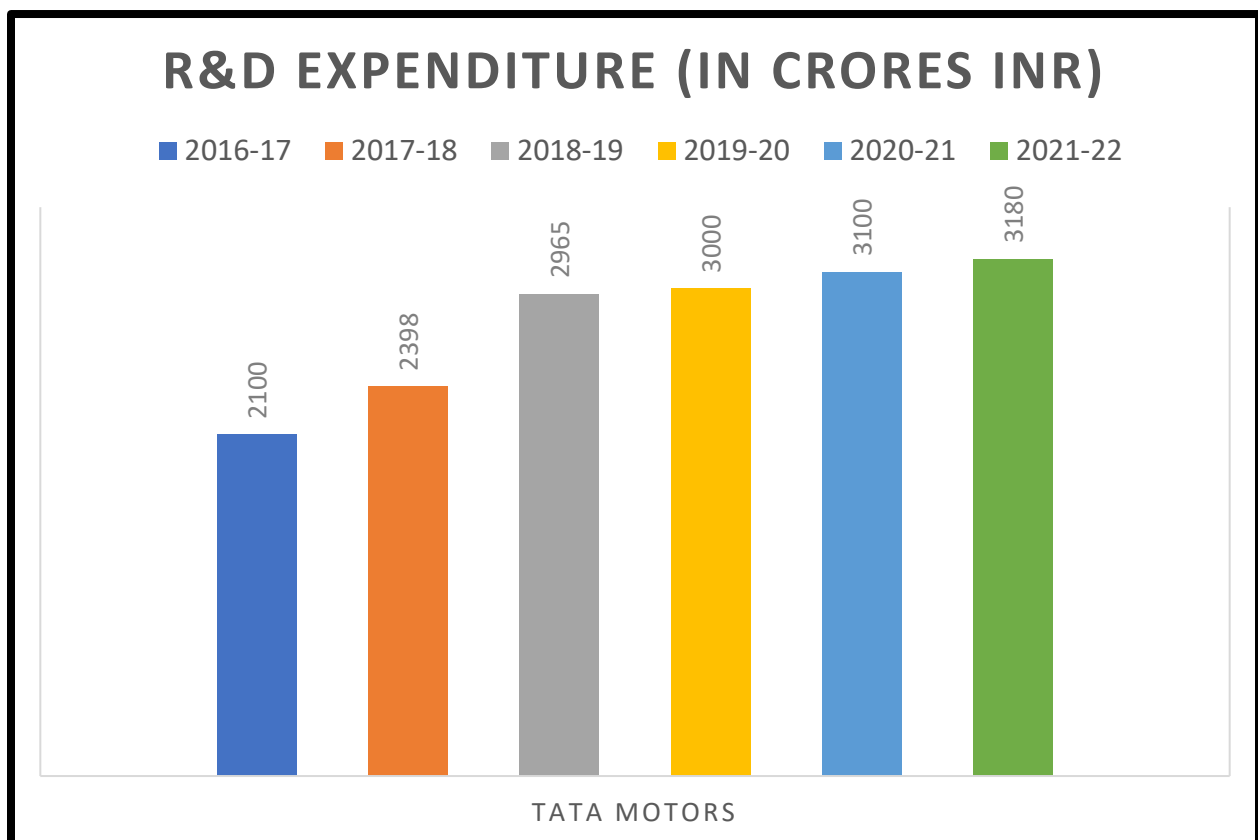


Figure 1: Tata Motors's R&D Expenditure (Narasimhan, 2019; Gohel, 2020; Tata Motors, 2021)

1 TECHNOLOGY MANAGEMENT INITIATIVE

The Indian cabinet's approval of a \$3.5 billion incentive scheme (five-year period) (Hampel, 2021) and continuous drive to promote manufacturing of local EVs under the FAME scheme (Times, 2021), Tata Motors has been provided with significant growth opportunities in the industry and this has influenced their operational model. Tata Motors already leads the EV sales in India (Sudhanshu, 2021), but still lacks in providing the highest driving range, and this is the reason why Tata needs to implement changes in their technology in order to be the leader in the complete driving experience along with sales.

From figure 2, EVs were in the Trough of Disillusionment for a long time as people waited for its complete development, and started losing faith in this technology due to lesser range and refueling/recharging than conventional ICE vehicles. Now, it's gradually moving to the Slope of Enlightenment with advancements in charging technology, infrastructure and range provisions, and due to these reasons, the electric vehicles are set to dominate the market till 2026. Traditional ICE vehicles still dominate the majority of the Indian automobile sector due to the above-mentioned drawbacks of EV, but also is an open invitation to development of better EVs.

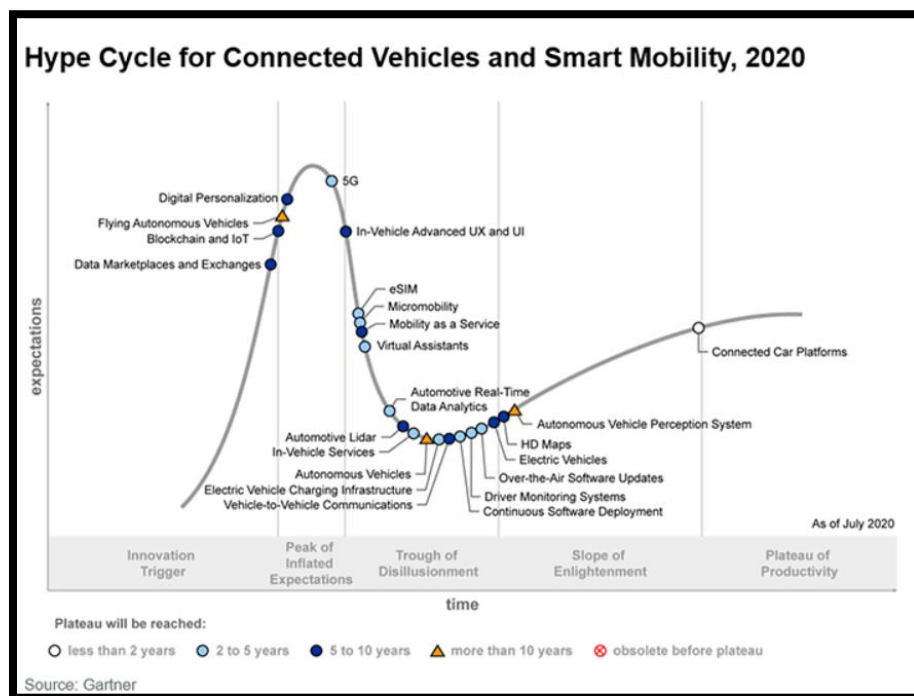


Figure 2: Hype Cycle for Connected Vehicles and Smart Mobility (Gartner, 2020)

Introducing heat pumps in the HVAC systems rather than standard electric resistance heaters is the change required in Tata Motors' new EVs. Heat pumps use the excess heat produced from batteries and the electric motor, and then distribute it to the cabin, which makes it beneficial for cold weather conditions. In hot weather conditions, heat pumps act as air conditioners by drawing out interior heat and humidity. Thus, the heat pump works both ways – acts as an air conditioner as well as a heater. A heat pump can produce 3kW of thermal energy for every 1kW of electric energy, thus resulting in an efficiency of 300-percent. Since the heat pump uses less energy in heating and cooling the cabin, it results in a better sailing range overall (Furyan Marine Technology, 2021). A heat pump developed by Visteon Corporation

consumed 50% less power than conventional heating systems and also increased the driving range by 30% (Dhimaan, 2021). MAHLE developed an ITS (Integrated Thermal System) based on heat pump which resulted in 20% prevention of driving range (MAHLE, 2019). Adoption of continuous improvement of heat-pump-based HVAC systems is Tata Motors' technology solution.

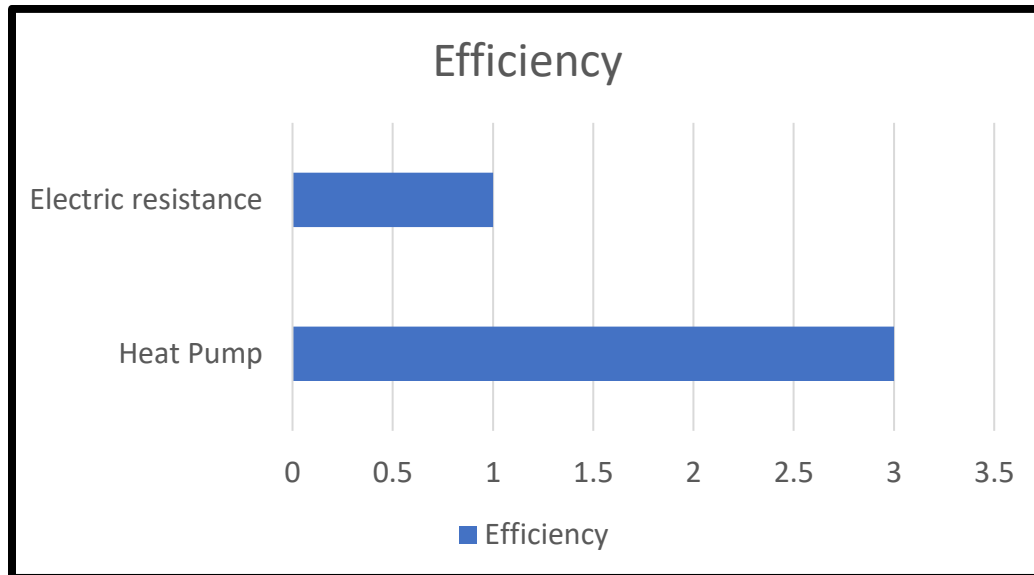


Figure 3: Comparison of efficiency in heating systems (Wachunas, 2020)

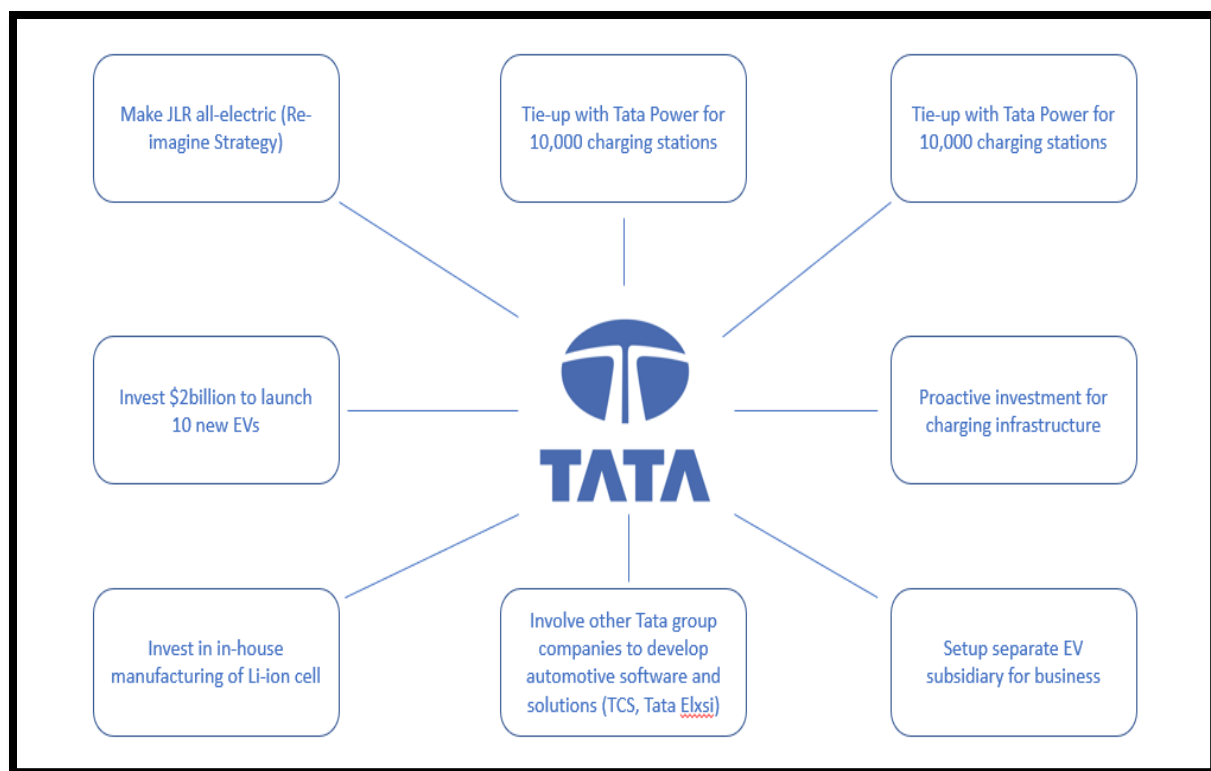


Figure 4: Tata Motors's Management Initiatives (until 2030) (Gaydon, 2021; Dada, 2021; Doval, 2021; Ghosh, 2021; Datta, 2021)

2 TECHNOLOGY ROADMAP FOR TATA MOTORS UNTIL 2026

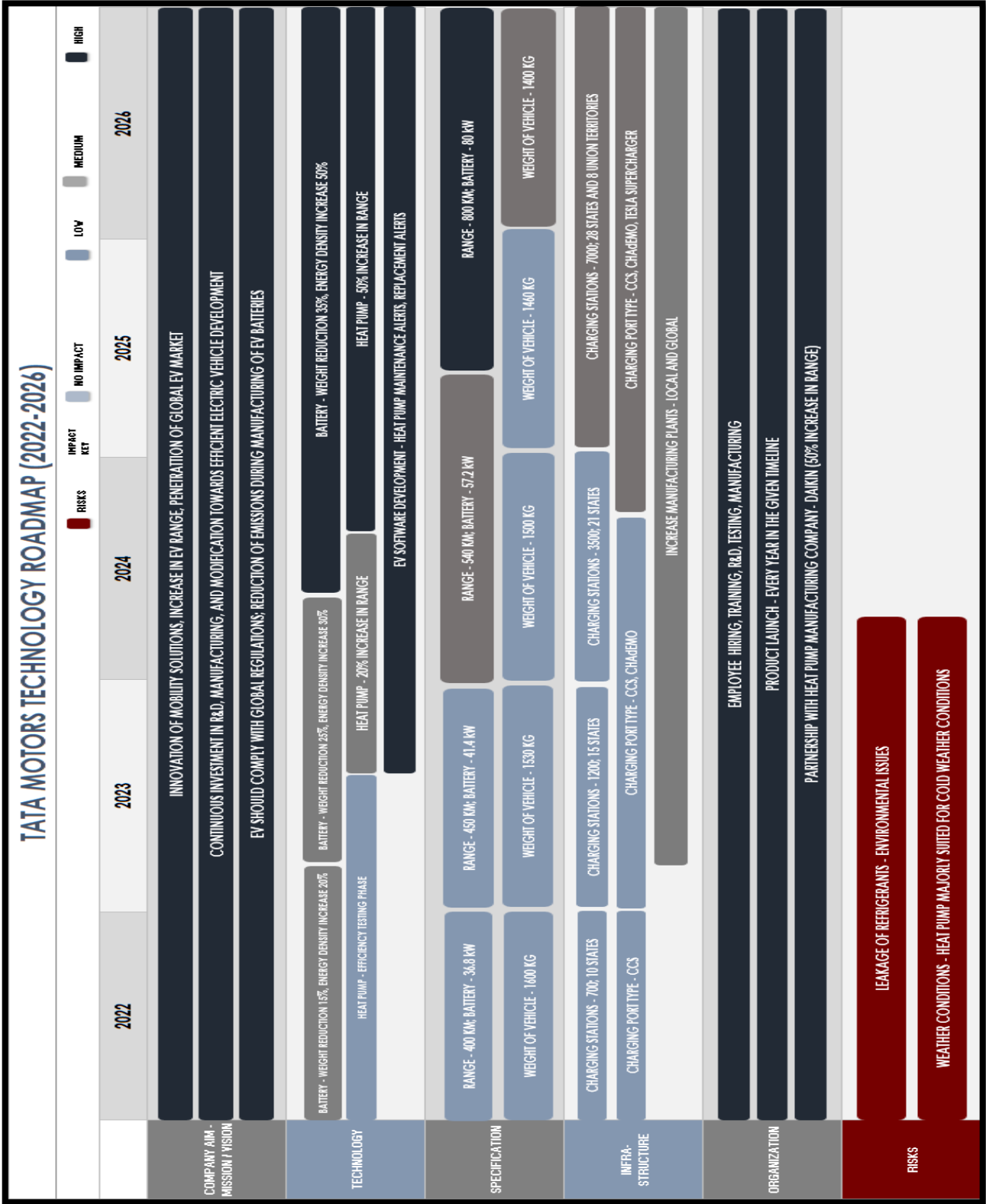


Figure 5: Technology roadmap for Tata Motors

3 COMPETITOR COMPARISON

3.1 INDIAN EV SALES

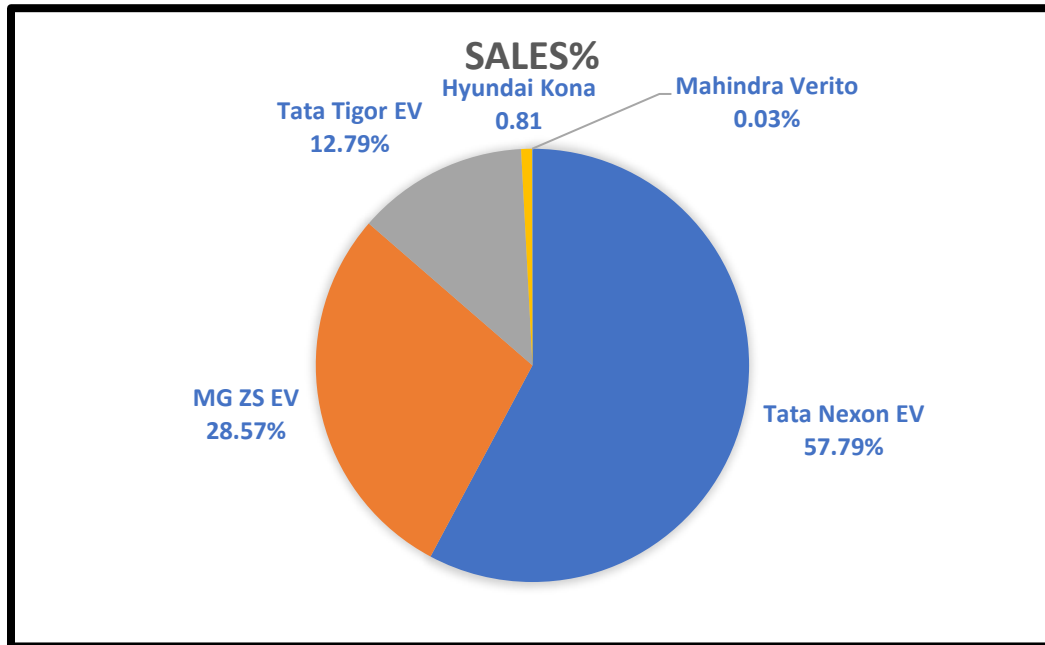


Figure 6: Tata Motors comprised of over 70% of India's total private EV sales for first half of FY22 (Sudhanshu, 2021)

3.2 COMPARISON OF TATA MOTORS WITH EVs USING HEAT PUMPS

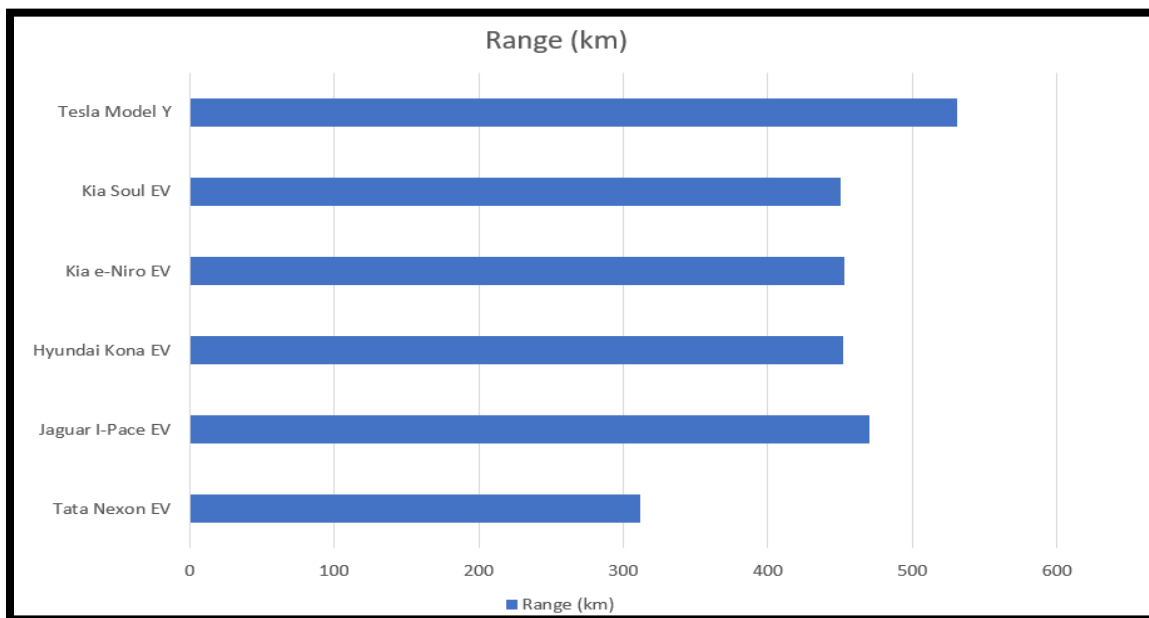


Figure 7: Range comparison of Tata Motors EV (without heat pump) vs competitors (with heat pump) (Auto Express, 2021; Horrell, 2021; Kane, 2021; Jaguar, n.d.; Top Gear Team, 2021)

3.3 SWOT ANALYSIS



Figure 8: Tata Motors' SWOT Analysis

3.4 PORTER'S FIVE FORCES

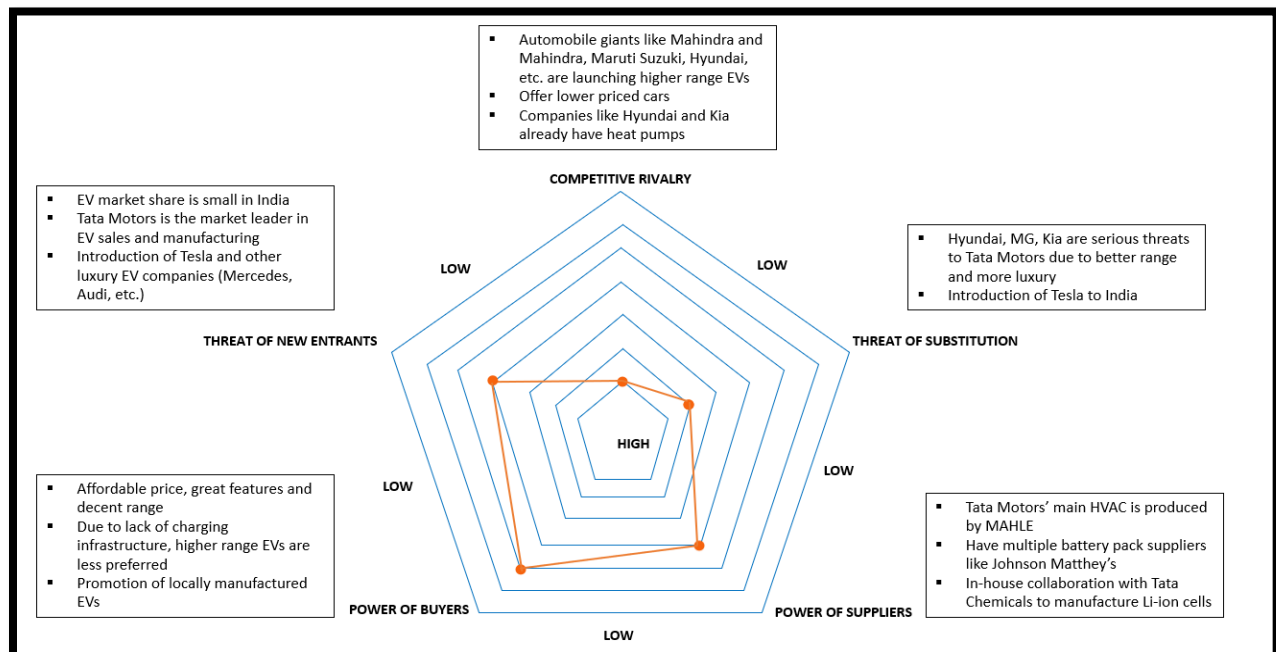


Figure 9: Porter's Five Forces Competitor Analysis for Tata Motors (Laskar, 2021; News18, 2020)

4 TYPES OF CHANGE MANAGEMENT REQUIRED

McKinsey senior partner Harry Robinson explained that roughly 70% of technology initiatives fail (Robinson, 2019). It is critical for organizations to know how to undergo changes, and to be able to sustain the changes in industry. Failure of effective change management has negative impacts on the company – loss of market position, removal of senior management, demotivated employees, loss of key employees, loss in stakeholder credibility (George, 2021).

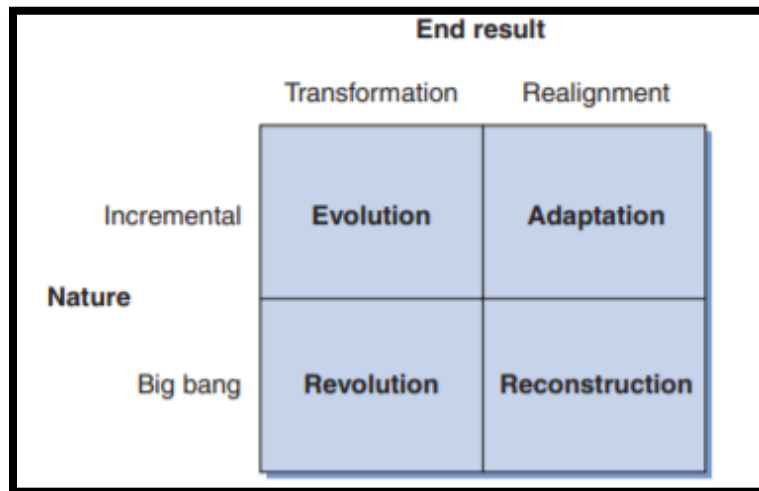


Figure 10: Types of Change Management (Balogun, et al., 2016, pp. 23-31)

Adaptation management means creating a steady stream of quality projects that either look to improve the business, develop and operationalize innovations or respond to changing market conditions (Schwisow, 2015). A company is sustainable when it adapts and progresses towards changes in the market (Mehedintu & Munteanu, 2016). Due to global advancements in the EV as well as automobile market, the ideal change process that Tata Motors should undergo is Adaptation because cutting-edge EV technology already exists globally, but Tata Motors can improve by benchmarking and continuous improvement.

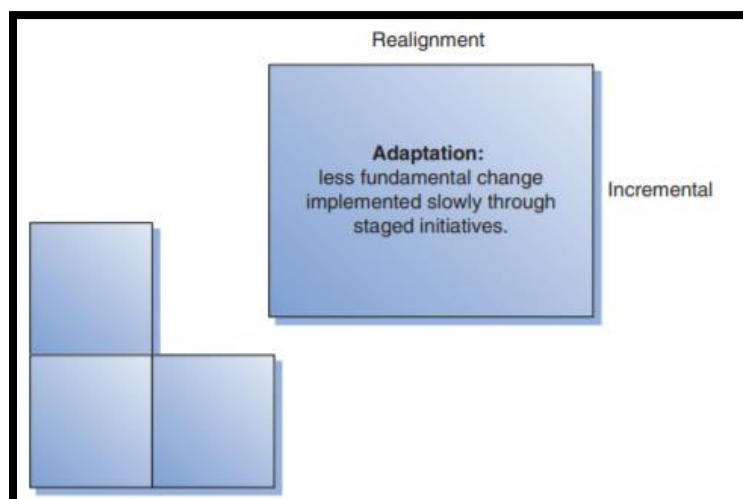


Figure 11: Adaptation change strategy (Balogun, et al., 2016, p. 31)

4.1 PESTEL ANALYSIS

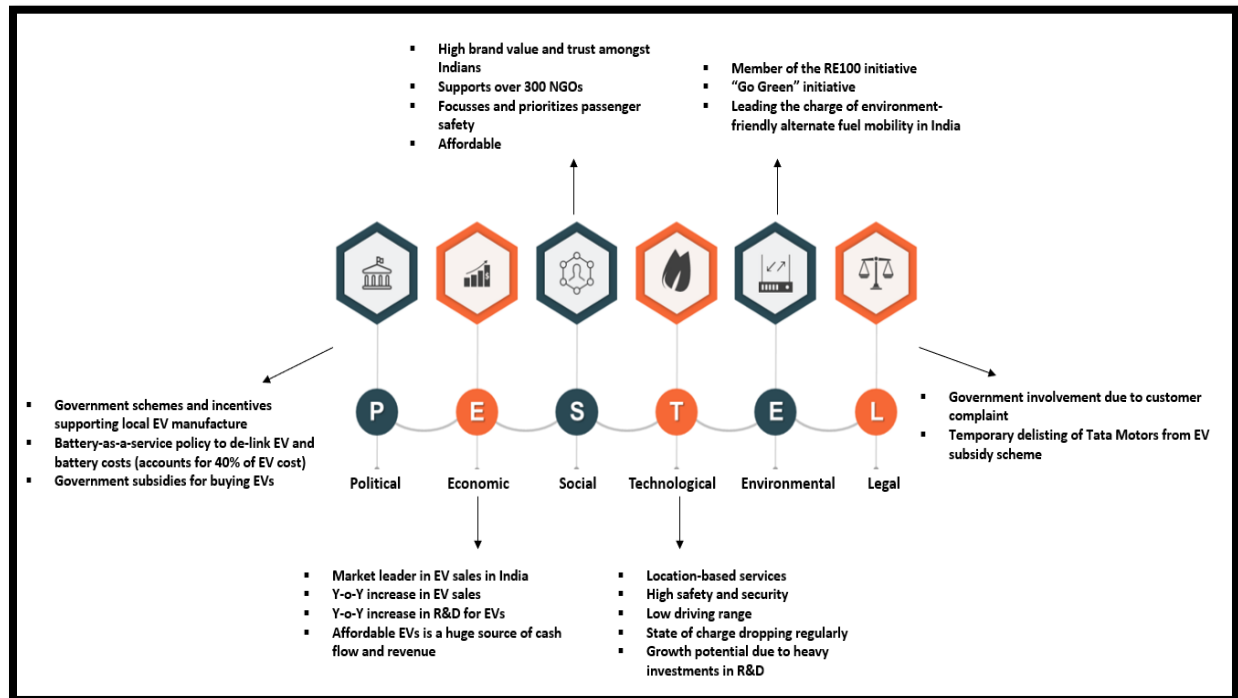


Figure 12: PESTEL Analysis for evaluation of key driving forces (Pathak & Patel, 2021; Wangchuk, 2021; Guenter Butschek, 2016; Team, 2020; RS, 2021; India, 2021)

4.2 KEY DRIVERS FOR CHANGE

To implement technology changes in any industry, there are key driving forces that contribute to its faster growth. The major driving forces for implementing heat pump technology are listed below:

- Customer Experience –
 - Increase in driving range improves driving experience
 - Reduction in range anxiety up to a certain extent
 - Increases brand value, trust and adoption of Tata Motors' EV
- Technology –
 - Prevention of heat wastage since excess heat is reused in HVAC systems
 - Heat pumps work in reversible direction i.e., heating and cooling provision
 - Increased efficiency due to lesser load on battery
- Environment –
 - No carbon emissions when working at full capacity

Other factors like Government support like subsidizing of EVs, promotion of local manufacturing, financial support for R&D, and public appreciation towards electric vehicles and their upcoming technologies play an important part in the driving forces for technology. Development of new technology will also result in increase of jobs, thus proving to be another key driving force.

The key drivers for change (positive driving forces) are mentioned in the figure 13 as shown below:

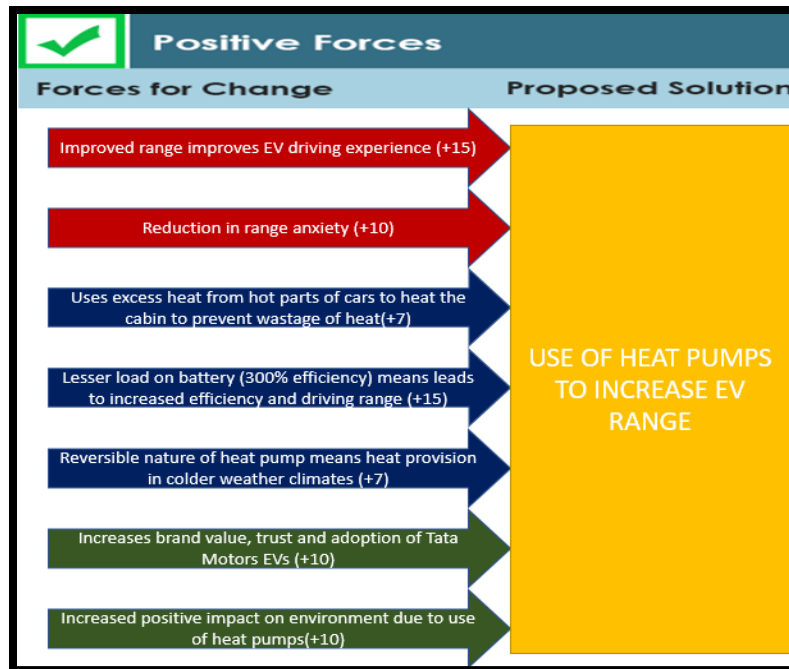


Figure 13: Key drivers for change

5 RESISTANCES TO CHANGE

Changes in technology lead to changes in the work culture, which in turn leads to Organizational inertia or the resistances to change in an organization. The resistances to change for Tata Motors' initiative are:

- Organizational –
 - Entire organization resists to changes
 - Internal power struggles
 - Poor decision making
 - Ineffective corporate systems result to protests and strikes
 - Lack of trust to new technology
- Individual –
 - Unawareness of new technology and corporate structure
 - Extensive research required to understand heat movement, as well as cabin cooling and heating requirements (based on geographic location)
 - Threatened feeling of replacement by either new staff or automation
 - Short-term effort seems tedious as compared to long-term yields
 - Lack of motivation to adapt to change

Depending on what heat pump the company opts to implement, its efficiency is bound to vary in colder temperatures. Figure 14 shows how Tata Motors' technology solution may face resistance to change in technology.

The Force Field analysis in figure 15 shows us that even though there are restraints to changes, the driving forces are stronger and thus, Tata Motors will be able to sustain the organizational change momentum.

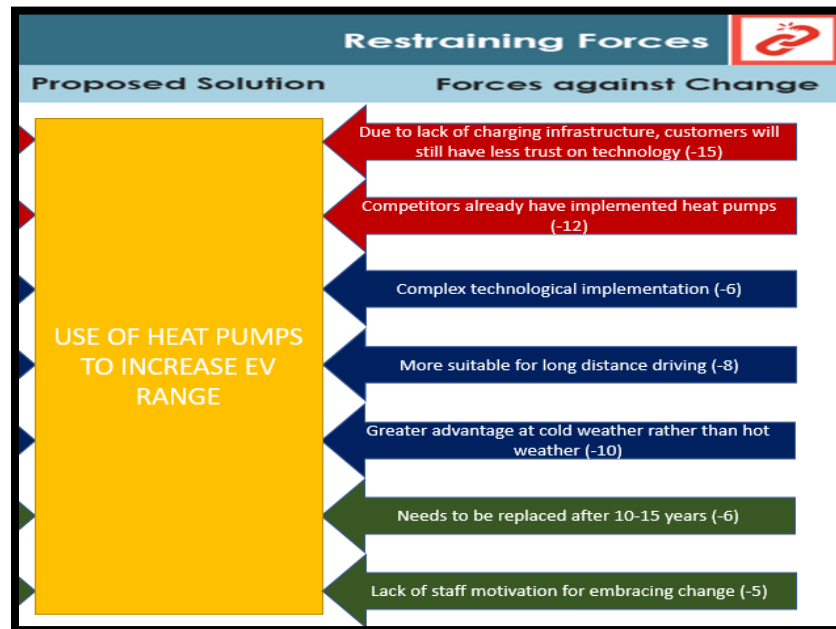


Figure 14: Resistances to change

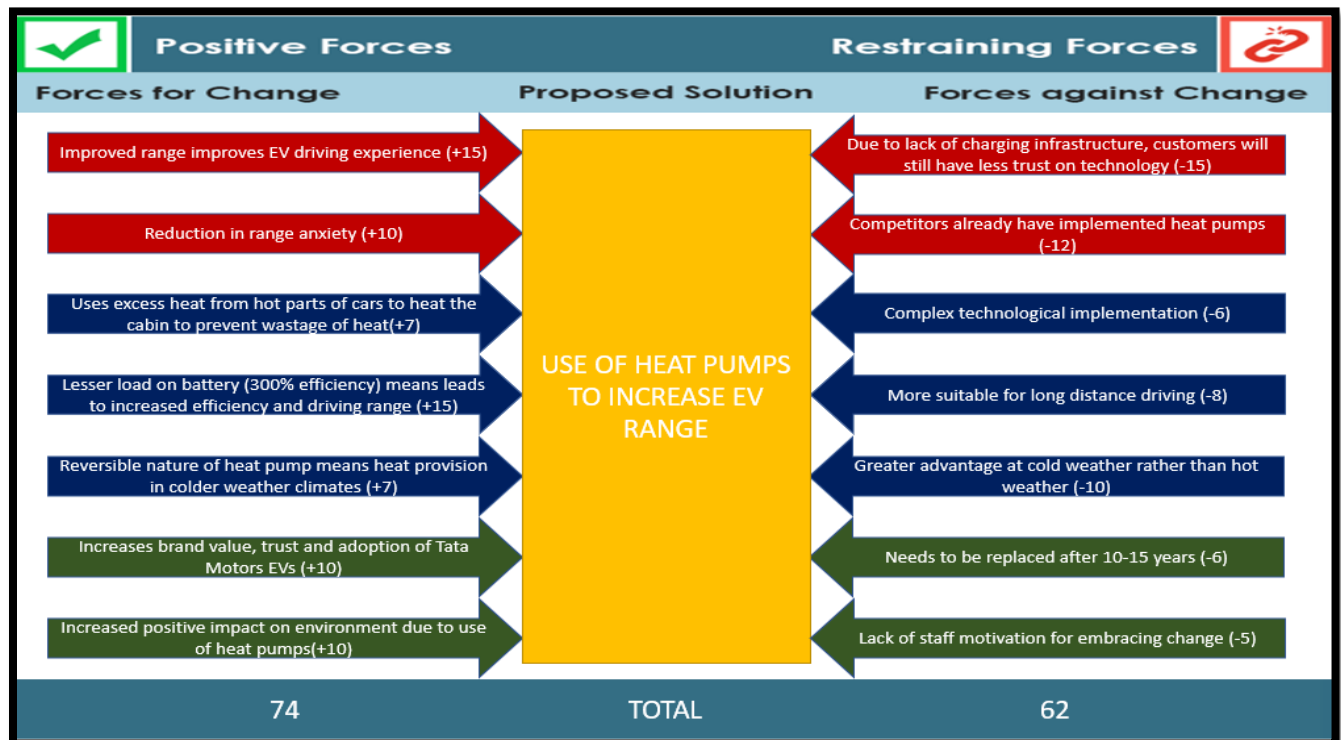


Figure 15: Force Field Analysis

5.1 ADKAR MODEL TO ANALYZE CHANGE AND OVERCOME RESISTANCE

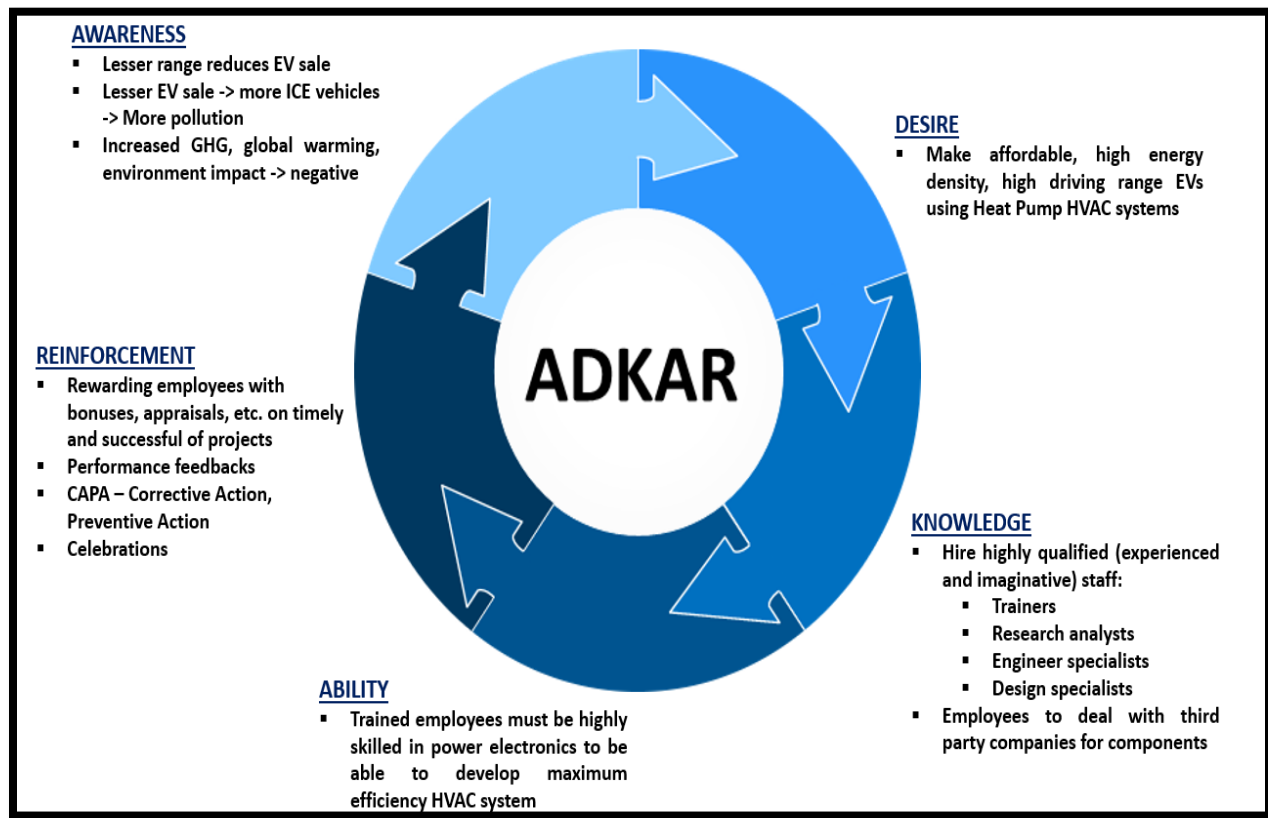


Figure 16: ADKAR model for process development and change management (Prosci, n.d.)

6 HARD AND SOFT CHANGES WITHIN THE INDUSTRY

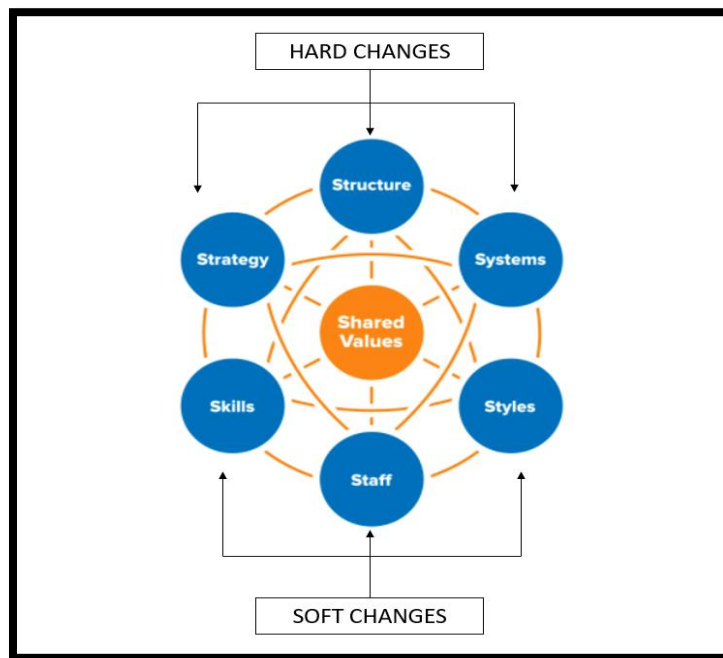


Figure 17: McKinsey's 7S model for Hard and Soft Changes (Team, n.d.)

6.1 HARD CHANGES

- Strategy
 - Aim to penetrate the global automobile as well as EV industry
 - Pricing strategy – Diverse due to cheap cars like Tata Nano (world's cheapest car) and the Jaguar Land Rover series (luxury)
 - Continuous investment for development of EV and its charging infrastructure
- Structure
 - Matrix organizational structure – Not traditional hierarchical work culture. Collaborations through various departments result in efficient day-to-day processes.
 - Each Head of Division/function – Solely responsible for performance of their area of work
- Systems
 - Quality control – Quality brings efficiency; thus, Tata Motors focuses on quality control across all processes. Continuous improvement, waste reduction, variations in supply chain, proactiveness in prevention of defects
 - High priority – Quality, customer satisfaction, comfort, safety, sustainability, continuous investments in R&D (Guy, n.d.)

6.2 SOFT CHANGES

- Staff
 - Number of employees – 78,906 (2021)
 - Inclusion and promotion of LGBTQ+ - Hiring of 276 bi-six employees (Desk, 2021)
 - Employee bonuses – Range from \$304 to \$3903 with average bonus being \$1027 (scale, n.d.)

- High motivation – Tata Motors ERC (Engineering Research Centre) has highly skilled and motivated employees that create EV technologies
- Skills
 - Engineers at Tata Motors have great technical expertise
 - Hired from highly world-renowned universities in India
 - Proficient in skills required to do the job
 - Fast-learners and capable of acquiring new skills for continuous R&D
- Style
 - Tata Motors' management have shown great leadership
 - Ratan Tata, Chairman Emeritus – Charismatic leadership traits; turned loss-making business to a tremendous profit-generating one; signed a deal with Ford Motors to buy luxury cars, Jaguar and Land Rover
 - Current upper management is successfully driving their teams towards EV technology development, making Tata Motors the number one company in EV sales in India
- Shared Values
 - Mission – Innovate mobility solutions with passion to enhance quality of life
 - Vision – Become the most aspirational India auto brand (TATA Motors European Technical Centre, n.d.)
 - Tata Motors' innovation and technology-driven approach towards EV development aligns with their mission and vision as heavy investments for EVs, charging infrastructure, partnerships with Tata Group companies are being made to provide customers with the best driving experience and mobility solutions.
 - Motto – Connecting Aspirations; an interconnected system of mobility solutions that are intelligent, perceptive, warm and expressive. It's a symbolic tagline that is the past, present and future (Tata Motors, 2017).

7 MAJOR RISKS OR DOWNTRENDS OF THE TECHNOLOGY INITIATIVE

Heat-pump based HVAC systems will increase battery efficiency by 300% (3 units of energy for every 1 unit), have a positive impact on the driving range of the vehicle, and provide efficient heating and cooling in difficult weather conditions. There are a few drawbacks to be considered:

- Environmental – At maximum efficiency, there is no carbon emission. But heat pumps have refrigerants in them, and regular maintenance is a must because if the refrigerant leaks, HFCs are emitted and can cause ozone depletion (lesser than CFCs).
- Weather conditions – Heat pumps are mainly advantageous for cold weather conditions. India being a rather warm country has few geographical locations with cold climatic conditions.
- Cost – Investing extra in heat pumps for small distance journeys is more expensive than electric heaters.
- Replacement – They have to be replaced in every 10-15 years given that there has been regular maintenance.

CONCLUSION AND RECOMMENDATION

Heat-pump-based HVAC systems for electric vehicles have a lot of potential for further upgrades and increase driving range. It's a game changer in the industry and will yield Tata Motors profits and greater adoption towards EV. Since Tata Motors manufacture high-quality yet affordable vehicles, their local and global EV market value will see upward trends in the future, and heat-pump-based HVAC systems will contribute to this because continents like Europe and North America do have very cold climatic conditions. The use of refrigerants like R134a, which have zero potential for ozone layer depletion should be used in the heat pumps for greater environmental sustainability. Incorporating a circular economy system by using recyclable raw materials for manufacturing new vehicles would reduce a lot of material waste, and the scrapped vehicular material could be reused for manufacturing new electric vehicles, thus contributing substantially towards environmental sustainability. Finally, reduction of emissions caused due to manufacturing of EV batteries, combined with all previous recommendations will lead to overall growth of the company. As a result, Tata Motors will continue to lead the Indian EV market, generate Y-o-Y profits, increase in revenue, maintain their aim to positively impact the environment, and attract global customers.

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