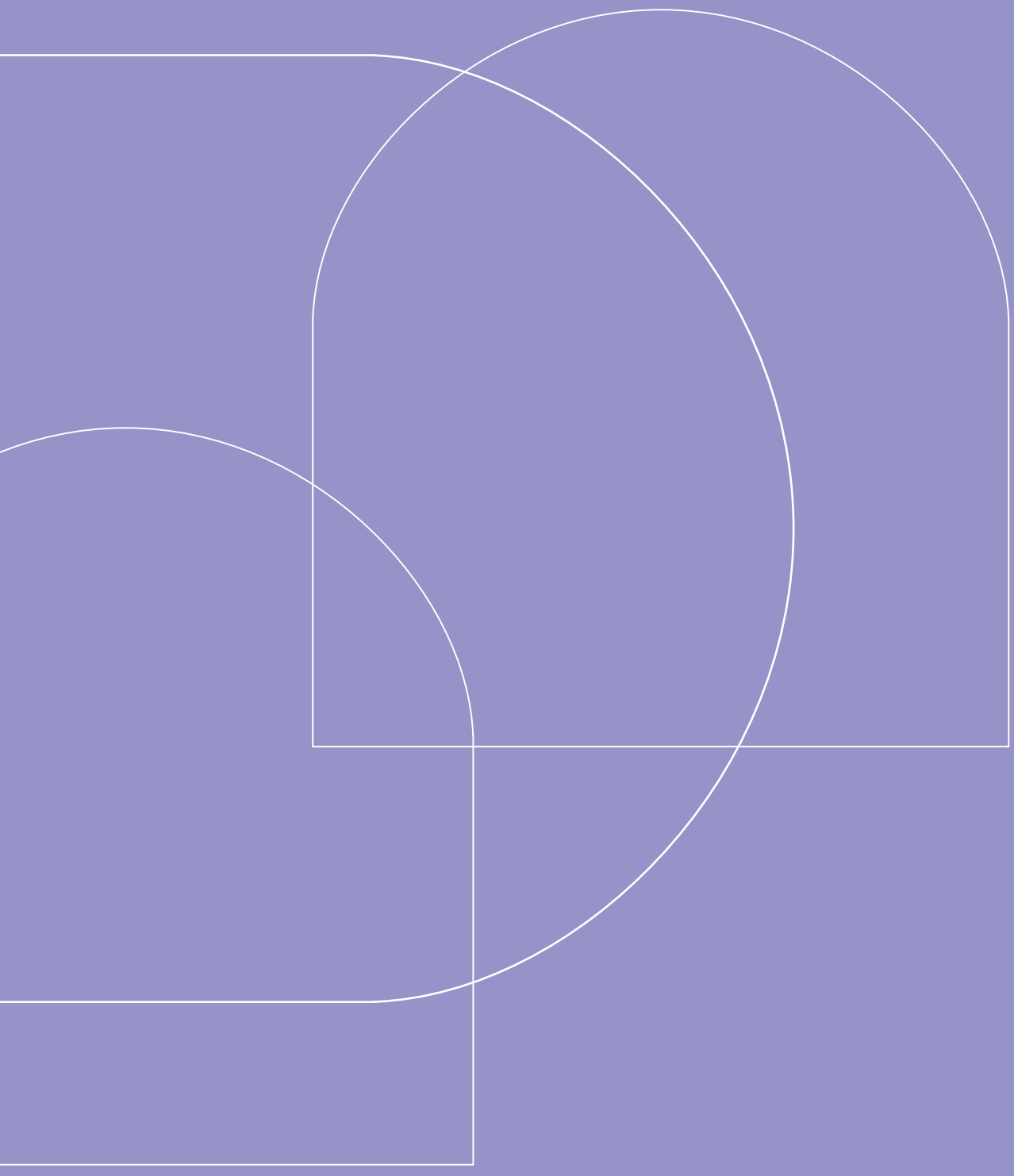
COMPILATION OF THE EXPERIENCES IN TÜRKİYE

FROM THE PRODUCT MANAGEMENT PERSPECTIVE

2022



COMPILATION OF THE EXPERIENCES IN TÜRKİYE

FROM THE PRODUCT MANAGEMENT PERSPECTIVE

2022

TECHNOLOGY DEVELOPMENT FOUNDATION OF TURKEY

www.ttgv.org.tr

MERKEZ / HEAD OFFICE
CYBERPARK CYBERPLAZA B Blok Kat: 5-6 06800 Bilkent ANKARA - TÜRKİYE
Tel: +90 (312) 265 0272
Fax: +90 (312) 265 0262

İSTANBUL/İSTANBUL OFFICE
ARI TEKNOKENT Arı 2 Binası A Blok Kat: 7 34469 İTÜ Ayazağa Yerleşkesi, Koruyolu Maslak İSTANBUL - TÜRKİYE
Tel: +90 (212) 276 7560
Fax: +90 (212) 276 7580

Compiled by
Esra Kaya

Graphic Design
Özge Egemen / www.kirmizitasarim.com

CHAPTER 13

CURRENT TRENDS IN THE AIR CONDITIONING AND REFRIGERATION INDUSTRY FROM A PRODUCT PORTFOLIO MANAGEMENT PERSPECTIVE

HASAN ACÜL

Hasan Acül graduated from Yıldız Technical University's Department of Mechanical Engineering in 1999. He completed his master's degree at Gebze Technical University's Department of Science and Technology Strategies. Hasan Acül's areas of expertise are new product development, refrigeration, air conditioning, and software development. Hasan Acül holds International Product Development and Management Association (PDMA) New Product Development Professional (NPDP), TUBITAK/Tüsside R&D Specialist, and Regional Environmental Center Corporate Sustainability certificates. The CO2 natural refrigerant cooling system project carried out by Hasan Acül as engineering manager was awarded the Istanbul Chamber of Industry 2010 Sustainable Environmentally Friendly Product First Prize. In addition to this award, Chiller Performance and Energy Efficiency Simulation Software development project won the third prize in the 2014 Air Conditioning Sector Design and Application Competition organized by the Air Conditioning Industry Exporters Association (ISIB.) Hasan Acül still continues his management and engineering duties at İKLİMSOFT, where he is the founder.

1. INTRODUCTION

Today's business leaders are primarily focused on two comprehensive goals when developing new products. The primary goal is to increase business growth through investment in new products. This calls for increased revenues and profits brought on by a constant stream of new products. The second goal is to strengthen the company's competitiveness both today and in the future through the development of new products (Marvin, 2005, p.46). Modern businesses need new products to succeed in the long run and compete with their competitors. Effective new product development processes have become a top strategic priority for businesses due to the circumstances brought on by rapidly evolving technology, market globalization, rising local and global competitiveness, and similar reasons (Cooper, Edgett & Kleinschmidt, 2001, p.1).

How businesses can manage their research and new product development resources in the most effective and efficient way in line with their goals is the most critical question in the new product development process. Finding a solution to this crucial question and enabling businesses to achieve their corporate goals through the effective use and management of their resources in the new product process are the key goals of product portfolio management (Cooper et al., 2001, p.1).

Product portfolio management and its significance in the new product process are addressed in this study titled Current Trends in the Air Conditioning and Refrigeration Industry from the Perspective of Product Portfolio Management. The study uses the air conditioning and refrigeration industry as an example industry, and current industrial trends that are believed to aid businesses in developing technology and product roadmaps during the portfolio planning process are provided in an effort to make the topic more concrete.

2. PRODUCT PORTFOLIO MANAGEMENT AND ITS IMPORTANCE IN THE NEW PRODUCT PROCESS

Referring to the totality of all investment or financial assets, including stocks, bonds, real estate, mutual funds, and other securities frequently used in the financial sector, the term "portfolio" (Benson, 2021, p. 1) has been adopted as "product portfolio" in the literature on product development. A product portfolio is the collection of goods and services that a business sells, seen in its broadest sense (Tolonen, Shahmarichatghieh, Harkonen, & Haapasalo, 2015, p.468).

Portfolio depth and breadth are the two main characteristics used to characterize the product portfolio. Portfolio depth refers to the number of product types grouped inside a product line, whereas portfolio breadth refers to the number of primary product lines in a company's product range. A class of products with slight deviations from a typical type or norm is known as a product range. In this context, product types are variations of the same product that businesses create to appeal to customers with various needs. The strategic and tactical approach is taken into consideration while developing a product portfolio in order to define the breadth and depth of the portfolio. The strategic approach deals with product portfolio breadth through activities such as increasing the number of main product groups in

the product range, diversification, removing one of the existing lines, etc., whereas the tactical approach is related to portfolio depth through activities, such as expanding, differentiating, and removing the product variety within the main product groups (Riesenera, Döllea, Schuha, Laufa, & Janka, 2019, p.726).

Product portfolio management is defined as a dynamic decision-making process in which ongoing new product (and development) initiatives are regularly updated and revised to guarantee that businesses get the most out of their product portfolios. New projects are evaluated, chosen, and prioritized in this process, while current projects can be sped up, canceled, reprioritized, and resource allocation reevaluated (Cooper, Edgett & Kleinschmidt, 1999, p.335).

Studies on innovation, new product development, and project management have addressed the problem of how to allocate resources to new product projects since the 1960s (Archer & Ghasemzadeh, 1999, p.207; Weissenberger-Eibl & Teufel, 2011, p.51). Product portfolio management helps managers allocate limited resources to project concepts that are believed to generate the best return, use them effectively, and create priorities in order to enable business strategy, optimize resources, reduce risks, and accelerate time to market (Jacobs & Swink, 2011, p.677). In other words, product portfolio management is about completing the proper projects rather than effective project management, interdisciplinary teams, the voice of the consumer, etc (Cooper, Edgett & Kleinschmidt, 2002, p.331).

The concept of the product (lifecycle) management is frequently used in connection with product portfolio management in the literature. Although product portfolio management and product management are essential components of an effective new product process, they have different primary objectives. Product portfolio management is more broadly connected to managing a portfolio of numerous products, resources, risks, investments, and budgets. Product management, on the other hand, is related to the process that encompasses all operations from the launch of a product through its removal from the market (Grischenko, 2016, p.1).

Product portfolio managers are responsible for managing the businesses' product portfolios. Product portfolio managers have a more strategic role than product managers. The success of multiple products from various departments within the company, their contribution to company goals, ensuring that the product portfolio is well aligned with the organizational strategy, allocating resources to the right projects in the most efficient way, and managing processes are all the responsibilities of product portfolio managers, whereas product managers are only in charge of one specific product (Product Plan, 2022, p.1).

Portfolio management is a management technique that enables businesses to institutionalize and enhance the selection of new product development projects and assure their alignment with corporate strategy, according to The Aberdeen Group's 2006 Product Portfolio Management Benchmarking Report (Aberdeen Group, 2006, p.13). Portfolio planning, when properly implemented, enables businesses to concentrate their efforts on the items that will provide the greatest value while reducing the risk and uncertainty involved in the introduction of new products.

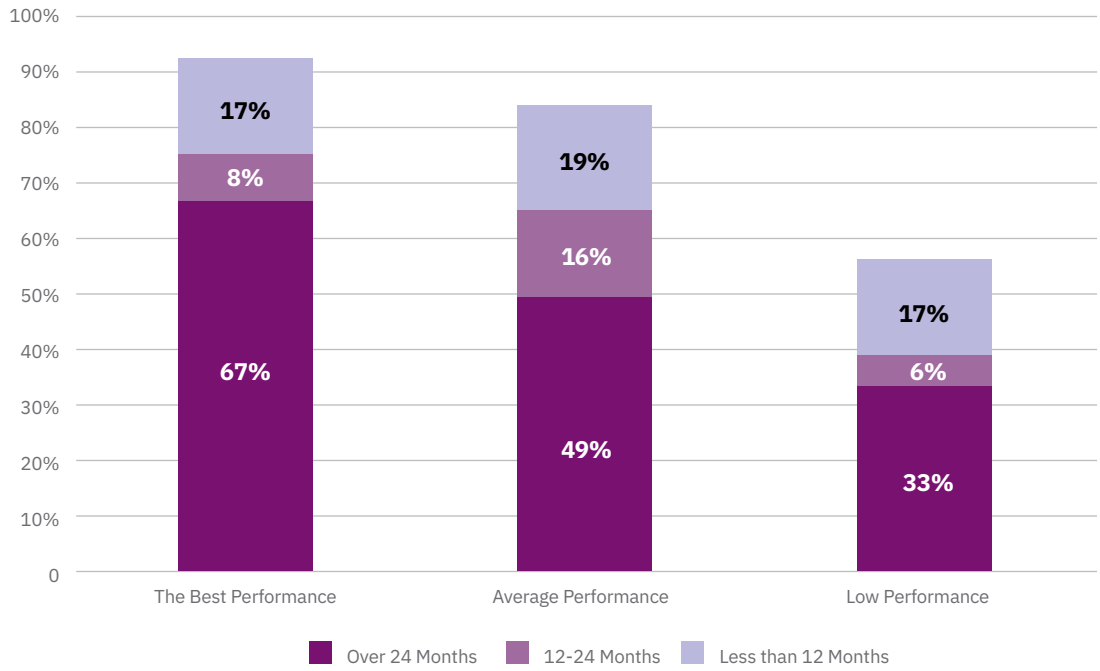


Figure 41: Product Portfolio Management Implementation Time Comparison Graph (AberdeenGroup, 2006, p.13)

According to the Product Portfolio Management Benchmarking Report, high-performing companies have been using portfolio management for longer and are more likely to have standardized portfolio management procedures and portfolio management techniques than low-performing companies (see Figure 41).

Portfolio management is crucial for businesses for the following reasons, per the findings of Cooper et al's study dated 1998 on Best R&D Portfolio Management Practices (Cooper, Edgett & Kleinschmidt, 2002, p.333):

- Maximizing return on investment and attaining financial goals;
- Increasing the efficiency of product development;
- Maintaining the competitive position of the business;
- Increase sales and market share;
- Allocating scarce resources appropriately and efficiently;
- Establishing the link between project selection and organizational strategy;
- Focusing on projects with high returns rather than a large number of low-return projects with limited resources;
- Better managing priorities within the organization, both vertically and horizontally;
- Ensuring balance between projects, objectivity in project selection, and eliminate inappropriate projects.

Best Practices in Product Innovation, a 2003 study by Cooper, Edgett, and Kleinschmidt, concluded that companies with effective and methodical product portfolio management have better new product development success (Cooper & Edgett, 2006, p.12). According to the findings of this study, high-performing businesses have more product projects in their portfolios that will add significant value to their operations, apply the project evaluation and prioritization process more frequently, have a more balanced portfolio structure, better manage project resources, and carry out systematic portfolio management and project selection processes much more successfully (See Figure 42).

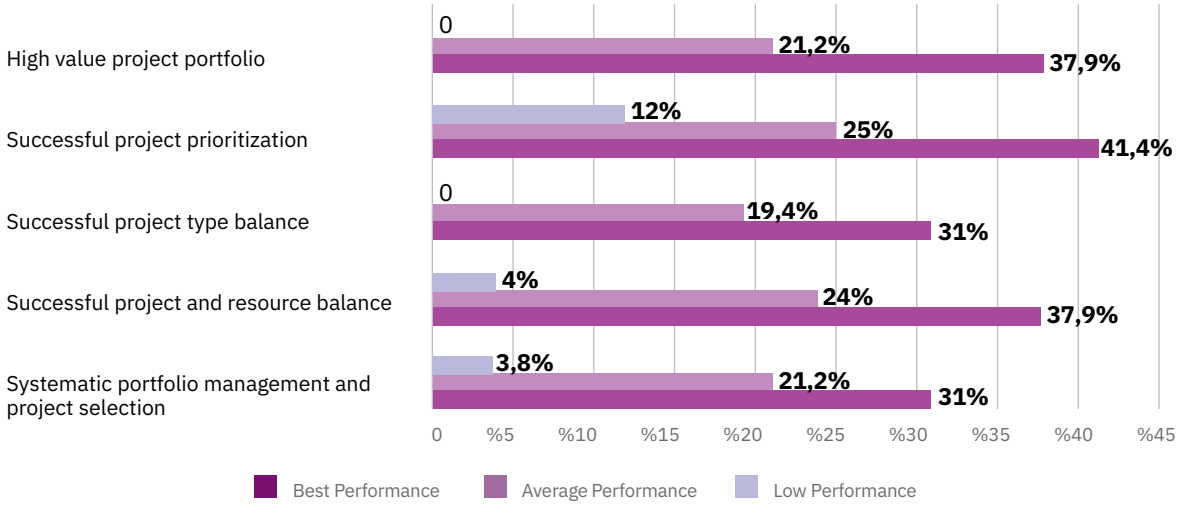


Figure 42: Effect of Product Portfolio Management on New Product Development Performance Graph (Cooper& Edgett, 2006, s.12).

Another topic covered in the literature is the connection between product portfolio management and company strategy. Following their development efforts, businesses will produce a variety of products, and these products' innovation categories are directly tied to the strategies of the company. One of the most crucial prerequisites for a successful product is a clear new product strategy (Cooper, 2001, p.57). The processes leading from product idea to market launch are impacted by the new product strategies that businesses employ to attain their objectives (Cooper & Kleinschmidt, 1986, p.74; Tzokas et al., 2004, p.620). Through new product portfolio management, the new product development process is connected to product strategy. To choose which new product concepts to evaluate and their relative priority, this dynamic decision process considers strategy implementation difficulties (McNally, Durmuşoğlu, Calantone, Harmancioglu, 2009, 127) The relationship between product portfolio management and strategic planning is shown in Figure 43. (Marvin, 2005, p.47).

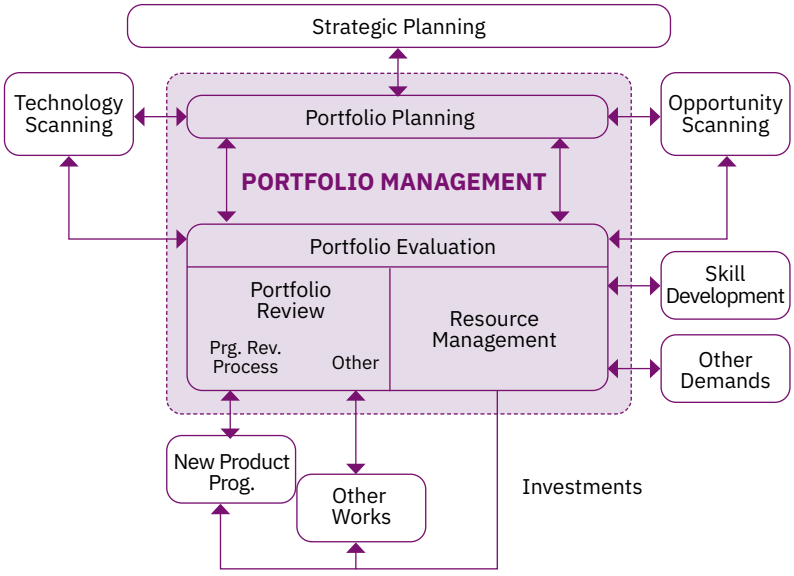


Figure 43: General Framework of the Product Portfolio Management Process (Marvin, 2005, s.47)

Product portfolio management, according to Marvin (2005, p. 57), is supported by organizational functions and activities such as strategic planning, technology monitoring, opportunity monitoring, skill development, and others.

During the **portfolio assessment process**, it is determined whether existing investments in new products and technologies have produced the anticipated return, to what extent the investments have steered the business in the desired strategic direction, and whether the current resources are being utilized as effectively as possible while accounting for shifting market conditions (Marvin, 2005, p.49). Resources allocated to projects for currently available items, priorities, and products that should be added to or withdrawn from the portfolio are assessed during this phase (Sanandres, 2022, p.1).

The assessment process makes use of a variety of analysis techniques. The GE-McKinsey Matrix (see Figure 45), which examines the product portfolio in terms of industrial competition and attractiveness, and the Boston Consulting Group (BCG) Portfolio Matrix (see Figure 44), which assesses the product portfolio in terms of market growth rate and relative market share, are two well-known analysis techniques (Henderson, 1970, p.3; Subhash, 2004, pp.250-259).

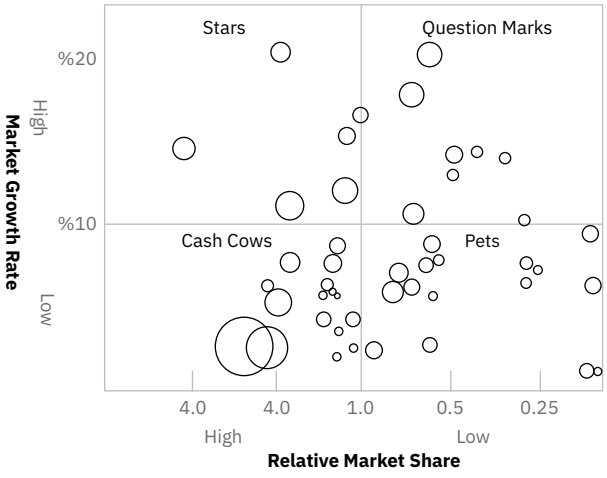


Figure 44: Boston Consulting Group's (BCG) Portfolio Matrix (Subhash, 2004, s.250). (Note: Circles represent turnover.)

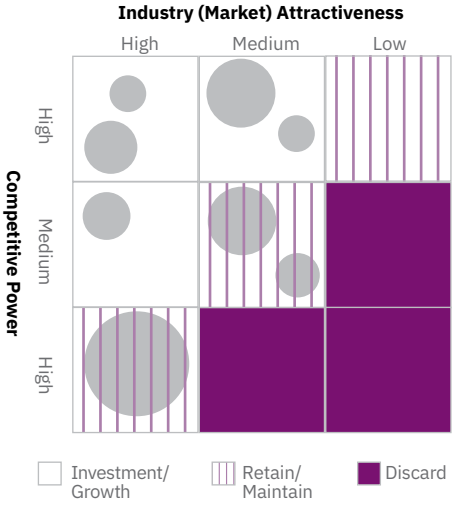


Figure 45: GE-McKinsey's Matrix (Subhash, 2004, s.260). (Note: Circles represent turnover.)

According to the Boston Consulting Group (BCG) Portfolio Matrix, "star" products are those that have a large market share and rapid growth rates and will lead the company into the future. The development of "question mark" products, which are likely to become star products in the future, is fueled by so-called "cash cows." Pets are products that have reached the end of their lifespan (Henderson, 1970, p.3).

Utilizing two axes -industrial attractiveness (market attractiveness) and product (business unit) competitiveness- the GE-McKinsey Matrix assesses the product portfolio. There are three levels on each evaluation axis (low, medium, and high). The three top sections of the matrix indicate products and services that should be invested in or expanded, where market attractiveness and competitiveness are high; the three middle sections of the matrix indicate products and services that should be maintained, where market attractiveness and competitiveness are in balance; and the three bottom sections of the matrix indicate products and services that should be divested or disinvested in, where market attractiveness and market attractiveness are low (Subhash, 2004, p. 260).

Market size and growth rate, profit margin, market diversity, steady demand, competitive structure, industrial profitability, inflation vulnerability, value-added, capital intensity, raw material availability, technological role, energy impact, social and environmental impact, legal impact, human resources, and similar factors are used to determine industrial attractiveness (market attractiveness).

Market share, product sales growth rate, product range, sales/distribution efficiency, price competition, advertising and promotion efficiency, facility location and innovation, capacity and productivity, value-added, investment utilization, raw material cost, product quality, R&D, cash position, corporate synergy, company image, and similar factors are used to evaluate a product's (or business unit's) competitiveness.

Depending on how the companies are structured, the **portfolio review process** may be done on a monthly, quarterly, or annual basis. Within the parameters of the techniques employed by businesses in the new product development process, such as stage threshold, etc., it can also occur at various times. The state of product investments matching expectations, the balance between projects, project performances, resource availability, priorities depending on the changing scenario, strategy compatibility, etc. are examined during the portfolio review process (Marvin, 2005, p.50; Cooper et al.., 2002, p.333).

Resource management is the efficient allocation and management of internal and external resources, including money, people, technology, time, equipment, hardware, etc. to the appropriate product projects in order to accomplish the goals of the product portfolio. Fundamentally, effective resource management necessitates a thorough comprehension of the workload generated by the current portfolio, the burden that will be generated by upcoming product developments, and the inherent ability to complete the tasks (Pennypacker, 2005, p.39).

Portfolio planning is a process used by organizations to decide which product projects to fund, staff, and prioritize in order to achieve their objectives. It also helps organizations balance their product portfolio. The corporate strategy benefits from portfolio planning and optimization by helping to make wise investment choices, maximize portfolio value, and allocate resources as effectively as possible (Sopheon Partners, 2022, p.1; Marvin, 2005, p.48).

In response to the company's overall business strategy, the process' goal is to develop a strategic plan for new goods and technology. This plan establishes the direction the company will take its future product and technological investments. Roadmaps for upcoming technology, product, and service investments are made throughout this process. The three broad goals of product portfolio management -portfolio maximization, strategic alignment, and portfolio balance- are taken into consideration during the portfolio planning process (Cooper, Edgett & Kleinschmidt, 2001, p.247; Wilyard, 1987, p.14; Marvin, 2005, p.48).

- *Portfolio maximization* aims to maximize portfolio value by allocating resources to the appropriate product projects (McNally et al., 2009, p.130). In terms of long-term profitability, economic value added, return on investment, success probability, and related goals, projects are chosen to maximize the portfolio total. In order to accomplish this, a variety of techniques can be used, including financial models like net present value (NPV), expected commercial value (ECV), return on investment (ROI), productivity index (PI), etc., as well as scoring models that take into account factors like strategic fit, product advantage, market attractiveness, strengthening of core competencies, technical viability, return versus risk, etc (Cooper et al, 2001, p.29).
- *Strategic alignment*'s goal is to translate company strategy into efficient and targeted new product investments. By investing in new goods and services, the company should transform its operations from their current situation to one that will be strategically advantageous

(McNally et al., 2009, p.127). Providing strategic direction for the growth of capabilities such as educating the current workforce, hiring new personnel, obtaining new tools, creating new business procedures, boosting production capabilities, establishing new strategic partnerships, etc. is another goal of strategic alignment (Marvin, 2005, p.48).

- *Product portfolio balance* refers to the mix and balance of the products in the portfolio in terms of product innovation levels (high, medium, low), project durations (long, medium, short), risk levels (high, medium, low), return on risks, return on investment, market share, product categories, technologies, and a variety of other factors. The balanced distribution of the items that make up the portfolio in terms of these and comparable criteria should be considered during portfolio design (Eggers, 2012, p.315; Cooper et al, 2001, p.73).

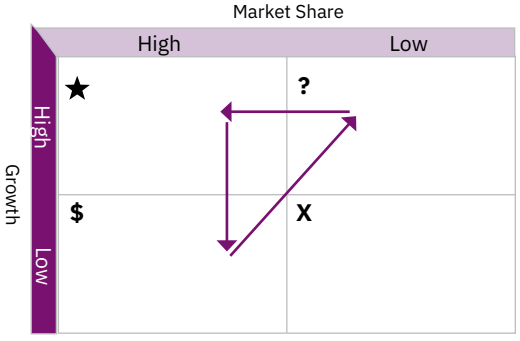


Figure 46: Successful Cash Flow (Henderson, 1970, s.3)

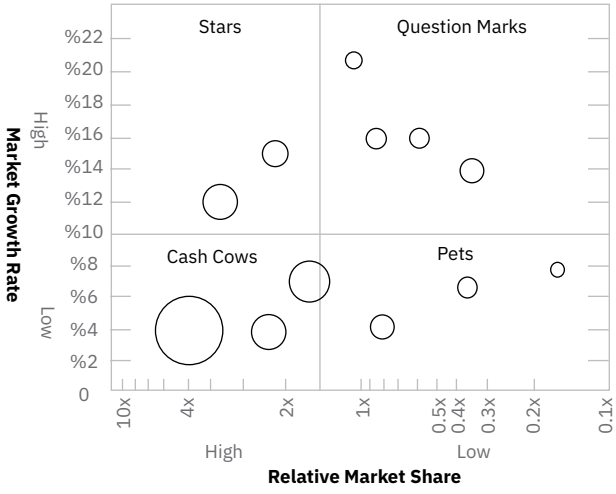


Figure 47: Balanced Product Portfolio Chart (Subhash, 2004, s.257) (Note: Circles represent turnover.)

As an illustration of the various product project types that should be balanced in a company's portfolio, Figure 48 provides a map of product development projects created by Wheelwright and Clark (1992, p.92). The degree of change in the product and the degree of change in the manufacturing process are the two main classification dimensions. The level of innovation is higher and resource-intensive initiatives are needed the more drastic the shift is in both dimensions. The balance of each project type is essential for the competitiveness of the organization because each has a distinct function to play.

As an illustration of the various product project types that should be balanced in a company's portfolio, Figure 48 provides a map of product development projects created by Wheelwright and Clark (1992, p.92). In this section, the air conditioning and refrigeration industry, which covers air conditioning, refrigeration, heating and ventilation machinery, equipment and systems, is taken as an example and current sectoral information is presented to help companies develop technology and product roadmaps in the portfolio planning process.

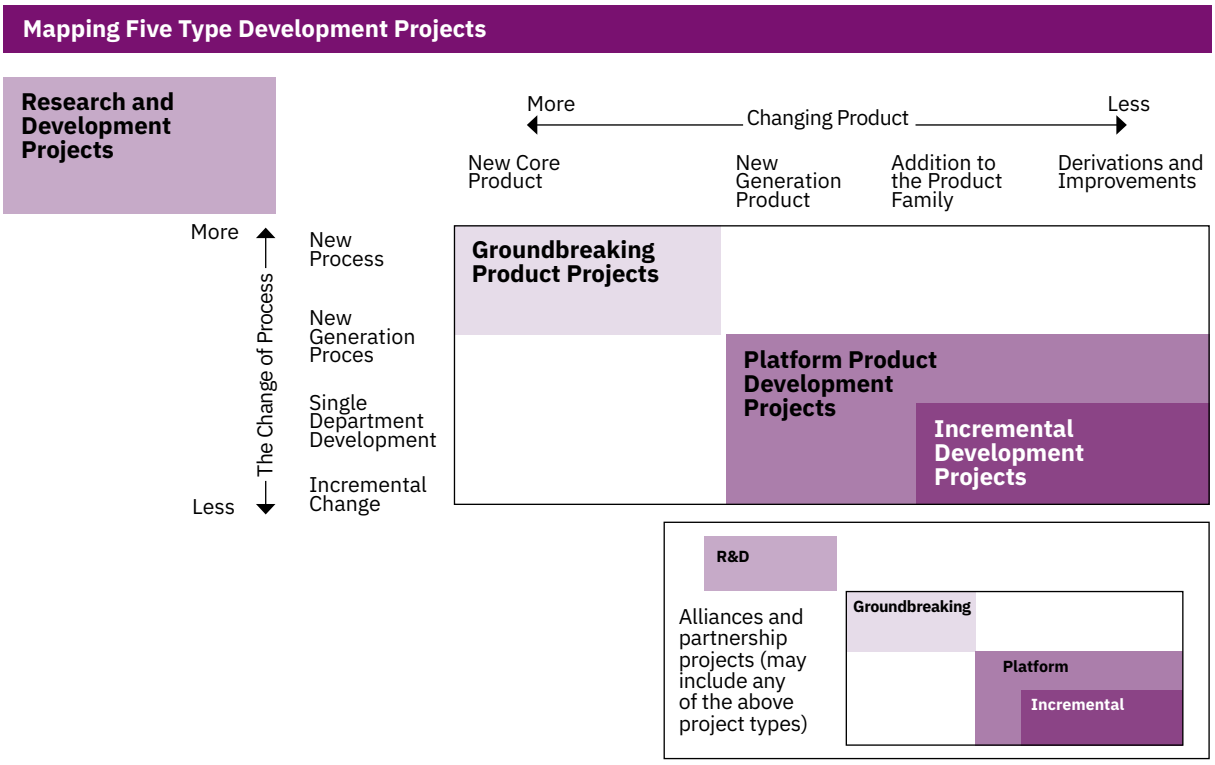


Figure 48: Mapping Different Type Development Projects (Wheelwright &Clark, 1992, p.93)

3.
CURRENT TRENDS THAT COMPANIES IN THE AIR CONDITIONING AND REFRIGERATION INDUSTRY SHOULD TAKE INTO ACCOUNT IN PRODUCT PORTFOLIO PLANNING

As an illustration of the various product project types that should be balanced in a company's portfolio, Figure 48 provides a map of product development projects created by Wheelwright and Clark (1992, p.92). In this section, the air conditioning and refrigeration industry, which covers air conditioning, refrigeration, heating and ventilation machinery, equipment and systems, is taken as an example and current sectoral information is presented to help companies develop technology and product roadmaps in the portfolio planning process.

Strategic documents that depict the stages of product development and product roadmaps are crucial tools that offer direction and consistency in the product development process (Münch et al., 2020, p.1). A product roadmap's major objective is to connect the product's vision with the company's commercial goals. The roadmaps outline the overarching goals for the product as well as the management plan. Important details like product vision, strategy, goals, features, requirements, deadlines, and so forth are typically included in product roadmaps (Münch et al., 2020, p. 1; Altexsoft blog, 2022, p. 1).

Technology roadmaps are needs-driven planning techniques for developing new technologies that can be

used to address a variety of product needs. They offer data to pinpoint important technologies and gaps in technology. Teams of specialists frequently come together to compile crucial technology planning data and create a framework for creating technology roadmaps (Garcia & Bray, 1997, p.3-4).

The Member Views Report for the Research Strategic Plan was written and released by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Research Advisory Board in 2009. Companies in the refrigeration and air conditioning industries can utilize the information in the report to create product and technology roadmaps. To examine, review, and reconfigure their product portfolios through product and technology roadmaps, sector companies can use the concerns presented in the research as relevant data and trends.

Through a questionnaire, the opinions of close to 400 industry experts were gathered for the report. The experts were mostly questioned about their projections for the air conditioning and refrigeration sector's next 20 years. The majority of the experts questioned for the report believe that energy, sustainability, and indoor air quality are the three most significant concerns that the air conditioning and refrigeration sector will focus on in the next twenty years. Changes in codes and standards, operation and maintenance, software, control, and training come next after these three crucial challenges (ASHRAE, 2009, p.1). The subtopics for the energy, sustainability, and IAQ issues are in Table 10, and the weights and prioritization of the issues are shown in Figure 49.

Table 10: Energy, Sustainability, and Indoor Air Quality Subtopics (ASHRAE, 2009, pp.7-12)

Energy	Sustainability	Indoor Air Quality
Energy efficiency	Sustainability	Indoor air quality
Energy saving	Climate change	Comfort
Alternative energy/ Green	Environmental issues	Air movement
Energy consumption/	Reducing carbon footprint	Ventilation
Energy cost	Refrigerants	Air cleaning/Hygiene
Energy resources	Efficiency	Filtering
Energy analysis/monitoring	Water saving / Water recovery	Humidity control
Net-zero energy buildings	Recycling	Pollutants

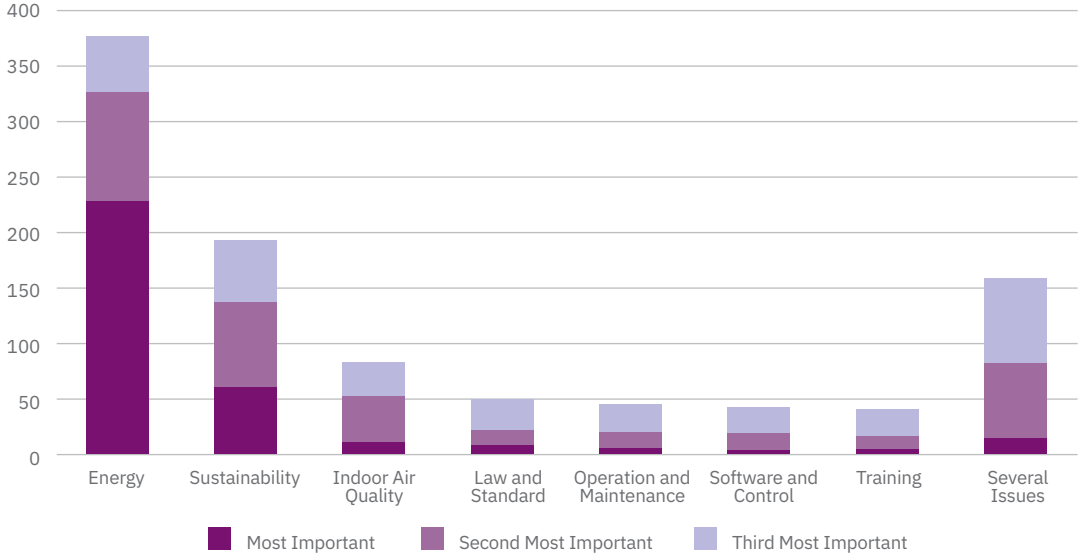


Figure 49: Industry's Most Important Issues in the Next 20 Years (ASHRAE, 2009, p.3) [Note: Y-axis values indicate the weight score of the subjects.]

The primary energy use in residential and commercial buildings in the US in 2014 is shown in Table 11. (DOE, 2015, p.5). 50.8% of all energy is needed for heating, air conditioning, water heating, cooling, and ventilation. For Europe, the scenario is pretty similar. Heating and cooling accounted for 51% of Europe's overall energy demand in 2012. (European Commission, 2006, p.6).

Table 11: US 2014 Residential and Commercial Building Primary Energy Use (DOE, 2015, s.5)

Areas	Energy Use (Quadrillion Btu)	Rate (%)
Heating	8,0	20,8%
Air conditioning	3,84	10,0%
Water heating	3,54	9,2%
Cooling	2,55	6,6%
Ventilation	1,61	4,2%
Industry total	19,54	50,8%
Other	11,58	30,1%
Lighting	4,35	11,3%
Computer and electronics	2,35	6,1%
Drying	0,68	1,8%
Other Industries' Total	18,96	49,2%

The US Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) has established the Building Technologies Office (BTO) with the goal of reducing building-related primary energy consumption by 50% by 2030 compared to consumption in 2010. BTO has a primary energy savings objective of 12% by 2020 and 24% by 2030, particularly for concerns about the air conditioning and refrigeration sector (Goetzler, Guernsey&Young, 2014, p.vii).

The importance of sector companies focusing on products, systems, and technologies with high energy efficiency (efficiency ratios and classes), low consumption, low loss, and energy recovery in their product portfolios becomes clear when the energy perspective in the ASHRAE report, BTO's targets, and energy use data are combined.

Sustainability is listed in the ASHRAE report as the second most important and linked concern after energy. Due to their high energy consumption, air conditioning and cooling systems are crucial for sustainability goals in many facilities. Another crucial component of the decarbonization policy is reducing energy demand for air conditioning and cooling systems (European Commission, 2012, p.7).

One of the key options for increasing sustainability is the use of heating and cooling technologies that make use of renewable energy sources in air conditioning and cooling systems. Examples of environmentally friendly and renewable technologies used in air conditioning and cooling systems include desiccant heating, cooling, and ventilation, evaporative cooling, natural cooling, solar heating and cooling systems, geothermal heating and cooling systems, biomass heating and cooling technologies, heat pumps, and heat recovery systems (Asim et al., 2022, p.2).

In terms of sustainability, it is critical and becoming more prevalent to utilize in air conditioning and cooling systems natural and alternative refrigerants (R717, R744, R290, R600, etc.) that have little or no global warming potential (GWP) and ozone depletion potential (ODP). To combat climate change, numerous countries are establishing legislative frameworks that prohibit or restrict the use of fluorinated greenhouse gases. The most significant legislative regulations in this area are the

Mobile Air Conditioning Systems (MAC) Directive (2006), the Montreal Protocol (2016-Kigali), and the European Union F-gas Regulation (2014). The Montreal Protocol's (2016-Kigali) and European F-gas laws' phase-down program for hydrofluorocarbon (HFC) usage is depicted in Figure 50.

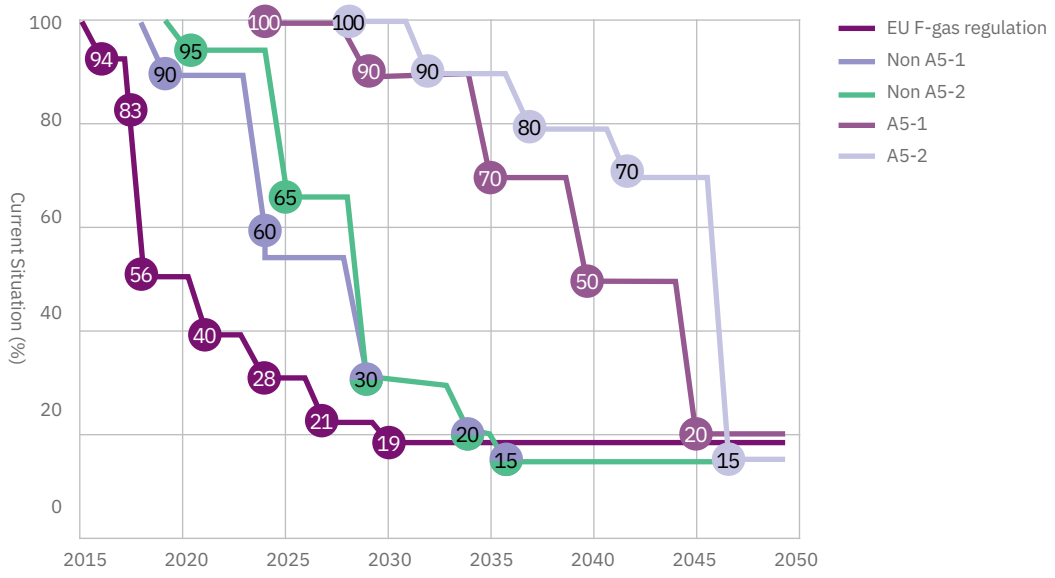
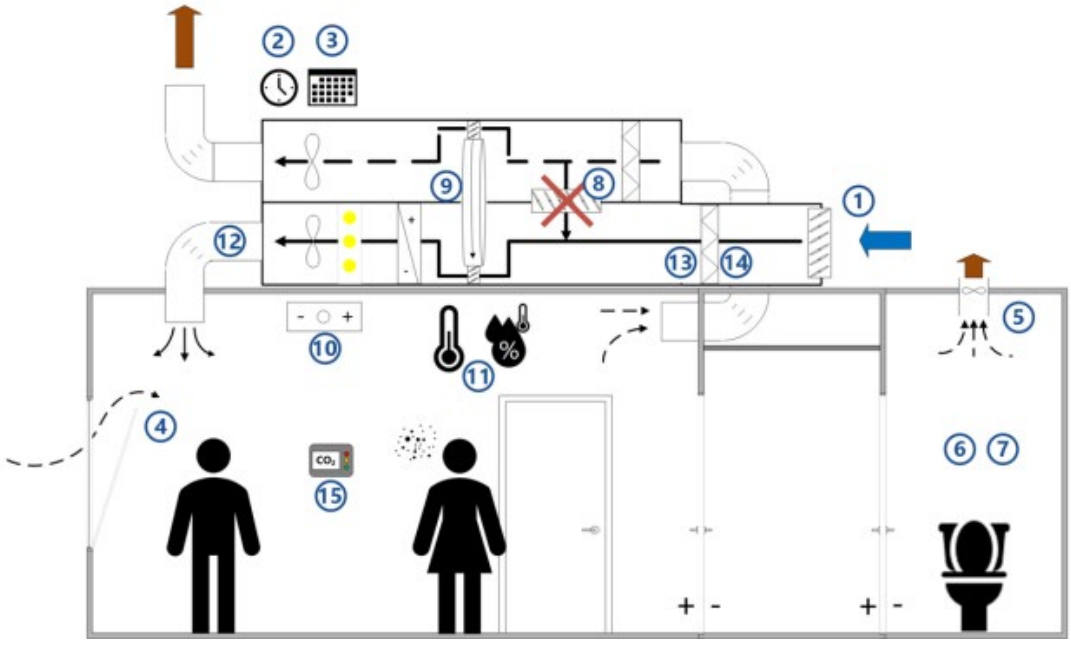


Figure 50: Montreal Protocol (2016-Kigali) and European F-gas Regulations HFC Consumption Reduction Program (Danfoss, 2022, p.5)

Indoor air quality is another significant issue for the industry. Acceptable indoor air quality is characterized by the absence of known pollutants and the lack of complaints from 80% or more of those exposed, according to the ANSI/ASHRAE 62.1 Standard (ANSI/ASHRAE 62.1, 2010, p. 3). The most crucial function in guaranteeing indoor air quality, which takes into account elements like temperature, humidity, airflow, and cleanliness, is played by air conditioning and refrigeration systems. Systems that are inadequately designed or operated have the potential to develop a wide range of microbial contaminations, contain them, and pose a major risk to human health.

Controlling the spread of microbial contamination in air conditioning and refrigeration systems is crucial, considering recent serious pandemics like COVID-19, SARS, MERS, and H7N9 (Asim et al., 2022, p.6). Numerous sectoral organizations that work closely on this issue include ASHRAE, the Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA), the Chartered Institution of Building Services Engineers (CIBSE), EUROVENT, and many others. They direct the industry by developing standards, regulations, certifications, application guides, trainings, etc. In the REHVA COVID-19 Guidance Document, which REHVA published in 2020, one of the topics covered by the system operation to lower the risk of infection during an outbreak is shown in Figure 51.



1. Ventilation rates
2. Ventilation operation times
3. Continuous operation of ventilation
4. Window opening
5. Toilet ventilation
6. Windows in toilets
7. Toilets with flush
8. Recirculation
9. Heat recovery equipment
10. Fan coils and induction units
11. Heating, cooling, and humidification settings
12. Duct cleaning
13. Outside air and exhaust air filters
14. Maintenance work
15. Indoor air quality monitoring

Figure 51: Air Conditioning Systems Indoor Environment COVID-19 Infection Prevention Points (REHVA, 2020, p.8)

Software, BIM (building information modeling), simulation, control devices and systems, sensor technology, internet of things, direct current (DC) powered systems, renewal, alternative materials, low initial investment and operating costs, health, safety, reliability, quality, and durability are additional issues that the air conditioning and refrigeration sector should pay importance to in the future and take into account when planning their product portfolios (Asim et al., 2022, p.2-12; ASHRAE, 2009, p.2-29).

4. CONCLUSION

In this article, the concept of product portfolio management and its significance for businesses are set out through various studies and examples from the literature, and to help concretize and better understand the issue, the air conditioning and refrigeration industry is used as an example. The article includes current technological advances that are believed to aid businesses in their procedures for developing their product portfolios, as well as reports, opinions, and data from top sectoral organizations. In order to compete in the long run, it is obvious that it is crucial for the sector companies to develop a portfolio of goods, systems, and technologies that will address energy, sustainability, new refrigerants, indoor air quality, and other issues described above.