

EFFECTS OF GREEN PRODUCT INNOVATION AND GREEN STRATEGY ON COMPANY PERFORMANCE: ARÇELİK A.Ş. CASE FROM TURKEY

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ABSTRACT

Green innovation has been a popular concept due to scarce environmental resources. Companies should conduct green innovation practices to have a sustainable growth and competitive advantages in the market place. If companies have green innovation strategies which are consistent to their corporate strategies and make green product innovations according to them, they can improve their performances. Green strategy and green product innovation have positive effects on performances of companies. The purpose of this study is to shed a light to the effects of green product innovation and green strategy on the performance of a Turkish company Arçelik A.Ş.

Keywords: Green Innovation, Green Product Innovation, Green Innovation Strategy, Company Performance

GREEN INNOVATION

Green innovation is essential for companies to balance requirements of their stakeholders, have competitive advantages, and grow continuously. Managers need to leave substantial budgets for green innovation practices and control their efficiencies for sustainability.

Green innovation is the generation of new ideas, management systems, goods, services, and processes for achieving sustainability and reducing environmental pollution (Rennings, 2000). It can enhance product value, balance environmental investment costs (Chang, 2011), enable companies to meet environmental regulation requirements (Barney, 1991) and enhance environmental and economic performance (Chan, 2005) [4, p. 1090].

Green innovation requires a process to modify a product design to decrease negative environmental effects during the product life cycle (Chen et al., 2006; Chiou et al., 2011). According to the literature (Chen et al., 2006; Chen, 2008; Chiou et al., 2011), green innovation is classified as green product innovation and green process innovation [3, p. 316].

Green innovation has the following components: (1) Green product innovation is the commitment of the company to innovate products to decrease environmental effects in the supply chain (Cleff and Rennings, 1999; Chen et al., 2006); (2) Green process innovation is the corporate responsiveness to enhance production processes to line up with eco-efficiency trends and innovative technologies related to corporate environmental management, pollution prevention, energy saving, waste recycling, and green product design (Cleff and Rennings, 1999; Chen et al., 2006). (3) Green management innovation is the corporate effectiveness to manage green supply chain and organize resources, operations and budgets (Chiou et al., 2011) [8, p. 195].

The main focus of green innovation is protecting the environment through eco design, energy saving, reducing waste and pollution, recycling, green purchasing and production (Chen et al., 2006). Companies can adopt green innovation by implementing new hardware and software to enhance economic and environmental performances [5, pp. 97-98].

Chang's (2011) measurement for green innovation is as follows: (1) The company chooses materials which produce the minimum amount of pollution for the product development and design; (2) The company uses minimum amount of materials for comprising the product development and design; (3) The company plans reusing, recycling, and decomposing alternatives for a product before product development and design; (4) The production process decreases the consumption of electricity, water, oil or coal; the emission of hazardous substances and waste and the use of raw materials [6, pp. 142-143].

GREEN PRODUCT INNOVATION

Green product innovation has been conducted by several companies for launching new distinguishing products or improving the current ones. It requires additional efforts such as developing effective relations with suppliers and customers. Companies should sense green product innovation expectations of their customers and adopt themselves and their suppliers to develop new products based on them.

Green product innovation can be defined as the production of a new product by leaving no negative effects on the environment or less effects than competing or existing products (Wong et al., 2012) [7, pp. 40-41].

Green product innovation is related to using environmentally friendly materials and packaging, eco-labeling, recovering products and recycling (Zhu and Sarkis, 2004; Chiou et al., 2011) [3, p. 316].

There are four factors to measure the green product innovation: (1) companies develop strategies for using less raw materials during product design and development (Fei et al., 2016); (2) companies should develop products which use fewer amounts of energy while they are working; (3) companies should formulate strategies to develop products which have fewer amounts of material; (4) products should be recycled (Chiou et al., 2011). Companies can decompose products easily and re-manufacture by using same materials. The product design should be environmentally friendly. Companies should involve in green product innovation to enhance their economic and environmental performances (Sun et al., 2017) [5, p. 98].

GREEN INNOVATION STRATEGY

Companies should formulate green innovation strategies if they want to achieve influential green innovation practices. It is the duty of top management and they should be alligned to the corporate strategies to succeed.

A green innovation strategy is a major environmental strategy. Many researchers have explored effects of green innovation strategy on company performance and competitive advantage. Sharma and Vredenburg (1998) revealed the relationship between green innovation strategies, organizational capabilities, and how they were related to competitive advantages. Eiadat et al. (2008) examined effects of managerial environmental concerns, stakeholder pressures, and government environmental regulations on the development of green innovation strategy. The number of companies which have green innovation strategies as important means of having competitive advantages has been increasing (Chang, 2011; Chen, 2011). Several studies have examined greening suppliers, building green core competence, and achieving environmental sustainability for improving green innovation (Chen, 2008; Dangelico and Pujari, 2010; Chiou et al., 2011). A company should use its resources and human and technical capabilities to achieve

its green innovation goal (Amit and Schoemaker, 1993). According to the resource based view, resources are considered as the foundation of potential of a company for innovation (Chen, 2008). When a company focuses on a green innovation strategy, it increases its resources for green products and processes to enhance green innovation. Green innovation strategy triggers green innovation by reducing pressures of governmental policies on the company. Companies should have a proactive approach by formulating green innovation strategies to create a context for environmental innovation instead of to react to government-imposed restrictions (Eiadat et al., 2008). Companies coordinate different resources for green products and processes during implementing green innovation strategy to initiate green innovation. A green innovation strategy leads a company to avoid economic and social costs of environmental destruction, develop market opportunities and enhance competitive advantages (Henriques and Sadorsky, 1999; Chen et al., 2006). Environment conscious customers prefer green products and can pay higher prices for environmentally friendly products (Henriques and Sadorsky, 1999; Chen, 2008). A green innovation strategy is a crucial method for improving green product innovation and satisfying customer needs. An environmental strategy can trigger a company to apply green environmental ideas to designs and packages of products to increase the level of green innovation (Shrivastava, 1995) [6, pp. 135-138].

Since environmental innovation has more social returns than profit returns for companies, they don't make required investments. Environmental innovation is very systematic that it requires to use different raw materials, recycled products and manage wastes. Thus, companies should develop coordination and cooperation with their clients and suppliers. Depending on stakeholders for resources can influence the decision to engage in CSR initiatives (7, 2015). The high risk of failure and the uncertainty related to the outcome show environmental innovation a challenging task, depending upon characteristics of a CEO such as his risk appetite. Innovative strategies reducing pollution, environmental risk, and negative effects of resources cause taking actions under uncertainty (Nidumolu, Prahalad and Rangaswami, 2009) [1, p. 321].

A company should focus on product and process innovation tasks to achieve the environmental innovation goal. Managers should make employees realize that the company is ready to make efforts in green innovation. It initiates green awareness in the company and creates green core beliefs and values. Organizational identity can affect employee actions and provide reference for issues surrounding green innovation strategy (Chang and Chen, 2013). The green innovation strategy can have a positive influence on green organizational identity. First of all, it can shape product stewardship, environmental awareness of pollution prevention, and clean technology (Hart, 1997). Employees can realize that leaders pay attention to environmental problems and formation of green core values and beliefs which drive organizational behaviors by formulating green innovation strategy increasing green organizational identity capacity to deal with environmental pressures [6, pp. 138-139].

COMPANY PERFORMANCE

Green innovation practices affect company performance in several dimensions namely environmental performance, financial performance, managerial performance, operational performance and stakeholder performance. Companies which formulate appropriate green innovation strategies can achieve successful green innovation practices and reach higher company performance.

Fujii et al. (2013) reveal a positive relationship between reducing CO₂ emissions and financial performance in Japanese manufacturing companies. Callan and Thomas (2009) show a positive relationship between corporate social and financial performances. Dangelico and Pontrandolfo (2015) point out a positive link between product and process related environmental actions and company performance. Chen et al. (2006) reveal that performance of green product and process innovation is

positively related to competitive advantage. Dangelico and Pujari (2010, p. 480) show benefits of integrating environmental sustainability aspects with business operations and product development, including 'increased efficiency in the use of resources, return on investment, increased sales, development of new markets, improved corporate image, product differentiation, and enhanced competitive advantage'. Innovation which offsets environmental initiatives' costs due to the technological change leads companies to be more competitive (Thurow and Holt, 1997). Green product innovation leads companies to use their raw materials more efficiently, transform waste into a useful resources and decrease their costs (Porter and van der Linde, 1995). A company's engagement in green innovation is a managerial decision-making and concern rather than a matter of business policy or best practice. Managers who are more concerned about green issues devote more attention, time, and support to strengthen the likelihood of green innovation positively affecting company performance (Bansal and Roth, 2000; Papagiannakis and Lioukas, 2012; Papagiannakis et al., 2014) . Several studies point out a positive relationship between green innovation and company performance (Pujari, 2006; Chen et al., 2006; Gluch et al., 2009; Chiou et al., 2011). Concern for the environment has a positive effect on adopting environmental innovation strategies (Bansal, 2003; Eiadat et al., 2008; Qi et al., 2010; Testa et al., 2016), It is also a trigger for green innovation to enhance company performance (Ar, 2012). Dangelico (2015) believes that considering environmental issues is a success factor for green product innovation. Tang et al. (2018) reveal that green product and process innovation positively affect company performance. A meta-analysis of 64 studies published between 1978-2008 revealed that 55% of the studies found a positive, 30% a null, and 15% a negative impact of environmental performance on company performance (Horváthová, 2010). A meta-analysis of 63 studies published between 1991 and 2013 showed that green product innovation improved company performance (Dangelico, 2016) [7, pp. 39-44].

The effect of green innovation on the sustainable performance was presented in these studies: (1) Zailani et al. (2015) highlighted the integration of factors through green innovation which showed the positive effect on the sustainable performance in terms of the increase in competitive advantages and productivity; the decrease in costs (Eiadat et al., 2008) and waste in manufacturing process (Zailani et al., 2015) through environmental regulations (Eiadat et al., 2008), market needs (Chiou et al., 2011), corporate policies and practices on initiatives of green innovation (Eiadat et al., 2008). Weng, et al. (2015) revealed the effect of green innovation on the corporate and environmental performances in terms of stakeholders namely employees, competitors, suppliers, customers, and officials (Freeman, 2010) to determine decisive policies on green innovation which affected the efficiency of management and production leading to social and environmental performance (Renning, 2000) [8, p. 193].

Pressures from stakeholders affect green innovation strategy to enhance environmental sustainability and social welfare lead companies to adopt environmentally friendly business practices. Green innovation improves resource efficiency of manufacturing process (Lee and Kim, 2012; Scarpellini et al., 2012; Chang and Lin, 2014 and Minguela-Rata et al., 2014). Green innovation creates new markets, improves company reputation, competitive advantages and performance. Green innovation practices increase social legitimation, reputation, sales, market share, profitability, and performance. Paraschiv et al. (2012) show that green innovation affects company performance and stakeholder trust positively. Several studies reveal that green innovation decreases costs, improves business and environmental performances (Lin et al., 2013; Alhadid and As'ad, 2014; Weng et al., 2015) [2, pp. 154-156].

Green innovation improves products and processes leading to environmental and economic performances. Environmental, operational and economic performances increase customer satisfaction and decrease costs for environmentally sustainable products (Green Jr et al., 2012) [5, pp. 91-92].

Researches point out that green innovation investments initiate positive economic benefits and improvements (Chen, 2008; Peng and Lin, 2008; Huang and Wu, 2010; Chiou et al., 2011; Przychodzen and Przychodzen, 2015). Green innovation has substantial organizational benefits to enhance competitive advantages, performance (Peng and Lin, 2008; Chiou et al., 2011; Zhu et al., 2012), image and reputation (Chen, 2008). Green product and process innovation are found positively related to environmental performance (Huang and Wu, 2010; Chiou et al., 2011; Dong et al., 2014). Huang and Li (2017) find that green product and process innovation have positive influences on organizational and environmental performances [3, pp. 309-324].

ARÇELİK GREEN INNOVATION CASE

The purpose of this case is to shed a light to the effects of green product innovation and green strategy on the performance of a Turkish company Arçelik A.Ş.

Arçelik A.Ş is one of the sub company of Koç Group, the leader company in Turkey and 3rd one in Europe in consumer electronics sector with its white goods, kitchen accessories, and small home appliances. Arçelik with unique products and technologies takes its domestic leadership position to the worldwide level, presents its services and products in 146 countries, by producing in 21 manufacturing plants in 8 different countries and by selling with 34 sales and marketing offices in 30 countries. Arçelik develops value added products for its customers with 1500 R&D personnel who work in 2800 inventions in nine R&D Centers in six countries [11].

The modern business world has the responsibility to obtain requirements and expectations of customers to manufacture end-to-end solutions for economic and environmental problems of the society. Koç Holding has several manufacturing and service companies which are sensitive to sustainability in Turkey. It turns risks into opportunities by improving environmental issues with creative, sustainable and innovative solutions through experiences they pursue with an innovative perspective which brings urgencies of sustainability to the forefront [12].

The environmental policy has been formulated and applied in Koç Holding with "Sustainable Development and Environmental Protection" thoughts. It provides solutions for environmental impacts by reducing energy consumption, water usage, emission and waste. The purpose is to increase recycling, protect biodiversity, and work on improvements to realize goals based on "the best existing practices". Additionally, Koç Holding tracks environmental impacts of products and services during their life-cycles, beginning with their design and ending with their economic lives. It reduces environmental impacts by producing sustainable and environmentally friendly products [13].

Consuming low levels of energy and water and decreasing noise levels are critical issues for the company vision. Arçelik R&D which allocates resources has the following priorities: big data analysis, cyber security approaches, sensor technologies, system and material-component based design and advanced analysis methods and remote access protocols. Many products which were developed by R&D department were exhibited in consumer events in 2018. IFA is one of the most famous and strategic global consumer electronics fairs in the world and Arçelik's innovative and high-quality products were exhibited at IFA in 2018 [10]. The following list indicates sustainable products that were presented in Berlin in 2018 [10]:

- The Grundig Diamond is manufactured from carbon fiber which is stronger and lighter than steel with 25-year-warranty
- Technology of Fresh-Guard® eliminates bad smells up to 90% with no harmful substances with special coated filters and UV LEDs.

- Washing machine of Beko with AquaTech™ technology provides up to 50% more precise and faster washing performance.
- AirTouch® technology of Grundig, which is the laundry dryer, dries delicately and efficiently.
- Microfiber Filter technology prevents microfiber leakage up to 99% from machines to water resources.
- Technology of AntiCrease® prevents crease and has Air Refresh feature which ventilates 1 kg daily garments with hot air circulation in 30 minutes.
- Gourmet Chef Intelligent Oven of Grundig is equipped with sensors and new technologies to provide greater precision.
- Beko Combi Steam Oven offers advantages of both traditional cooking and vapor cooking.
- PractiClean™ makes cleaning easier than stainless steel stoves.
- Technology of FlameAdjust™ lets the user adjust fire level with a 9-stage power alternatives and time.
- Technologies of HobToHood® and HobToHood+ work with un-wired connection units and temperature sensors, automatically adjust the hood speed according to the hob to optimize noise and energy consumption.
- FlexiSmart Induction hob allows to infrared sensors to have the best results in a variety of foods.
- Automatic dosing is the first home dishwasher in Europe with a liquid detergent adjustment system.
- Smart assistant Arçelik Asista is the world's first Turkish-speaking assistant, and let users to manage voice-control with various applications, such as smart home functions and news.
- Alexa Built-in OLED TV in Europe enables consumers to interact with Amazon Alexa™ by remote control.
- Slow Fruit Juicer prevents around 80% of vitamins by protecting oxidation and producing 15% more vegetable and fruit juice.
- Quiet Mark certified eco-friendly SilenceDry™ hair dryer reduces noise with centrifugal fan design and DC motor design.
- Bagless Imperium® is the quicker vacuum cleaner with A+++ successful energy consumption, special insulation and capsule design of the Quiet Mark which minimizes noise levels.
- Tornado® is the world's first 5A electrical bagged vacuum cleaner.
- A new generation of Vacuum Blender prevents oxidation and discoloration in food when it has an air contact by the help of vacuum technology.
- Ehl-i Kahve Turkish coffee machine with six different coffee alternatives makes coffee by selecting coffee design algorithm based on the main voltage.

By examining the company sources and these innovations, it is understood that Arçelik A.Ş. has green innovation strategy to conduct green product innovation practices and improve its company performance.

MINI INVERTER COMPRESSOR PROJECT

In this paper, with the help of Yeşilaydın, who is the R&D System Design Team Leader and Çetintürk who is the Principle R&D Engineer at Arçelik Compressor Company, one of the most critical innovative and sustainable projects of Arçelik is introduced and analyzed in detail based on the green innovation principles described in the literature. This project is called as Mini Inventor Compressor Project. The following sections are summarized from Project Details Document prepared and provided by Çetintürk and Yeşilaydın (2019). In the beginning, a project brief is given and expected targets and outcomes of the project are explained from the green innovation perspective. Then the purpose, definition and scope of the project are summarized, objectives, leadership, methods and techniques are described. Finally, outcomes are explained by comparing the expected performance results.

Project Brief

Due to global energy efficiency trends and European Union energy regulations which will change in 2020, the need and the awareness about energy efficiency has increased, this has resulted improvement on cooling technology and compressors. That's why the most critical components of coolers have gone through a massive change with the use of inverter technology. The inverter technology resulting from such technology shift increases the energy efficiency of refrigerators by 15 to 25% as compared to conventional compressors. Mini Inverter Compressor is a high-tech and compact product using a digital-controlled inverter technology for refrigerators with cabinets up to 70 cm in width. Arçelik compressor division, the sole consumer-type cooler compressor manufacturer in Turkey, leads this change in technology and offers Mini Inverter Compressors simultaneously with lower prices compared to World's two leading compressor manufacturers. Considering that the compressor is the heart of the refrigerator and the most expensive imported semi-finished good, the Mini Inverter Compressor is manufactured locally and priced competitively. Mini Inverter Compressor uses 30% less raw materials as compared to a conventional compressor. During the design stage, manufacturing efficiency and automation readiness were considered, and results showed that the manufacturing efficiency was 10% higher than current designs. With the reduced size resulting from the unique design, the new inverter compressor is more technological, competitive and energy efficient [9, p. 1].

Purpose, Definition and Scope of Project Development

Product ranges of Arçelik A.Ş. compressor division are leaders and offer high technology to the customers through Eskişehir refrigerator facility as well as Arçelik A.Ş. affiliates in Thailand, India and Romania. Arçelik A.Ş. provides competitive products in local and neighbour markets with a combined manufacturing capacity of 40 million products, and helps decreasing the current deficit of Turkey by offering domestic compressors which are the most significant imported semi-finished goods in a refrigerator. With the new regulation accepted by the European Parliament in 2017, energy labels for certain products including refrigerators were listed from Class A to Class G and revised labels would be applied in 2020. The energy regulation has been implemented in Turkey since 2002 within the scope of the EU membership process and the high energy efficiency levels which are important for customers are no longer reachable using conventional compressor technologies after the amendment of the regulation. The increased need for energy efficiency in the cooling market is the driver for the development of this technology for a compressor as the most critical component of a refrigerator. The inverter technology resulting from such technology shift increases the energy efficiency of refrigerator by 15 to 25% compared to conventional compressors and provides the increased energy demand. Permanent magnet synchronous (PMAC) motor technology ensures less noise with the design of low-rev sleep mode rather than stop and start as compared to fixed rev compressors. Besides, it increases total system efficiency and optimum performance through FOC (Field Oriented Control) drives. On the other hand, cabinet volume functions more efficiently in terms of cooling with the smaller mini compressor size. This is a significant parameter in terms of cost benefits. In addition to such benefits, the smart control algorithm was designed to meet the cooling requirements with minimum power consumption and protects the system in case of overload. The mini inverter compressor adjusts the cooling capacity, minimizes the amplitude of cabin temperature to keep the food fresh and creates a sense of high technology by responding to fast cooling needs. Arçelik compressor division, the only compressor manufacturer in Turkey, decided to ensure that all products used the inverter technology to lead the technological transformation. Mini Inverter Compressor project developed at Arçelik A.Ş. Refrigerator and Compressor R&D Center was an R&D project including the design and mass production of this high-tech product. The project was funded by the company and supported by Turkish Republic Ministry of Industry and Technology [9, pp. 1-2].

Project Objectives

The Mini Inverter Project was designed as a compressor platform with high energy efficiency and compact size to replace conventional mini compressors where there was a strong competition and start mass production. Mini Inverter Compressor is a new-generation, high-tech and compact compressor platform using a digital-controlled inverter technology for refrigerators with cabinets up to 70 cm in width. Variable-rev compressor was developed based on interdisciplinary interactive cooperation of mechanical, thermodynamics, electrical drive, control technology and power electronics disciplines. The objectives were defined based on energy trends for consumer-type cooler industry, developments in engineering software, demands of local and global refrigerator manufacturers, competition and costs. After analyses of these data, the compressor with a competitive edge in terms of technology and cost was developed with a stroke volume of 5 cc, 7cc and 9 cc for Turkey and the World [9, p. 3].

Leadership of Management

Arçelik A.Ş.'s top level management, operations management, and the rest of the project team worked very hard for the project. Objectives were set to detect changes in the compressor technology, its effects on the product portfolio and operating technology. The project work packages were delegated for a measurable performance evaluation. The purpose of the performance management system is to assess performances of Arçelik employees to support Arçelik's vision, strategies, values and create the culture of high performance. Continuous improvement of employee performance is the main purpose of the system. High-performing project members were recognized within the award system. Arçelik A.Ş. has an award management system to recognize achievements of employees to increase their loyalties and motivations to achieve company objectives, strategies, and policies [9, p. 3].

Methods and Techniques

R&D project management system at the R&D center was used for the compressor platform developed within the scope of the project. The project was divided into three phases. The first phase was the concept design including the objective definition. The objectives were defined based on energy trends for consumer-type cooler industry, developments in engineering software, demands of local and global refrigerator manufacturers, competition and costs. The performance requirements of the platform were developed within the scope of these data including general measures and cost breakdown for the compressor. Technical feasibility analysis marked the start of the second phase including time and resource planning. The mechanical components, engine and electronic control cards were designed simultaneously during the detailed design of the compressor. The structure of the components was defined based on the target dimensions of the compressor at the mechanic design process. Alternative 3D designs were made for each component during the structural design process and tested with up-to-date CAE analysis tools. Constructive limits were defined before the engine design process, design options for windings were evaluated based on the performance and cost objectives. The engine was designed using computer-aided mathematical modelling analyses of electric motors and drive techniques. Detailed magnetic analyses were performed, heat and losses under various load conditions were monitored for preliminary design verification. A prototype was manufactured using design details, measurements were made to provide input for algorithms in the laboratory. The inverter control software was developed as a significant factor for final performance evaluation. Compressor performance tests were performed with the prototype engine and software, accelerated lifecycle tests, refrigerator safety and functional tests were performed for the product. Measures were taken against risks with alternative designs during design processes. The final project phase was the commissioning process, compliance of product lines and quality systems were ensured. After pilot manufacturing, field tests were performed to monitor field performance based on the feedback [9, pp. 3-4].

Performance Results

The mini compressor portfolio includes 3 types of products which have reached the required performance and useful life requirements. Test approval processes for the product in terms of cost and energy efficiency were performed for refrigerators manufactured by Eskişehir refrigerator factory as well as Arçelik A.Ş. affiliates in Thailand, India and Romania. Serial production started in 2019. The project ensured a higher level of customer satisfaction and less noise as well as an increase in the perceived quality of the project due to energy efficiency and operation at lower rev. The inverter technology maximizes the energy efficiency in cabinets, automation-focused design processes allow more efficient use of capital and human resources. With this project, the plant manufactures high-tech products, and employee loyalty for the product and the company has increased in the last two years. It is expected to reduce the country's current deficit by \$150.000.000 in the next 5 years. The product weights are 30% less than equivalent products and 2 kg less materials are used. This means 12.500 tons of savings in terms of natural resources. With the use of Mini Inverter Compressor, 15% less energy will be consumed in the next 5 years as compared to conventional fixed-speed products. The energy savings will reach 228 GWh which is around energy production of Hirfanlı Dam in Turkey. This project with its innovative design tools, accelerated tests, and solutions has produced the most compact mini inverter compressor of the World [9, pp. 4-5].

CONCLUSION

Green innovation practices mainly product innovation affects company performance. If companies formulate appropriate green innovation strategies alligned with their corporate strategies, they can implement more successful green innovation practices and reach higher performances. As it is presented in the case study, Turkish companies are aware of it and perceive green innovation practices as opportunities to have more distinguishing competitive advantages and achieve higher performances. They are aware of the importance of formulating appropriate green innovation strategies, implementing them willingly and successfully, and developing better green products day by day to reach higher sales, market share, profitability, and customer satisfaction.

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