Artificial Intelligence in Procurement: An Overview and Case Study of Qatar Foundation

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Abstract

Although artificial intelligence (AI) has been reluctant to gain attraction in the procurement segment of a company, many organizations have started to see its potential in the supply chain activities since it enables numerous sectors in the evolution of their business models. AI refers to intelligent algorithms or apparatuses that are capable of autonomously and systematically performing activities or cognitions without human intervention or mental decisions. In procurement and supply chain applications, AI can enhance design and operational frameworks, data visibility and analytics, opportunity assessment, accurate report generation and contract management, etc. This paper presents opportunities and applications of AI in procurement with particular emphasis on the procurement process carried out by Qatar Foundation (QF). QF is a non-profit organization which has a unique system as it involves over 50 entities with different activities related to education, research, and community development. This one-of-a-kind ecosystem comprises a unique and complex supply chain model. As a result, procuring different materials and services to cope with all entities' requirement is a challenge due to the tremendous amount of data and purchases. The use of AI methodologies is anticipated to provide multiple benefits towards achieving improvements over diverse areas.

Keywords
Artificial Intelligence, Procurement, Qatar Foundation.

1. Introduction
Industry 4.0 (I4) technologies towards the digital transformation of the procurement process are evolving to enhance it as I4 enables the connection of the physical and digital environments, resulting in better decision making and increased resilience and efficiency. Based on Deloitte (n.d.), digital technologies are categorized to the degree in which they are deployed in procurement into three categories: core, maturing, and emerging. The core category represents solutions already implemented in larger systems with longer implementation, including spending analytics, eSourcing, electronic catalogs, contract management, supplier information management, eProcurement, eInvoicing, and eAuctions. The maturing category covers solutions that transform procurement with minimal investment: cognitive computing/artificial intelligence, intelligent content extraction, predictive/advanced analytics, visualization, collaboration networks, crowdsourcing, 3D printing, and robotics. Finally, the emerging technologies are the solutions that could impact procurement in the future, including blockchain, sensors, cyber tracking, and virtual reality.

According to Oxford Dictionary (2005), AI is defined as the theory and development of computer systems capable of performing activities ordinarily requiring human intelligence, such as visual perception, speech recognition, decision-making, and language translation. AI is the driving force of the fourth industrial revolution in the same way as mechanization, mass production, and automated production were previously (Sammalkorpi and Teppala 2019). The development of Industry 4.0 revolution is illustrated in Figure 1.
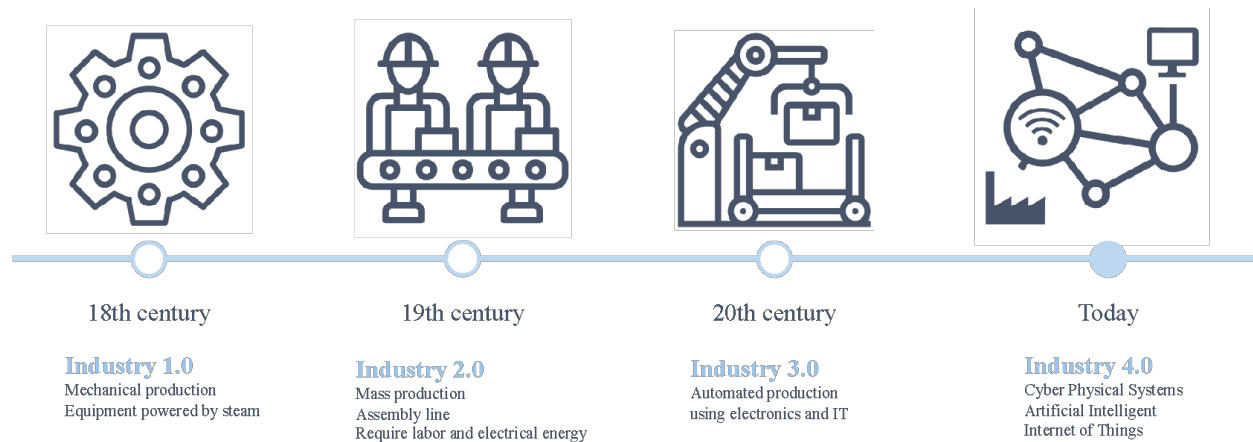
Figure 1: Industry 1.0 to 4.0 revolutions.

This paper first provides a generic review on AI opportunities and applications in procurement. Then, it discusses the uniqueness of Qatar Foundation and their motivation to use AI for procurement processes. Finally, it presents the challenges of QF's current system and formulate a problem statement to be further addressed in future work.

2. Opportunities of AI in Procurement

The application of AI extends across multiple organizational functions, from automation of operations to optimization in decision-making and advanced analytics in forecasting. AI involves any software solutions that comprise smart algorithms and machine learning (Cui et al. 2021). With the majority of corporations today receiving and processing diverse data from various enterprise-wide systems, investment in AI is fast growing. Procurement segments of organizations, for instance, use AI in the interchange of electronic and structured business data with suppliers (Chopra 2019). As an advanced aspect of information technology, AI can be entrenched into multiple software applications to conduct strategic sourcing and management. AI enables procurement corporations to solve sophisticated problems competently and successfully using compute algorithms.

For procurement firms, the biggest challenge is often to identify the leading suppliers in the area, the most appropriate suppliers to evaluate, potential market partnerships, and mergers and acquisitions. To facilitate this process, experts collect incoming and outgoing data, both from external suppliers, pricing, transactions, clients, spending, and contracts (Boute et al. 2021). As a result, the volume of these data can be overwhelming to manual data input, especially in such an extremely connected operational setting. In addition, manual data input in the supply chain can result in uncategorized, inaccurate, and misclassified information that might be invaluable to the interest of more strategic and efficient management (Boute et al. 2021). With such concerns, procurement organizations use procurement market intelligence to search and extract important information across numerous digital sources.

In procurement, AI facilitates smart business processes towards making better choices and improving operations by using different forms of smart algorithms, including machine learning, artificial intelligence, robotic process automation, and natural language automation. AI provides the data-driven and timely analytic vision to make exclusive sourcing decisions (Kiefer and Ulmer 2019). In addition, machine learning allows for extensive spend analytics, more organized supply chain management, and profound need analysis (Chopra 2019). This form of AI also embraces natural language processing (NLP), which permits human beings to coordinate more naturally with AI, both text and voice searches (Kiefer and Ulmer 2019). With machine-learning technology, procurement experts can minimize suppliers' buying prices, warehouse costs, and quantity, secure suppliers, develop products with suppliers, optimize internal activities, outsource effective procurement procedures, and ensure quality guidelines are met.

Procurement can restructure and enhance high-volume, complex, and repetitive errands using robotic process automation. The software Robots aids in controlling vital performance for internal process in handling invoices and purchase order approvals (Pournader et al. 2021). Allal-Chérif et al. (2021) notes that AI has the most impact in

identifying and eliminating supplier compliance problems and informing the business and suppliers on distribution interruption. As a result, AI offers a competitive advantage by improving efficiencies and providing excellent decision-making by allowing smarter procurement. Depending on the extent of complication, AI can complete simple tasks as well as complex decision-making that requires direct human interactions.

Given the high level of complexity and resources required to merge data from procurement and supply chain processes manually, AI performs unlimited automation of manual procurement tasks. AI can automate numerous time-consuming tasks, allowing extra time and other resources for more strategic and creative activities (Boute et al. 2021). The vast quantity of sophisticated data that procurement teams handle daily consumes time and exerts pressure on administrative functions. Some of the major areas identified by systematic studies as posing the utmost potential for automation include invoice processing, procurement performance reporting, and approval of proposed purchases (Chopra 2019). AI consolidates these data automatically, making the variables of sources, quantity, and system controllable (Modgil et al. 2021). As a result, the procurement team gets adequate time to concentrate on high-value tasks and establish relations with internal stakeholders and suppliers by gaining data control.

Additionally, AI prompts the identification of opportunities that have a greater impact. Collecting and analyzing huge quantities of data enables AI to disclose revenue opportunities and new savings and optimize supplier connections (Cui et al. 2021). A study on AI applications in Pournader et al. (2021) suggests that advanced data analytics by AI offers clients an extraordinary chance to recognize opportunities to ensure exclusive outcomes. With access to an extensive amount of external data, AI has the potential to recognize new markets and make more data-informed connections with suppliers. When digital analytical strategies are leveraged to create a strong data basis, they can be processed via multiple algorithms to identify underlying opportunities across various levers (Allal-Chérif et al. 2021). The more resources procurement can secure, the greater its value to the organization.

3. Application of AI in Procurement

AI is applied to identify and monitor potential risk positions within the supply chain. The machine-learning approaches provide insights into a huge amount of data and existing information necessary for risk management (Kiefer and Ulmer 2019). For instance, in risk intelligence, big data approaches are utilized to screen multiple data sources and give alerts in supply chain management (Modgil et al. 2021). As businesses become global and more complex, supply-chain risk management has multiplied. Therefore, the key to risk management is comprehending relevant data for every organization, presenting the fast and necessary information to the appropriate team, and making sure that data is processed into actionable intelligence.

As purchasing software, AI works to review and approve purchase orders automatically. The fundamental purchase-to-pay procedures for recording and processing procurement transactions have been automated (Chopra 2019). AI advances this automation using software like Chatbot to automatically approve virtual payments and confirm purchase status (Cui et al. 2021). Consequently, staff can use guided buying to monitor placed orders. In addition, through supporting automated invoice processing, AI helps systems identify potential fraud and understand non-standard invoices.

AI can also be utilized to manage and improve the strategy of sourcing. For example, under the request for proposal (RFP), procurement teams can leverage AI-driven tools to recommend the potential suppliers to be contacted (Modgil et al. 2021). A review by Cui et al. (n.d.) maintains that AI supports the sourcing, awards contracts, and direct new methods of selecting suppliers. Using the sourcing automation software, with specialized category-specific online sourcing bots, staff can apply machine learning for the acknowledgment of bid sheets (Chopra 2019). From previous evidence, AI is essential in designing the process and documents and aiding the evaluation. By ensuring suppliers possess the accreditation needed to conduct business AI digital processes.

In contract management, AI is used to explore the current contracts in businesses to review terms and conditions that may impose a threat to the potential buyer. Existing organizations reveal that AI is likely to assume the role of contract management at each phase of the procurement cycle (Boute et al. 2021). A concrete instance is natural language processing, which automatically allows the Seal software to process large documents for possible savings opportunities. AI works by detecting the supplier information required to manage the contrast and performance and ensuring clear records and reports for future reference (Kiefer and Ulmer 2019). AI guides the strategic planning for new contracts while recommending appropriate terms and conditions.

AI relies on machine learning to drive product research and internal improvement as a basic driver for innovation. As Cui et al. (n.d.) clarify, machine learning involves the application of automated self-learning data to enhance operational efficiency. For example, using spend analysis machine learning algorithms, such as vendor matching and automatic spend classification, procurement enhances numerous supply chain processes (Pournader et al. 2021). While the uptake of AI in business is relatively low, there are many instances in which AI is applied in procurement functions. The concept of market intelligence is relatively new. However, many organizations are noticing that supply markets are hypothetically extensive sources of competitive advantage and innovative ideas.

Additional areas in which procurement firms use AI are identification of suppliers and account payable automation. When handling supply chain management, procurement experts use big data to pinpoint, manage, and apply data across internal and external databases (Boute et al. 2021). AI-driven search competence enables corporations to outline and recognize the client, which will probably increase competitive advantages. Progressively, machine learning is used in supplier identification to advance supplier discovery based on information acquired, processed, and approved from the Internet (Pournader et al. 2021). For account payable automation, software that utilizes machine learning to detect fraud and fasten payment are applied. The software links supplier information in purchase orders and invoices to a specific vendor.

4. Case study of Qatar Foundation
4.1 Motivation
Qatar Foundation (QF) is a non-profit organization founded in 1995 by Emir Hamad bin Khalifa Al Thani and his wife, her highness Moza bint Nasser, which she chairs. QF is comprised of over 50 entities involved in education, research, and community development. This one-of-a-kind ecosystem is supported by world-class international partnerships based on initiatives to address challenges, create global opportunities, and empower people to share their present and future.

QF started its mission with education by founding one school named Qatar Academy. Today, as an education city, it provides primary and secondary education through schools that run directly by the Foundation, while its higher education initiatives include partnerships with some of the world's leading universities which are Carnegie Mellon, Virginia Commonwealth, Georgetown, Texas A&M, Weil Cornell Medicine, HEC Paris, and Northwestern. In addition, the Foundation established a homegrown University, Hamad Bin Khalifa (HBKU), for postgraduation. Currently, the total programs offered by all universitates are 61 programs with 4000+ alumni. Presently, QF hosts more than 8,000 students across 8 universities and 13 schools.

QF is playing a role in establishing Qatar as a global hub for research and innovation. It has established various pioneering initiatives that are creating transformative change throughout the country, the region, and the globe at large. QF funded more than 2,300 projects, with an approximate investment of $1.4 billion provided by Qatar National Research Fund. These efforts resulted in 331 inventions, 20 startups, and 15 patents.

The work of QF is centered on providing individuals with opportunities. At the same time, the other initiatives focus on creating opportunities for excellence in education and research. QF's community development projects provide a platform for entirely engaging communities on the ground and building programs that improve the nation as a whole. QF established different kinds of community development institutions and centers that vary in their work type. The list is as follow:
- Qatar National Library, which includes more than 1 million books.
- Al Shaqab, which is a leading global equine center.
- Equine Veterinary Medical Center, which is a modern equine veterinary hospital.
- Education City Mosque, which is a premier community-focused mosque.
- Qur'anic Botanic Garden, which exhibits and conserves the plants mentioned in the Holy Qur'an and the native flora in Qatar.
- Qatar Philharmonic Orchestra includes more than 100 musicians to perform western and Arabic music.
- Arab Museum of Modern Art offers an Arab perspective on modern and contemporary art.
- Qatar Career Development Center, which guides to contribute to building Qatari human capital.
- Qatar Green Building Council, which provides leadership and encourages collaboration in the implementation of ecologically friendly methods for green building design and construction in Qatar.
- Qatar Diabetes Association, which supports people in managing diabetes.

- Qatar Biobank is a research institution to reduce the number of chronic illnesses.
- Qatar Nanny Training Academy provides a high-quality training program for Arabic-speaking nannies to become qualified childcare providers.
- Qatar Debate and Doha Debate are national debating organizations.

The use of AI to solve complex challenges was supported by QF strategy for 2022 – 2032. The strategy included AI as one of the main themes. In addition, QF AI strategy contributes to Qatar National Artificial Intelligence Strategy published in 2021 by the Ministry of Transport and Communications in collaboration with HBKU's Qatar Computing Research Institute.

The strategy emphasizes that, first Qatar must develop world-class AI applications in areas of national interest and create a business environment that allows AI to be used as a catalyst for innovation. Second, Qatar must be an effective AI consumer with a well-educated population, good regulations, and ethical standards. QF defined AI as using big data, algorithms, and cognitive computing to advance society and improve quality of life. The AI theme was divided into six subthemes as in Figure 2.

Then, each subtheme was further defined in the areas it could be applied to. After analyzing each subtheme, two out of the six subthemes were found to be the most applicable to procurement: Smart Economy and Analytics and Decision Support. Smart economy focuses on E-services, process automation, e-commerce, blockchains, digital currencies, and e-payments. Analytics and Decision Support indicate the focus on security (cybersecurity, sensors, and early warning), data analytics (the use of algorithms to develop more efficient diagnostic tools, genome analysis, and wellness advice), decision making (focus on investment decisions), and predictive analysis (focus on demand forecasting and economic behavior).
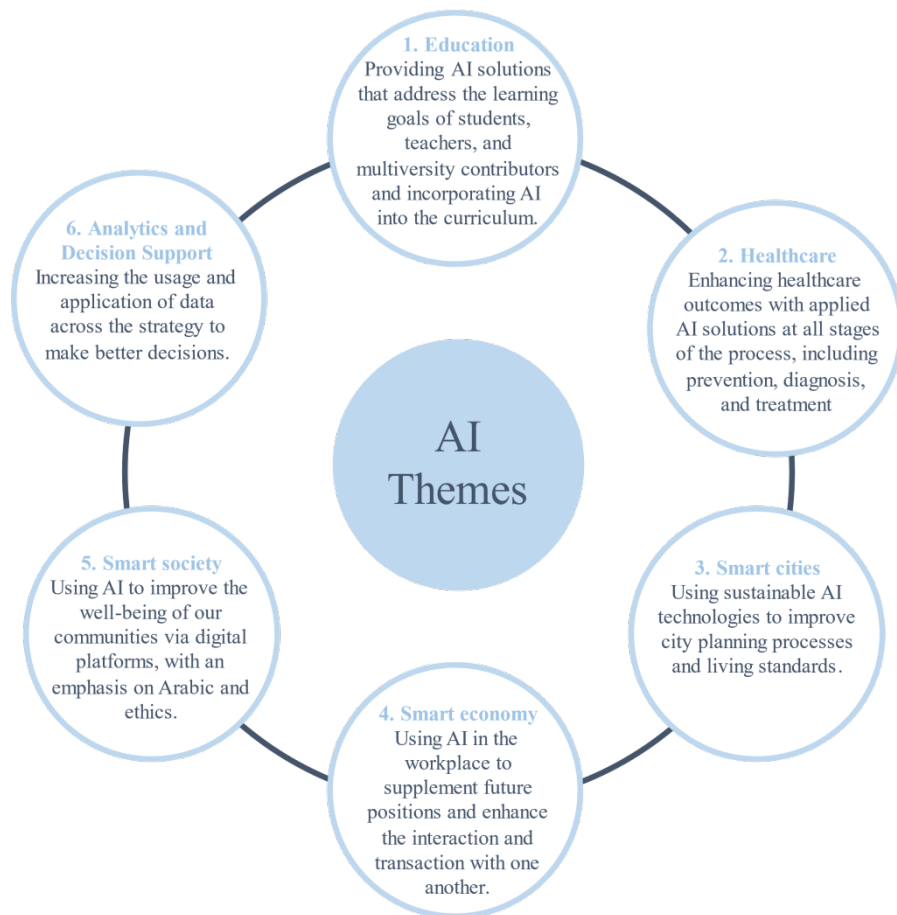

Figure 2: AI themes in the QF 2022-2032 Strategy.

4.2 Problem statement

QF and its institutions, schools, universities, and centers worked together and made a unique model that may not exist in any other organization. This unique system comes with different requirements for each, varying from ordering stationeries to horses. Therefore, this resulted in huge amount of data and spend that need to be classified into procurement categories. The challenge that the Procurement department currently face is the need of categorizing tremendous number of distinct transactions into procurement categories using data from invoices, purchase orders, and other sources.

4.2.1 Current system

The procurement in QF works mainly with three types of contracts as shown in Figure 3. The strategic sourcing is for the long-term contracts that require a blanket purchase agreement (BPA), some examples include stationaries, Human Resources contracts, and events. Supply is for the on-demand requests including all materials. The last one is the services, for all licenses and systems. Regardless of the contract type, all purchases will go to the warehouse and will be delivered as needed.
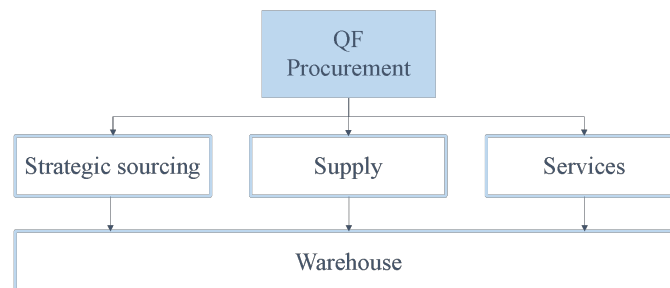

Figure 3: Types of contracts in QF.

Currently, the procurement department does not have proper categorization system in place for all its purchases. The Purchasing Category is directly linked to the charge account which is purely related to finance. Therefore, it is not relevant to procurement purchasing and causes difficulty to track procurement spend. Moreover, Ministry of Commerce and Industry (MOCI) developed around 1600 activity codes for business activities, and procurement department would like to align the purchase categories with MOCI codes. Additionally, there is no visibility of the provided products and services by the suppliers in the system.

The first goal for QF procurement is to have a meaningful and relevant purchasing categories to QF and to be able to identify potential suppliers that can provide specific purchasing category by linking QF purchasing categories with MOCI's suppliers business activities registered in their commercial registration, an illustration is shown in Figure 3. The second goal is to maintain up-to-date purchasing categories and MOCI data and being able to adjust the purchasing categories based on future purchases and suggest new categories if needed.

Categorizing purchases will help QF to better understand the spend, better utilization of suppliers, and monitor purchasing trends which will create new saving opportunities. To build and update purchase categories using traditional techniques will require manual work to maintain data and will create extra unnecessary tasks. With help of AI, it can be used to minimize the spend classification challenge by automatically classify spend data into procurement categories. Additionally, it can provide suggestions for categories and maintain up-to-date and real-time data.
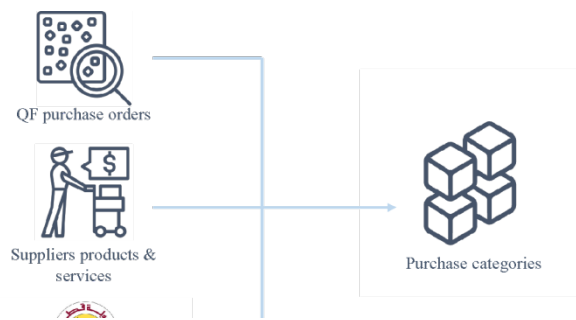
Figure SEQ Figure * ARABIC 4: Purchasing categories goal.

5. Conclusion

Industry 4.0 technologies and the digitalization of the procurement process are evolving in this field, resulting efficient decision making and increased efficiency. AI is efficient at solving complex problems containing a vast amount of data. Such a technology has the potential to manage all the data from multiple sources, including supplier management software, online catalogs, and contracts. AI can automatically consolidate data, process data, and utilize it across business operations with its set of algorithms. Applying this know-how enables clients to constantly monitor and use complex information at any phase of the procurement cycle, from supplier identification to adopting deals, monitoring invoices, and organizing orders. Besides value extraction, analysis visibility, and quick and accurate automated data integration, AI also helps customers manage procurement performance by fastening decision-making, disclosing savings and cost visibility, and using machine learning to generate reports.

QF is a unique organization with different entities involved in education, research, and community development. This uniqueness in products and services created challenges in purchases categorization. Using AI by procurement department in QF will help to overcome the current challenges and will contribute in QF AI strategy. Therefore, adopting AI in procurement in QF is anticipated to provide numerous benefits for procurement and supply chain applications.

Acknowledgments

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Biographies

Bedoor Ali Bahameish is a Master student of Logistics and Supply Chain Management as part of Engineerting program in Haman Bin Khalifa University with a background of Industrial and Systems Engineering. Currently she is working at Qatar Foundation Head Quarters in Operational Excellence. She actively participates in projects related to improvement as her core interest are in Optimization, Process Improvement, Process Control, Quality Management, Digitalization, and Excellence. Her Master project thrive to improve QF's procurement process to be more effective and efficient through introducing new revolving technologies.

Robert Eduard Franzoi holds a Ph.D. degree in chemical engineering from University of Sao Paulo (Brazil, 2021), and a bachelor's degree in chemical engineering from Federal University of Santa Catarina (Brazil, 2016). His major field of study comprises computer-aided modeling and optimization of large-scale industrial applications. He is currently a Postdoctoral Researcher in the College of Science and Engineering at Hamad Bin Khalifa University in Qatar. His research interests comprise large-scale modeling and optimization, computer-aided process engineering, scheduling and supply chain, machine learning, surrogate modeling, and Industry 4.0.

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