Analysis and assessment of ABB Distributed Control Systems in a changing business environment in terms of commercial technology development.

AMBS and Dept. of EEE

The University of Manchester

May 2024

Location – Global

Challenge topic – Industry, Innovation, and Infrastructure

Formative Quiz – 92%

Citation Quiz – 100%

Contents

List of Tables

List of Figures

1 Introduction

ABB (Asea Brown Boveri) Ltd., a Swedish-Swiss multinational corporation formed in 1988 through the merger of Sweden's ASEA and Switzerland's BBC, stands as a global leader in power generation, transmission, and distribution, as well as industrial automation and robotics. With a rich history dating back to the late 1800s, ABB has continually expanded its reach through strategic acquisitions and innovations. With a presence in multiple continents and a diverse portfolio of products and services ranging from electrification to motion solutions, ABB remains at the forefront of shaping the future of technology and industry.
ABB has four customer-focused, globally leading business areas: Electrification, Process Automation, Motion, and Robotics & Discrete Automation, all of which are vital for Industry 4.0 [1]. With a history of more than 130 years, ABB not only invented or pioneered many power and automation technologies but has retained technology and market leadership in many of these areas. This industry leadership allows ABB economies of scale, large research and development budgets and high pricing power [3]. “ABB's purpose is to enable a more sustainable and resource-efficient future with our technology leadership in electrification and automation” [2].

The company's solutions support economic development and human well-being by providing affordable and equitable access to essential services and technologies, thereby fostering inclusive growth. ABB launched its formal environmental management program in 1992, by establishing its environmental affairs organization and an environmental advisory board, to assess ABB’s initial environmental performance and formulate a general environmental strategy [4]. By 2000 ABB consolidated its environmental affairs organization into sustainability organization and published its first triple bottom-line sustainability report [4].
Since its introduction more than four decades ago, the Distributed Control System (DCS) – a digital platform for automated control and the heart of the process and energy industries, ABB’s DCS has maintained a leading position in a market worth more than $19.9 billion in 2023 [5] [6]. This report aims to verify how the latest generation of ABB Distributed Control systems contribute to the global effort to mitigate climate change and build a sustainable future, amid rapidly changing technological and political environments.

1.1 Individual Background and Venn Diagram

ABB’s global presence in the field of Automation and electrification, paired with the author’s specialisation in mechatronics, makes it an ideal organisation for this analysis.

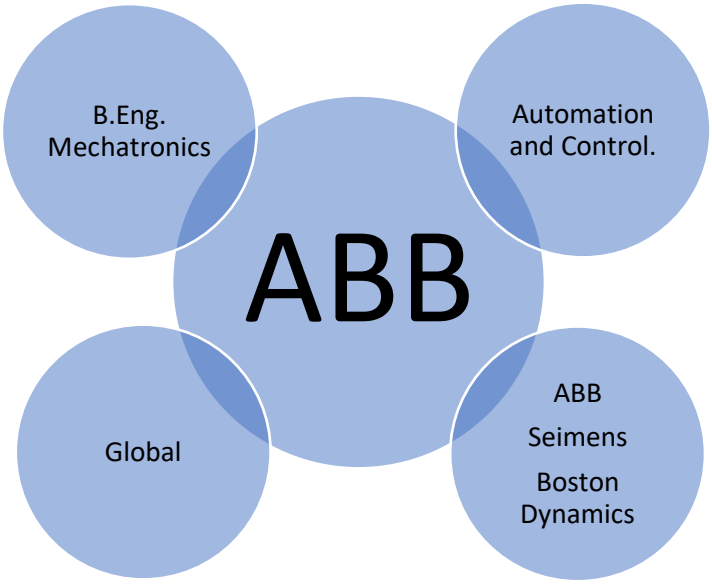

Figure 1. Venn Diagram of company selection

2 Literature Review

2.1 Industry 4.0 and UN Sustainability Development Goal 9

As per Eurostat the manufacturing sector in 2021 in the European Union comprised 2.1 million enterprises employing 30 million persons [7]. This directly underscores paragraph 2 of Lima Declarations stating that industrialization is a driver of development, boosting economies and thereby reducing poverty and addressing other sustainable development goals [8]. However, the manufacturing industry was also the biggest producer of Greenhouse gasses (GHG) in 2021, with 800 million tonnes of CO_2-eq; representing 22% of total GHG emissions in the EU [9]. As the global population continues to grow and standards of living rise, the manufacturing industry faces increasing demands. However, addressing these dual challenges requires careful ethical considerations. Therefore, achieving lower environmental impacts necessitates significant technological advancements and innovations within the industry. Industry 4.0 (I4.0) introduces key concepts shaping modern manufacturing. Smart factories are equipped with sensors and autonomous systems for seamless digitalization and control [10]. Cyber-physical systems (CPS) blend physical and digital realms, the main advantage of these systems is that the tight coordination of cyber and physical elements provides greater autonomy, efficiency, functionality, reliability, and adaptability [11]. A Distributed Control System (DCS) automates industrial equipment, reducing risk to people

and the environment. Large-scale production aimed at cost reduction is no longer feasible for individualised goods. Leveraging computing, sensing, and networking capabilities, machines can distribute decision-making authority, moving away from centralized control [12]. Decentralized self-organization is increasingly replacing traditional hierarchies. Distribution and procurement become more personalized, while product development emphasizes adaptability and innovation. Corporate social responsibility prioritises sustainability and resource efficiency in manufacturing design [13]. Industry 4.0 implementations have the potential to increase industry throughput by 10% to 30% [14]. I4.0 plays an important role in addressing SDG 9, [15] identifies the technologies enabling I4.0 as shown in Figure 1, with ABB having offerings in Autonomous Robots, Cybersecurity, IIOT and enabling technology for Additive Manufacturing and Big Data and analytics.

Figure 2. enablers and elements technologies *[15]*

3 Product/Service

3.1 ABB Ability™ System 800xA® Architecture (System 800xA)

As mentioned in Section 2 Distributed Control Systems are an integral part of I4.0, especially in large operations. System 800xA (where xA stands for extended Automation) DCS boasts 10,000 installed systems in over 100 countries, monitoring and controlling over 50 million tags and helping ABB be the number one global DCS supplier for over a decade. The ABB Ability™ Distributed Control System (DCS) 800xA is a comprehensive automation platform that integrates process control, electrical control, safety, and plant optimization functionalities into a single system, this reduces the total cost of ownership and creates an unparalleled plant operation environment. It is designed to enhance operational efficiency, improve decision-making, and ensure the seamless operation of industrial processes across various industries including oil and gas, power generation, chemical, and manufacturing. The 800xA DCS is designed to be scalable, allowing it to accommodate the needs of both small and large-scale industrial operations. Its flexible architecture enables easy customization and expansion, making it suitable for diverse application scenarios. Overall, the ABB Ability™ Distributed Control System 800xA stands out as a comprehensive and versatile automation solution, making it a compelling subject for analysis in coursework focused on industrial automation and control systems.

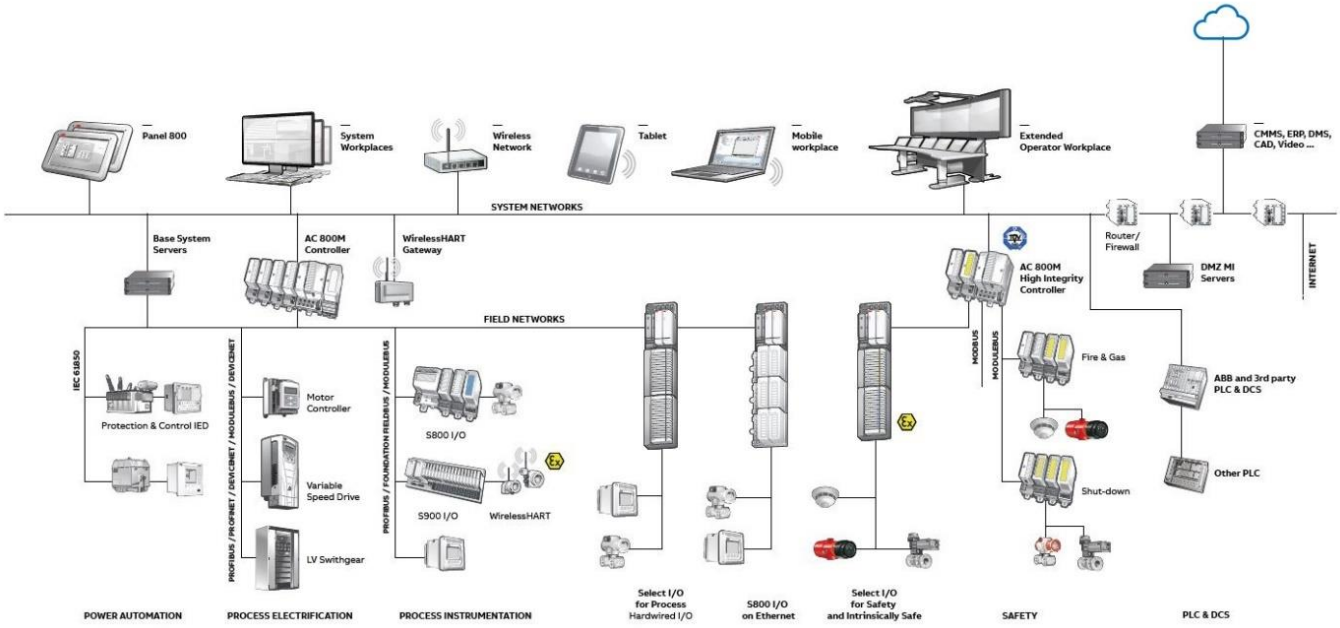

Figure 3. Example Architecture of ABB Ability 800xA DCS [16].

3.2 Business Model Canvas: System 800xA

Table 1 provides the graphical Business Model Canvas (BMC) for system 800xA. BMC is an invaluable tool for dissecting and understanding the complexities of ABB's System 800xA, offering a structured approach to analysing its key components and value propositions.

Table 1. Business Model Canvas for System 800xA

The Business Model Canvas

Designed by: Mahir Pokar

Date: 30/03/2024

Key Partnerships

- System Integrators and Technical Distributors
- Component Suppliers
- Maintenance Providers
- Industry Consultants

Key Activities

- Research & Development
- Manufacturing
- Sales & Marketing
- Customer Support

Key Resources

- Research and Development Team
- Intellectual Property portfolio

Value Propositions

- Comprehensive Automation Solution
- Integration Capabilities
- Scalability and Flexibility
- Advanced Analytics and Optimization

Customer Relationships

- Personalized Support
- Training & Education
- Consultation
- Online Communities

Channels

- Direct Sales
- Online Platforms
- Industry Events
- Partner Networks

Customer Segments

- Oil & Gas Companies
- Power Generation
- Chemical Manufacturers
- Manufacturing Plants

Cost Structure

- Research & Development
- Manufacturing
- Marketing & Sales
- Customer Support

Revenue Streams

- Product Sales -$6.3 bn in 2021 [24]
- Maintenance Fees
- Consulting Services
- Training Programs

3.3 Value to the Customer/Market:

The ABB Ability™ Distributed Control System 800xA offers significant value to customers and the market by providing a comprehensive automation solution that enhances operational efficiency improves decision-making and ensures the seamless operation of industrial processes. Table 1 provides a list of key benefits of the 800xA DCS.

Table 2. Key Benefits of System 800xA

Value	Description
Industry Dominance	ABB is a leading provider of automation and control solutions globally, and the 800xA DCS is one of its flagship products. It is widely adopted across various industries and has a strong reputation for reliability and performance. This gives ABB immense experience in various applications, providing easier installation for new clients.
Comprehensive Functionality	The 800xA DCS offers a wide range of functionalities, including process control, electrical integration, safety systems, and advanced optimization features. This comprehensive suite of capabilities makes it a significant player in the automation market.
Integration Capabilities	One of the key strengths of the 800xA DCS is its ability to integrate diverse control systems, devices, and protocols into a single platform. This is evident in the fact that system 800xA supports 13 different communication protocols, including wireless protocols [17].This integration capability enables seamless communication and data exchange across different parts of the plant, leading to improved efficiency and operational visibility.
Scalability and Flexibility	The 800xA DCS is designed to be scalable, owing to its modular design, allowing it to accommodate the needs of both small and large-scale industrial operations.
Advanced Analytics and Optimization	ABB Ability™, the digital platform associated with the 800xA DCS, offers advanced analytics and optimization tools that enable users to extract valuable insights from process data. These tools facilitate predictive maintenance, energy optimization, and performance monitoring, contributing to overall operational excellence.

Support for Industry Standards	The 800xA DCS complies with industry standards and protocols, ensuring compatibility with existing infrastructure and future-proofing investments.

3.4 Current Competitors

Some current competitors to the ABB Ability™ Distributed Control System 800xA include Siemens SIMATIC PCS 7, Emerson DeltaV, and Honeywell Experion Process Knowledge System (PKS). These competitors offer similar automation solutions with varying degrees of integration, scalability, and analytics capabilities. It is difficult to directly compare two DCS systems as they are modular, and the cost and complexity differ based on the scale of application. However, ABB can manage its dominance owing to its vast experience and global presence. ABB has more than 40 years of experience in digital technology and operations across 100 countries. This is an important advantage as clients rely upon ABB to aid the integration of DCS into their plants. DCS implementation requires exceptional technical expertise of both the system and the plant where it needs to be integrated. ABB's vast experience and market leadership allows them to offer their clients unparalleled technical support.

3.5 Stakeholder Analysis

Within ABB, the internal stakeholders for the Ability System 800xA encompass a diverse range of teams and individuals. The Product Management Team plays a pivotal role in driving the product's vision, roadmap, and feature development. Their deep understanding of market trends, customer needs, and technological advancements shapes the strategic direction of the system. Alongside them, the Development Team contributes their expertise in engineering, design, and software development, ensuring that the product meets high standards of functionality, performance, and reliability. Collaboration between these teams is critical for translating market insights into tangible product features that resonate with customers and differentiate ABB's offering in the industrial automation sector. Additionally, the Sales and Marketing Team leverages their understanding of customer pain points, competitive landscape, and value propositions to effectively position and promote the Ability System 800xA in the market, driving adoption and revenue growth.

Externally, stakeholders for the ABB Ability System 800xA include a wide array of entities that interact with the product ecosystem. Customers, ranging from manufacturing plants to utilities and infrastructure providers, are key stakeholders whose feedback and usage patterns directly impact product evolution. Understanding their evolving needs, challenges, and priorities is crucial for enhancing product features, usability, and overall customer experience. Industry partners, such as technology integrators, consultants, and solution providers, form another critical external stakeholder group. Collaborating with these partners enables ABB to extend the system's capabilities, integrate with complementary technologies, and address specific industry requirements, fostering a robust ecosystem around the product. Moreover, engagement with regulatory bodies ensures compliance with industry standards, certifications, and legal frameworks, enhancing the system's credibility, trustworthiness, and market acceptance. Overall, effective engagement with external stakeholders is essential for driving innovation, market relevance, and sustained growth of the ABB Ability System 800xA.

4 Analysis

4.1 Current Design Criteria

The Design Criteria are analysed from four perspectives: Technical, Economic, Social and Environmental.

Technical Criteria: Designing a Distributed Control System (DCS) demands a holistic approach, balancing scalability, redundancy, security, and interoperability. Scalability ensures the system can grow without performance compromises, while redundancy safeguards against downtime with backup components and networks. Robust security measures, from network segmentation to encryption, shield the DCS from cyber threats. Interoperability ensures seamless integration with other systems, enhancing data consistency and workflow efficiency. Reliability hinges on reliable hardware and predictive maintenance, maintaining uptime. A user-friendly Human-Machine Interface (HMI) aids operators in monitoring and controlling processes. Modularity facilitates expansion and upgrades, while performance monitoring and compliance with standards ensure optimal functionality and regulatory adherence. Integrating these criteria yields a resilient, adaptable DCS for complex industrial environments [18] [19].

Economic Criteria: DCS are expensive to install and maintain hence designing involves balancing initial investment costs with long-term operational savings and productivity gains. Scalability plays a crucial role by allowing the system to expand incrementally as needed, minimizing upfront expenditures while aligning with business growth. ABB emphasizes the system's ability to optimize operational efficiency, reduce downtime, and lower maintenance costs through advanced analytics, predictive maintenance, and energy optimization features. By enhancing productivity and minimizing operational disruptions, the 800xA DCS helps customers achieve significant cost savings over the system's lifecycle.

Social Criteria: In terms of social criteria, the design of the 800xA DCS prioritizes safety, usability, and workforce empowerment. The system is designed to ensure the safety of industrial personnel by incorporating robust safety features and adhering to industry standards and regulations. Moreover, the user-friendly interface and intuitive operation of the system empower workers to effectively monitor and control industrial processes, enhancing job satisfaction and productivity.

Environmental Criteria: The design criteria for the 800xA DCS also include environmental considerations such as energy efficiency and sustainability. ABB emphasizes the system's ability to optimize energy consumption through advanced control algorithms and energy management features, helping industrial facilities minimize their environmental footprint. Additionally, the system's longevity and reliability contribute to reducing electronic waste and promoting sustainable resource utilization throughout its lifecycle.

4.2 Triple Bottom Line Impacts

Table 3. Triple Bottom Line Impacts of System 800xA

System 800xA	Economic	Social	Environmental
Production	• The production phase of the ABB Ability System 800xA DCS involves manufacturing complex electronic components, which contributes positively to the economy through job creation and revenue generation for ABB and its suppliers. • High development cost for state-of-the-art components. Requires highly trained engineers and technicians.	• The production phase of the ABB Ability System 800xA DCS involves a complex supply chain, including manufacturing facilities, component suppliers, and logistics providers. This creates a network of employment opportunities across various skill levels, from assembly line workers to engineers and technicians. • The production requires a highly skilled workforce. ABB invests in training programs for its employees and collaborates with educational institutions to develop talent in areas such as electrical engineering, automation, and software development.	• The manufacturing process of the system consumes resources and energy, contributing to carbon emissions and waste generation. • ABB is committed to reduce its operational GHG emissions by 2030 by 80%. To do so ABB plans to electrify their entire vehicle fleet, source 100% of energy from renewables and improve energy efficiency across operations [20].

System 800xA	Economic	Social	Environmental
Use	• The system is designed to enhance economic efficiency for industries by optimizing and automating operations, reducing downtime, and improving productivity. These cost savings are essential to deliver a strong return on investment, as the initial cost is high. • Modular design allows easy scaling and descaling to match demand.	• The system prioritizes safety, usability, and workforce empowerment, fostering a positive social impact by ensuring the safety and satisfaction of industrial personnel. • ABB's diverse network and training programs, allows these systems to be installed in developing countries, which may not have access to sophisticated automation technologies previously. • Although manual labour jobs are replaced, these jobs usually tend to be hazardous or monotonous.	• The system implements cutting edge control algorithms to improve efficiency and thus reducing energy and resource consumption. • The system offers advanced analytics allowing industries to measure environmental performance metrics in real time. • The system supports easy integration of renewables.
End of Use	• Each part of the system has a very high lifespan, owing to robust design. This allows businesses to sell the components with minimal depreciation if they decide to upgrade or shut down. • The modular design means in event of a fault the maintenance costs are minimised. • The ABB lifecycle policy ensures clients that no part will be discontinued till an equivalent or superior compatible replacement is made available.	• The outdated parts remain functional, allowing them to be procured by smaller industries in developing countries, boosting local economies.	• The disposal contributes to e-waste generation. • ABB's circularity framework supports take-back services for refurbishment, reuse or recycling of products and components, and is accompanied by instructions for responsible end-of-life treatment.

4.3 Steps to Respond to Economic, Environmental, and Social Challenges

1. Economic: ABB can respond to economic challenges by continuously enhancing the cost-effectiveness and value proposition of the 800xA DCS through innovation, cost optimization, and strategic pricing strategies.
2. Environmental: To address environmental challenges, ABB can focus on further improving the energy efficiency and sustainability features of the 800xA DCS, as well as promoting eco-friendly manufacturing processes and materials.
3. Social: ABB can respond to social challenges by prioritizing safety, usability, and workforce training initiatives to ensure the well-being and satisfaction of industrial personnel using the 800xA DCS.

4.4 Main Risks and Steps to Manage Risk

One of the main risks for the ABB Ability™ Distributed Control System 800xA failing in the market is technological obsolescence, as rapid advancements in automation technology could render the system outdated. To manage this risk, ABB can invest in continuous research and development to innovate and upgrade the system, ensuring its competitiveness and relevance in the market. Additionally, ABB can establish long-term partnerships with customers and provide ongoing support and updates to address evolving industry needs and technological trends. For example, offering upgrade packages and migration services to

transition customers to newer versions of the system can mitigate the risk of obsolescence and ensure customer retention.

5 Concluding Remarks

5.1 Conclusion

The analysis of ABB's DCS within the changing engineering business environment highlights several key aspects regarding commercial technology development, sustainability, and industry impact. ABB's high investments in research and development have paid off, with them leading the industry making them a key player in the I4.0 era, directly contributing to SDG 9. The value proposition of ABB's DCS solutions, including scalability, integration capabilities, advanced analytics, and compliance with industry standards, delivers significant benefits to customers in terms of operational efficiency, safety, and cost-effectiveness. Their most popular DCS system 800xA is enabling industries to improve their productivity while reducing their carbon footprint. ABB's strong emphasis on sustainability, as seen in its environmental management programs, commitment to reducing GHG emissions, and circularity framework for product lifecycle management, demonstrates its dedication to minimizing environmental impact and promoting sustainable practices.

5.2 Reflection

Reflecting on this course unit has been incredibly enlightening and transformative for me. While my background in mechatronics provided a strong technical foundation, this course delved into the critical intersection of technology, business, and sustainability, offering a unique set of skills and perspectives that are crucial in today's complex engineering landscape. One of the most challenging yet rewarding aspects of this course was grappling with the intricate relationship between technological innovation, commercial viability, and sustainability. It required a deep dive into industry trends, market dynamics, and environmental considerations, pushing me to think beyond traditional engineering paradigms.

A completely new concept for me was understanding the triple bottom-line impacts of technology. This holistic approach, considering economic, social, and environmental aspects, has fundamentally shifted my perspective as an engineer. It has underscored the importance of designing and implementing technology not just for functionality but also with a keen awareness of its broader implications on society and the planet.

The case study on ABB's Distributed Control Systems and their role in Industry 4.0 was particularly enlightening. It showcased how cutting-edge automation solutions can drive efficiency, reduce environmental impact, and contribute significantly to sustainable development objectives. Learning about the strategic value of such technologies from both a technical and business standpoint has added depth to my engineering knowledge and highlighted the necessity of interdisciplinary collaboration in addressing complex global challenges.

Overall, this course unit has equipped me with a more comprehensive and nuanced understanding of technology's role in the business ecosystem and its profound impact on societal and environmental well-being. It has expanded my skill set beyond technical competencies, integrating business acumen and sustainability considerations into my professional toolkit. I am now better prepared to navigate the intricate landscape of engineering, innovation, and sustainability, contributing meaningfully to the creation of a more sustainable and equitable future through technological advancements.

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