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Comparative Analysis of Smart Building Solutions in Europe: Technological Advancements and Market Strategies

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Abstract: This paper provides a comprehensive comparative analysis of smart building solution providers within Europe, emphasizing the technological advancements and market strategies employed by companies selected for the study. As energy efficiency becomes a critical focus due to rising global energy demands and climate change concerns, smart building technologies have emerged as pivotal in optimizing energy use and enhancing occupant comfort. This study examines 19 products from 15 prominent manufacturers, categorized into six product categories: smart thermostats, smart valves, HVAC control, data acquisition and energy management software, smart home ecosystems, and home energy management systems. Using a comparative assessment matrix and SWOT analysis, the paper evaluates these products across five key areas: service impacts, market penetration, investment topics, business models, and value propositions. Findings highlight a strong focus of manufacturers in energy efficiency and comfort services, while identifying opportunities for improvement in energy flexibility and health integration. This analysis aims to guide stakeholders in strategic planning and decision-making, offering insights into the current and future landscape of the smart building solutions market.

Keywords: building energy management systems (BEMSs); artificial intelligence (AI); Internet of Things (IoT); smart technologies

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1. Introduction

With global energy demand on the rise and the pressing need to address climate change, the deployment of smart building solutions has emerged as the cornerstone of shaping the future of the built environment toward more sustainable living spaces [1]. The building sector is responsible for a large proportion of greenhouse gas emissions; in the European Union, it constitutes 36% of greenhouse gas emissions [2]. Therefore, joint strategies are being deployed globally to curtail energy utilization within the building sector, notably reflected in the European Climate Law, which prescribes a reduction in net greenhouse gas emissions by 55% until 2030 compared to 1990 levels [3]. The drive towards electrification, reflected by a broader deployment of electric heat pumps in the building sector [4], plays a crucial role in diminishing the demand for fossil fuels, but transitioning to renewable energy sources for electricity supply also requires a more sophisticated and load-optimized management of the increasingly volatile power grids [5]. This demand for grid-stabilizing technologies and efficient Building Energy Management Systems (BEMSs) can be expected to rise in the upcoming years, since the share of electricity in total worldwide final energy consumption is estimated to increase from currently 20% to more than 50% in the Net Zero Emissions projection of the World Energy Outlook by the year 2050 [6]. At the same time, the pursuit of energy optimization must not compromise indoor comfort. Estimates suggest we spend 80–90% of our lifetime indoors, making thermal comfort and air quality significant factors influencing our quality of life and health [7,8].

Smart building solutions can be a way to simultaneously address comfort requirements and the demand for greener, grid-friendly buildings. Researchers in the past decade have discussed how smart buildings and grids can increase energy efficiency without compromising user comfort, using intelligent control techniques to optimize BEMSs [9–11]. Smart building solutions hereby refers to the integration of data-driven and needs-based technologies, oftentimes utilizing real-time data from various sensors and user inputs to optimize building operations and resources according to the specific demands of the building occupants and external conditions [12]. Characterized by the integration of Internet of Things (IoT) devices, advanced energy management algorithms, and the intelligent linkage of building controls to occupancy and gird data, these technologies offer unprecedented opportunities to enhance building efficiency, occupant comfort, and environmental stewardship [13,14]. In Germany, for instance, digital building technologies are estimated to enable a reduction of approximately 30% of the national emission targets within the building sector [15]. The advent of data-driven technologies therefore unlocks opportunities to boost human health and productivity while advancing energy efficiency within the built environment [16].

Multinational technology conglomerates, established industrial manufacturers, renewable energy corporations, artificial intelligence startups, and smart home technology innovators are leading the vanguard of this technological revolution across Europe. Each manufacturer brings a unique set of innovations, strategies, and visions to the table, contributing to an ecosystem that is both diverse and rich in potential. This paper aims to delve into a comparative analysis of leading manufacturers and providers of smart building solutions, unraveling the current stand, latest developments, and future trends of this dynamic market. The core of this paper's analysis lies in the comprehensive evaluation of different product categories, examining their technological offerings, impacts on different service areas (e.g., energy efficiency, comfort, or flexibility), investment topics, business models, and value propositions of their solutions.

The methodology employed in assessing these product categories starts with a selection of prominent manufacturers and products from the Smart Building Solutions market for the subsequent analysis. After a categorization of the selected products into certain product categories, a Comparative Assessment Matrix (CAM) is developed as an evaluation framework, partly leaning on the Smart Readiness Indicator (SRI) methodology [17]. Information gathered through detailed research on manufacturers' websites, technical sheets, online newspaper articles, blog posts, and LinkedIn profiles is analyzed and synthesized into the CAM and enhanced through color coding to visually detect weak spots and saturated areas of the market. The CAM is used to identify the current and future developments and trends concerning business models, investment topics, and technological innovations. Finally, a SWOT analysis of the Smart Building Solutions market is carried out, shedding light on the current strengths and weaknesses of the market, opportunities to elaborate, and possible threats to tackle. This approach aims to offer a practical and accessible perspective on the current landscape of the Smart Building Solutions market, helping stakeholders in their decision-making and strategic planning.

2. Selection of Manufacturers

To analyze the smart building solutions market, a selection of manufacturers and products is first made, which are then rated and compared with each other in terms of their strengths, weaknesses, and functionalities. This section will explain the selection of smart home manufacturers and their products for comparative analysis. After explaining the methodology by which manufacturers are selected, an overview of the selected manufacturers will be given.

2.1. Methodology for Manufacturer Selection

The methodology for the selection of manufacturers and products is illustrated in the top area of Figure 1. Two main criteria served as the requirements for the selection of manufacturers and products. The selected manufacturers should represent prominent manufacturers of the smart building solutions market concerning sales volume and international prominence. Since many manufacturers in the smart home domain offer a variety of products, it was decided to restrict the considered products to those which contribute notably on the energy efficiency and indoor climate comfort of a building; thus, security-related products are not considered in this analysis since they do not have an impact on these areas. The manufacturers and products were then identified by means of an internet search and interviews with experts from the industry.

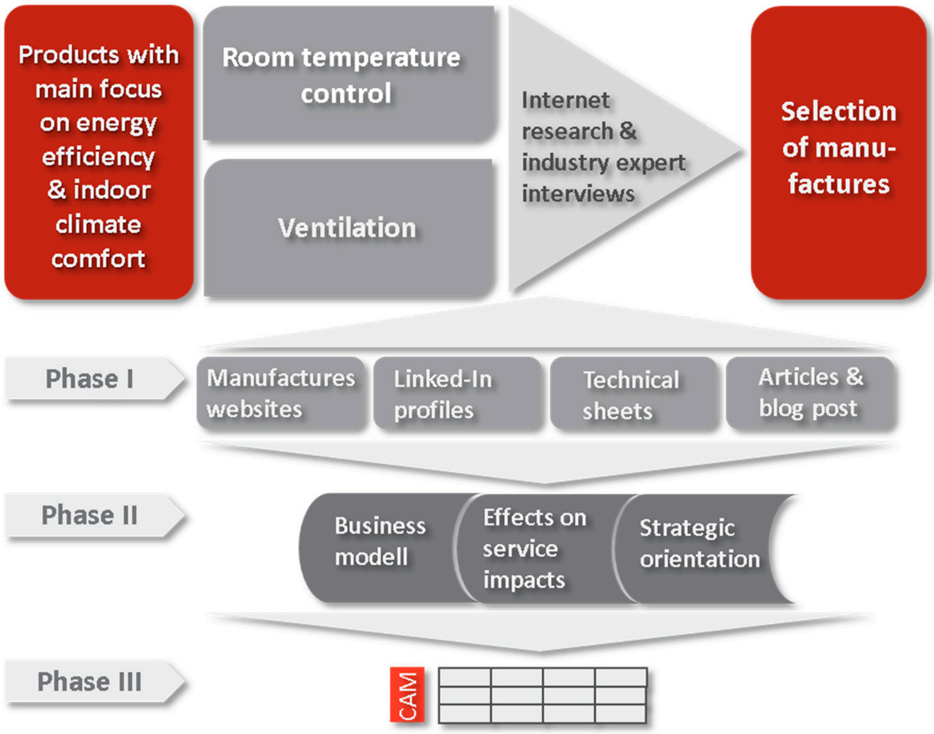

Figure 1. Methodology for selection and analysis of manufacturers and products.

2.2. Overview of Selected Manufacturers and Classification into Product Categories

The selected manufacturers and products are shown in Table 1. In total, 15 manufacturers and 19 different products were selected. Most of the products can be classified into one of three product categories: "smart thermostats", "smart valves", and "HVAC control". Products which cannot be classified in one of these categories are listed in the column "others". The columns "HVAC control" and "others" only list the manufacturers since most of them offer just one product.

Smart thermostats do not get installed directly at the radiator but are rather spatially separated from it, thus being able to operate centrally for multiple rooms as well as for each room individually. These thermostats influence various parameters, such as radiator valve positions, and can provide crucial data for building automation systems. Often, these thermostats are either integrated into such systems or sold in combination with them. Additionally, smart room thermostats can utilize weather data, room data (such as open windows or heating performance), and occupancy data for energy optimization. These data can be used for adjustments of other parameters in the heating system, such as the supply temperature or pump speed. To enhance comfort, smart room thermostats offer various functionalities, such as programmable schedules or self-learning heating behavior that adapts to occupancy patterns. These features contribute not only to increased comfort but also to efficient energy use [1,18].

Table 1. Selected products and manufacturers.

Smart Thermostats		Smart Valves		HVAC Control	Others
Product	**Manufacturer**	**Product**	**Manufacturer**	**Manufacturer**	**Manufacturer**
Smart Thermostat V3+	Tado	Smart Radiator Thermostat V3+	Tado	BrainBox AI	METRON
Smart Modulating Thermostat	Netatmo	Smart Radiator Valves	Netatmo	BeeBryte	Shelly
Room Thermostat II 230 V	Bosch	Radiator thermostat II	Bosch	DABBEL	Bosch (Energiemanager)
Nest Learning Thermostat	Google			R8 Technologies	
EasyControl	Bosch			MeteoViva	
Homix	Enel X			Evogy	
KONO Smart Thermostat	Lux Products				

Smart valves function similarly to smart room thermostats but are located directly at the radiator. Unlike room thermostats, the temperature sensor and actuator (valve) are not spatially separated. The functionalities of smart radiator thermostats often include similar comfort and energy-saving features as their central counterparts, such as programmable heating times and self-learning behavior. These thermostats offer a simple retrofit solution that optimizes energy use without requiring extensive modifications to the heating system [19].

Heating, Ventilation, and Air Conditioning (HVAC) control systems are products designed to regulate air-based systems and can manage components such as air heaters, air coolers, and airflow (fan) volumes. These systems frequently incorporate functionalities that utilize weather data, occupancy data, air quality data, and temperature data to ensure optimal indoor climate conditions. Many of the HVAC systems considered in this analysis make use of AI technologies, enabling self-learning behavior that adapts to the specific needs and habits of users [20]. These AI-driven systems continuously adjust ventilation parameters based on the collected data, achieving energy savings of up to 40% [21–23]. By learning from patterns in environmental and usage data, HVAC systems can predict and respond to changes more effectively, minimizing energy consumption while maintaining a pleasant indoor environment. HVAC control systems are predominantly used in non-residential buildings [24]. While some manufacturers can be classified as developers of data acquisition and management software, some others could be classified as manufacturers of a Smart Home Ecosystem (SHE), since their portfolio can be seen as a construction kit for smart home applications rather than a range of specific smart home products. The sixth category is Home Energy Management Systems (HEMS), which, in this study, is seen as a digital system that monitors and controls energy within a household. In total, the 19 products are categorized into six different product categories, with a strong number in the three categories of smart thermostats, smart valves, and HVAC control (16 of 19 products) and only one product in each of the other three categories of data acquisition and energy management software, SHE, and HEMS.

3. Comparative Assessment Methodology

To provide the CAM framework for evaluation of the smart technologies, products are first researched and gathered in the first phase. In the second phase, they are classified into a product category (see Section 2.2) and, consequently, in the third phase, they are rated and evaluated in comparison to other products from the same product category. Figure 1 shows the steps of the methodology to derive CAM assessments. The CAM covering these five areas is explained in more detail in the subsequent sections.

3.1. Development of Assessment Matrix

The evaluation criteria encompass five key areas. The service impacts are assessed across seven impact categories, which are derived from the SRI methodology: energy efficiency, maintenance and fault prediction, comfort, convenience, health and well-being, information to occupants, and energy flexibility and storage. Each product is rated on a scale from zero to four in these categories according to the abilities of each product. A clear definition of what each level of service impact means for each category is available in the SRI assessment sheets.

Categorizing product usage is assessed by building type—residential, commercial, or industrial. Investment topics provide insights into each manufacturer's research, marketing, and investment strategies, allowing for predictions of future market developments. The business model analysis focuses on customer targeting and profit generation methods, while the value proposition section highlights unique marketing aspects that differentiate products from their competitors. The evaluation of each criterion is documented in a table, forming the CAM in Figure 2.

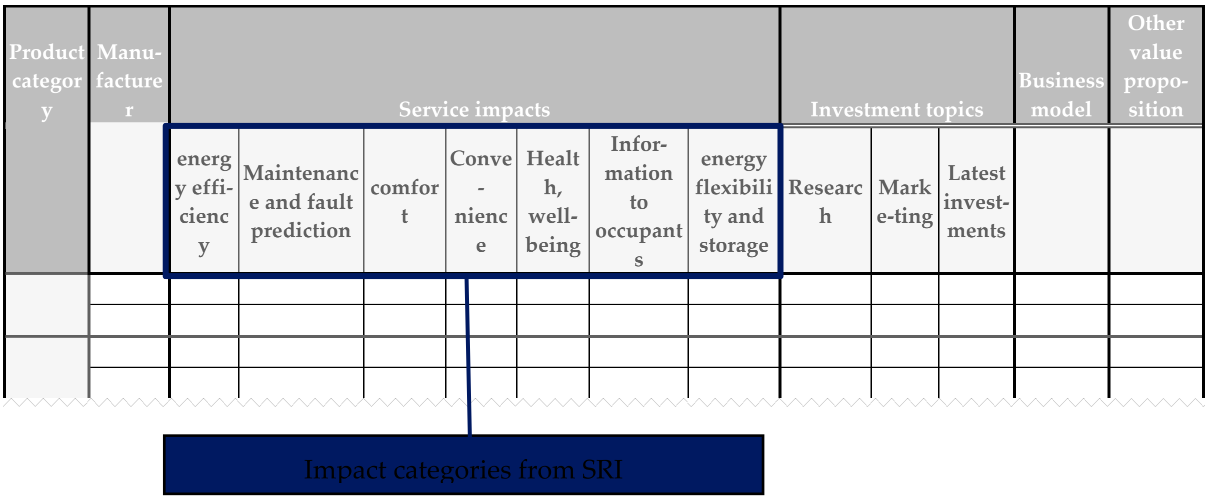

Figure 2. Comparative assessment matrix (CAM).

3.2. Phase I: Data Collection

The foundational phase involves a careful gathering of relevant data, essential for conducting a holistic comparative analysis. This phase comprises research on each of the selected manufacturers and their products using manufacturers' websites, technical sheets, online newspaper articles, blog posts, and LinkedIn profiles as the main sources. To ensure the validity and reliability of the data, we prioritized technical sheets and official manufacturer websites as primary sources, given their detailed product specifications and presumed accuracy. Secondary sources, such as online articles, blog posts, and LinkedIn profiles, were used to complement this information but were critically assessed for credibility through cross-verification with more reliable sources. In cases of conflicting information, we relied on data provided directly by manufacturers in their technical sheets and websites, assuming these values were derived through standardized testing processes. However, the inherent risk of relying solely on manufacturer claims is acknowledged as a limitation of the study. The search concentrated on information from which conclusions for the established areas of the CAM could be drawn later in the process, e.g., information regarding the abilities and functionalities of products.

3.3. Phase II: Data Analysis

In the second phase, the collected data are systematically analyzed and filtered to extract relevant information for the key areas. The information was then methodically organized into the CAM, aligning manufacturers and products against the defined criteria. Using the gathered data and analyzing a product's functionalities, the impacts of each product on the seven service impacts were determined.

Market penetration was measured by searching the collected data for the number of countries where a product is available and the various building types where the product is used. This analysis is supposed to provide insights into the geographical distribution and application breadth of the products.

The evaluation of the key area "investment topics" focused on manufacturers' current research themes, marketing campaigns, and recent R&D investments. This included an analysis of the information regarding research into specific technologies and functionalities, joint product developments with other market players, marketing strategies that differentiate products from competitors, and recent investments such as acquisitions and mergers.

To evaluate the business models, the collected data were analyzed for indications of the addressed customer types (e.g., private or business customers) and the sales models (e.g., fixed prices, contracting, subscription models). The examination of the investment topics and business models is intended to provide insights into the current trends and developments in the smart building solutions market.

Information that cannot be assigned to any of the previous key areas but is still regarded as relevant (e.g., unique innovative approaches or unique selling points) is categorized under the key area "other value proposition". This serves to retain potentially valuable information.

3.4. Phase III: Synthesis and Visualization

In the final phase of the analysis, we enhanced the CAM by applying a scoring system to visually articulate the data synthesized from the literature research. Each smart building solution is assigned a score from 0 to 4 in each of the seven service impact areas derived from the SRI (key area 1) according to the effect a product has on it. A score of 0, reflected by red color, means 'No Service Impact', indicating no measures for energy reporting or management are present. A score of 1, highlighted by yellow, 'Reporting on Current Consumption on Building Level', signifies basic reporting features without real-time analytics. Advancing to a score of 2 with bright green color, 'Real-time Feedback or Benchmarking on Building Level', solutions provide current energy data and comparative benchmarks at a building-wide scale. A score of 3, the green color, depicts 'Real-time Feedback or Benchmarking on Appliance Level', offering granular insights into the energy usage of individual appliances. The highest score of 4, which is shown with a dark green color, underpins 'Real-time Feedback or Benchmarking on Appliance Level with Automated Personalized Recommendations', and is attributed to solutions that deliver the most sophisticated level of service, with real-time, appliance-specific data analysis and AI-driven recommendations. The scoring criteria are summarized in Table 2.

Table 2. Color map assignments to individual service impact levels.

No Service Impact	0
reporting on current consumption on building level	1
real-time feedback or benchmarking on building level	2
real-time feedback or benchmarking on appliance level	3
real-time feedback or benchmarking on appliance level with automated personalized recommendations	4

The goal of this visualization is the intuitive visual detection of saturated areas as well as opportunities to elaborate in the smart building solutions market. This step was designed to make the comparative analysis accessible and informative for stakeholders, enabling informed decision-making and strategic planning in the smart building sector.

4. Results

This section will dive into the key results from the CAM. A detailed overview of the scores each product category reached in the seven service impact areas of the first key area "service impacts" will be given in Section 4.1. Subsequently, Section 4.2 summarizes key findings from the other four key areas. Section 4.3 deals with cross-key area results derived from the combination of multiple key area findings.

4.1. Key Area "Service Impacts"

Figure 3 displays the scores of each product category across the seven service impact areas derived from the SRI. In the CAM, high scores in the areas of energy efficiency, comfort, and convenience can be observed, indicating an advanced state of the market concerning these topics. All companies promise substantial reductions in energy consumption, with some manufacturers promising significant efficiency, with an up-to 40% reduction in energy demand [21–23]. By reducing energy consumption and optimizing building operations, these technologies contribute significantly to sustainability goals and offer profound environmental benefits. The CAM elucidates the potential for smart building technologies to play a pivotal role in mitigating climate change, being in line with current estimations and research [15,25,26].

On the contrary, the area of energy flexibility and storage has the lowest scores of all areas, with more than half of the products reaching a score of 0. This gap may be attributed to high costs of energy storage technologies, limited interoperability with existing building systems, and regulatory uncertainties, which collectively discourage widespread adoption. Future research could focus on modular, cost-effective storage solutions, enhanced demand-side management, and standardization frameworks to support broader integration. The area of health, well-being, and accessibility marks the second weak spot of the smart building solutions market, with around 30% of the products providing no service impacts in this area (score 0). Challenges in integrating these functionalities include the complexity of addressing diverse health needs and the absence of standardized metrics to guide development. Key functionalities such as advanced air quality monitoring, circadian lighting, and noise management systems are critical for improving occupant well-being. Future research could explore integrating these features through adaptive smart platforms, aligning with user preferences and health standards. The areas of maintenance and fault prediction and comfort show a high discrepancy between manufacturers, displaying the whole range of scores (0–4).

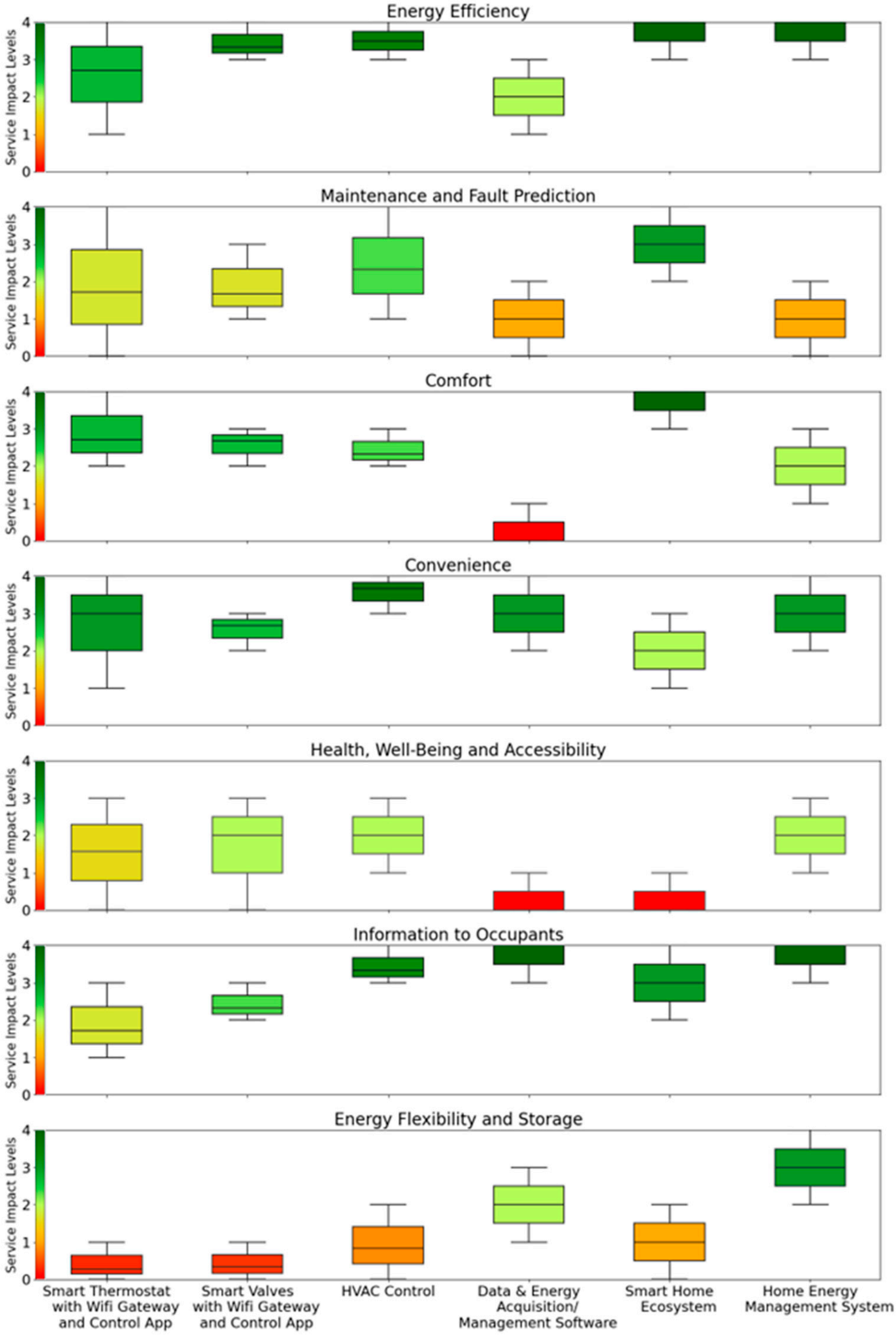

Figure 3. CAM results for key area "service impacts".

4.2. Core Results from Other Key Areas

The CAM has yielded insightful interpretations across various dimensions, including marketing strategies, investment topics, and business models. This section delves into these findings.

4.2.1. Key Area: "Investment Topics"

The analysis highlights varied market strategies among the manufacturers. While companies such as Enel X, Tado°, Netatmo, and Google adopt a user-friendly approach aiming to democratize smart home technologies [27–30], companies such as Bosch emphasize experience through offering wide-spread consulting services to customers [31,32]. Overall, 60% of the evaluated manufacturers are actively investing in building their partner networks. Other common research topics include compatibility, scalability, and IoT integration.

4.2.2. Key Area: "Business Model"

The analysis of the business models of the considered manufacturers reveals a variety of approaches. While in the residential sector sales to private individuals dominate the landscape, the commercial and industrial sector sees an uptake of contracting and subscription models. In some cases, the subscription price is linked to the achieved energy savings, meaning that the price is calculated as a percentage of the achieved savings [21,33,34].

4.3. Cross-Key Area Results

Focus on certain product categories: Most of the products considered in this analysis can be found in the three product categories of smart thermostats, smart valves, and HVAC control systems, indicating a high density and saturation of solutions in these categories. On the contrary, the categories of data acquisition and energy management software, SHE, and HEMS are each comprised of one product only, indicating that they are not as equally addressed as the other categories by the most prominent manufacturers. This does not mean the smart building solutions market hardly offers any solutions for these categories but that the most prominent manufacturers seem to currently focus on the first three product categories predominantly. Here might lie an opportunity for smaller manufacturers and start-ups to fill this gap.

Technological innovation: The development and exploration of AI-based technologies for predictive and real-time adjustments in HVAC systems has reached a ready-for-market status, underscoring a broader industry trend towards harnessing data-driven insights for energy conservation. The trend in the harvesting and processing of building operational data also manifests itself in the rising penetration of data visualization and control apps, allowing building occupants and owners to gain insights into building operation and performance data, underlining the industry's efforts of creating user integration [1].

Holistic approaches: Another result from the CAM is the industry's shift towards user-centric innovations. Manufacturers are increasingly focusing on not just the functional aspects of their products but also on enhancing user comfort and convenience, with nearly all products being capable of voice control integration. While some manufacturers approach convenience by minimalistic and self-installation-friendly products [30], other manufacturers embrace a more luxurious high-end approach [35]. The examined providers exemplify the trend towards creating more intuitive and responsive smart building environments, integrating self-learning and auto-adapting methods like geofencing or malfunctioning detection algorithms. The societal interest in health-consciousness is reflected in the broader deployment of health-related features, such as with Bosch's Room Thermostat II 230V integrating air quality sensors and monitoring functionalities [36]. These trends illustrate a multifaceted focus not only on energy efficiency but also on enhancing indoor environmental quality and enhanced information flows [12]. This is in line with Industry 5.0 movement and an increased focus on the societal impacts of products which can be observed in other economic sectors [37].

5. Roadmap of Smart Building Solutions Market

Interpreting the smart building solutions market through CAM reveals the strategic positioning, internal dynamics, and external pressures within this market. This analysis enables us to distill the strengths, weaknesses, opportunities, and threats (SWOT) for each manufacturer, providing a comprehensive overview of the sector's competitive and operational landscape. Figure 4 encapsulates the SWOT for the smart building solutions market based on the analyzed prominent manufacturers. The identified SWOT is confirmed by previously conducted research on the benefits and challenges of the adoption of smart building technologies [1,38].

	Opportunities	**Threats**
	• rising demand for comfort-increasing products • information to occupants: interfaces, graphical dashboards, real-time monitoring, detailed reports • IoT integration (gateways necessary)	• increased customer expectations • highly competitive market • quickly changing regulations • requirements differing by climate zone and country • installation challenges
Strengths	**S-O strategies**	**S-T strategies**
• highly developed technologies concerning energy efficiency • user-friendly and convenient products • control apps with advanced functionalities	➢ new business models, e.g., subscription/contracting ➢ IoT gateways and ports to anticipate future market developments	➢ customer interaction ➢ strategic partnerships and cooperation ➢ installation support
Weaknesses	**W-O strategies**	**W-T strategies**
• energy flexibility and storage barely addressed • lacking integration of health functionalities into one product • maintenance and fault prediction algorithms • difficult installation of some products	➢ personalized health recommendations ➢ AI-based predictive maintenance algorithms ➢ linking data to cloud ➢ energy management systems for flexibility and storage	➢ expansion to new countries ➢ incentives to build trust

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Figure 4. SWOT analysis of smart buildings solution market.

Strengths identified through the CAM underscore the sector's vigorous engagement with technological innovation, particularly the integration of AI and IoT, which has become a defining feature for leading manufacturers. This integration has been extensively applied in various sectors, including smart buildings, to improve efficiency, sustainability, and user experience [39,40]. The strong brand reputation and diverse product portfolios further establish these manufacturers as key players in the smart building domain. These technologies are designed to optimize energy use, reducing costs, and minimizing environmental impact. Other studies also reflect the role of AI and the IoT in enhancing energy efficiency in smart buildings by enabling precise control and optimization of building systems, leading to significant cost reductions and minimized environmental impacts [41,42]. The products within this market are not only user-friendly but also highly convenient, offering intuitive interfaces and seamless integration into everyday life. Advanced control apps with sophisticated functionalities enhance the user experience by providing comprehensive control over building systems. These strengths reflect the sector's capability to drive forward with significant advancements in building management and efficiency.

Weaknesses, as revealed by the matrix, include challenges related to the interoperability of different technological systems, which can hinder the seamless integration essential for optimal smart building operations. The complexity of the installation processes is also marked as a weakness, potentially limiting wider adoption and impacting user experience negatively. Another significant issue is the limited focus on energy flexibility and storage solutions. For example, another study discusses the challenges of integrating energy storage solutions in smart buildings, noting the need for advanced energy management systems to enhance energy flexibility [43]. This gap leaves room for improvement in managing variable energy demands and storing energy efficiently. Additionally, there is a lack of integration of health functionalities into a single product, which can limit the holistic appeal of smart building solutions. This point is seconded by other researchers, indicating a lack of focus on health functionalities in existing smart building solutions, and highlights the need for incorporating such features to enhance occupant well-being [44]. The market also struggles with underdeveloped maintenance and fault prediction algorithms. Simplifying installation processes through plug-and-play designs, modular systems, and pre-configured setups can lower barriers for users and promote wider adoption. Additionally, providing robust training programs and professional support for complex installations could address challenges in commercial applications.

Opportunities emerge from a growing global emphasis on sustainability and energy efficiency. The sector is well-positioned to capitalize on governmental incentives aimed at green building initiatives, as well as advancements in related technologies that can enhance product offerings. Other studies also characterize the smart building sector by rapid technological advancements, particularly in integrating AI, machine learning, and IoT for energy management and user comfort [45]. Increasing awareness among consumers and businesses about the benefits of smart building solutions presents a significant opportunity for market expansion. Furthermore, there is a rising demand for comfort-increasing products as occupants seek more comfortable and livable environments. Providing enhanced information to occupants through interfaces, graphical dashboards, real-time monitoring, and detailed reports can significantly improve user satisfaction and engagement. The integration of IoT gateways is another promising opportunity, which some studies have also defined as a key game changer, through its enabling efficient data collection and real-time processing, enhancing both energy management and occupant comfort [46,47]. As IoT technology becomes more prevalent, integrating it into smart building solutions can create more connected, intelligent, and responsive environments [42].

Threats to the sector include the pace of technological evolution. Increased customer expectations, driven by rapid technological advancements and the proliferation of smart technologies, mean that market players must continuously innovate to stay relevant. A review of the research trends in the design and implementation of smart technologies in buildings also states that the rapid advancement of technologies such as AI, IoT, and automation in smart buildings presents a continuous challenge for companies to innovate and adapt. The need for ongoing technological upgrades and the integration of new systems can strain resources and require significant investment [48]. The market is highly competitive, with numerous players offering similar solutions, which can drive down prices and squeeze profit margins. Regulatory changes, particularly concerning data privacy and environmental standards, pose potential risks to operations and market strategy. Additionally, the threat of market saturation and the impact of economic fluctuations necessitate strategic foresight to navigate these external pressures effectively.

6. Conclusions

With the goal of illuminating the development status, current dynamics, and future trends of the smart building solution market, this paper first selected a range of prominent manufacturers and their products. The 19 identified products from 15 different manufacturers were categorized into six product categories. For the analysis, CAM was developed to evaluate products and manufacturers regarding their service impacts, investments, market penetration, business models, and value propositions. The framework and evaluation of the service impacts were based on the Smart Readiness Indicator (SRI) methodology.

The selected products and manufacturers were thoroughly investigated using manufacturers' websites, technical sheets, online newspaper articles, blog posts, and LinkedIn profiles. The gathered information was analyzed and synthesized into the CAM. Using color-coded visualization techniques, strengths in the market were identified in the areas of energy efficiency, comfort, and convenience. However, weaknesses were found in the integration of flexibility and storage functionalities. Additionally, health, well-being, and accessibility were identified as weak spots in the smart building solution market. There is development potential in further elaborating interoperability and fault detection algorithms as well as improvement of the information flow to building occupants. To further foster and enrich the study, it is recommended to provide a development of industry standards, such as open APIs and communication protocols, to enable seamless integration across systems. Open-source platforms and collaborative efforts among stakeholders could further enhance compatibility and foster innovation in smart building solutions.

Building on the CAM results, a SWOT analysis of the smart building solution market was conducted. Among the selected manufacturers and products, there is a noticeable dominance in the product categories of smart thermostats, smart radiator valves, and HVAC control, indicating the current focus of the most prominent manufacturers. The market is technically innovative (e.g., AI integration) but also highly competitive. Uncertain regulations and government incentives create uncertainty for manufacturers. Concerning business models, a trend towards subscription and contracting can be observed, particularly in the commercial and industrial sector. Approximately 60% of the manufacturers considered in this paper are actively investing in expanding their partner networks, reflecting the rapid developments in the market.

To conclude, the analysis conducted through the CAM and SWOT analysis offers a more holistic understanding of the smart building solutions sector. This exploration reveals a vibrant industry at the forefront of technological innovation, driven by a commitment to sustainability and efficiency. Despite facing challenges, the sector is ripe with opportunities for growth, particularly as global demand for sustainable infrastructure intensifies. Additionally, integrating smart technologies for electric vehicle charging within smart building ecosystems presents a promising revenue for future energy flexibility and management on the building and district level. The strategic insights underscore the importance of agility and foresight in navigating the competitive landscape. As research in this domain advances, future studies could delve deeper into the development of standardized frameworks and advanced methodologies to address interoperability challenges within the different impact categories.

While the study provides insights into the geographical distribution and application of products, it does not delve deeply into sales volumes or user demographics due to data availability constraints. Future research could leverage survey-based methods or partnerships with manufacturers to access anonymized datasets. Collaborations with industry stakeholders or access to third-party market reports may help address these limitations. Moreover, an accurate evaluation of manufacturers' claims requires real-life testing or controlled experiments, which were beyond the scope of this study. Future research could focus on comparative testing of products under standardized conditions, such as lab conditions or pilot implementations, to ensure a more objective validation of performance claims. It should also explore long-term environmental impacts using life cycle assessments and address social aspects like accessibility and equity to ensure alignment with sustainability goals.

As the sector continues to evolve, these insights can serve as a resource for different stakeholders, guiding strategic decisions and fostering innovation in the pursuit of smarter, more sustainable buildings. Future market developments should explore enhancing energy flexibility and storage technologies, integrating health-related functionalities into unified platforms, and establishing standardized protocols to improve interoperability across smart building systems.

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