API Market Research-Data Collection and Database Handling

Case Study Intelligent Systems in Production

By

Group-1

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CONTENTS

Abstract—This case study illustrates the collection, storage, and analysis of market data for Arduino UNO, a very important component in the growing electronic components market. Using the Nexar API [6] to collect real-time data, the project ensures storage through the SQLite database, allowing observation of changes in price, sales volume, and availability to make better decisions regarding purchasing, pricing, inventory, and supply chain management. Data visualization, done in R, shows key trends such as flat pricing for small quantities, volume-based pricing for larger quantities, and an upward trend in availability, especially around mid-January 2025. The Arduino-compatible market is expected to grow from $1.2 billion in 2023 to $3.4 billion in 2033, at a CAGR of 10.7% [1]. Recent developments, such as the introduction of the Arduino UNO SPE Shield in November 2024, show the commitment to developing more connectivity under this platform through technologies like Single Pair Ethernet and RS485 [5]. Recent research uses this product as a case study in investigating the growing market for Arduino-compatible devices, which was forecasted to reach 5.2 million units in 2023, with the educational sector being the largest user group at 45% of the market [1]. These studies help businesses and developers understand and adapt to this fast-changing market, which is key for innovation and the Internet of Things.

Keywords—Arduino, UNO, Arduino-compatible, Market, data, analysis, Nexar, API, SQLite, database, Data, visualization, Pricing, trends, Sales, volumes, Availability, trends, Volume-based, pricing, Educational, market, share, IoT, applications, Supply, chain, management, Single-Pair, Ethernet, (SPE), RS485, connectivity, Technological, Innovation.

1 INTRODUCTION

The electronic components market, particularly the Arduino-compatible segment, is experiencing rapid growth due to increased adoption across IoT, educational, and DIY electronics sectors. Known for its accessible and versatile microcontroller boards, Arduino has become a cornerstone of innovation for hobbyists, educators, and professionals. The Arduino-compatible market is forecasted to grow from $1.2 billion in 2023 to $3.4 billion by 2033, with a Compound Annual Growth Rate (CAGR) of 10.7% [1]. In 2023, the market volume reached 5.2 million units, with the educational sector accounting for 45% of the share [1].

Recent product advancements, such as the Arduino UNO SPE Shield launched in November 2024, showcase innovations in connectivity through Single-Pair Ethernet (SPE) and RS485. These technologies simplify the integration of industrial communication into projects [5]. Furthermore, Arduino's strategic focus on IoT accessibility and cloud integration solidifies its position as a key player in industrial IoT [4]. Regional dynamics also influence the market, with North America leading, Europe following, and Asia Pacific showing rapid growth potential [3].

Despite these advancements, existing research often focuses on broad trends while overlooking component-level data such as price, sales volume, and availability. This study addresses this gap by analyzing real-time market data using the Nexar API for collection, SQLite for storage, and R for visualization. Key findings include price stability for small orders, volume discounts, and increasing availability trends.

Research Question: How do price trends, sales volumes, and availability of Arduino UNO components vary across suppliers, and what insights can be derived to optimize purchasing, pricing, inventory, and supply chain management decisions?

2 MATERIAL

This project focused on analyzing market trends for electronic components by leveraging the Nexar API. Using Python for data collection, R for visualization, and Docker for containerization, we developed a streamlined, reproducible workflow tailored to the unique nature of electronic parts. By addressing complexities like tiered pricing and fluctuating availability, our approach ensured accurate insights and practical applications for real-world use.

2.1 Data Collection

The first step was data collection from the Nexar API, which is a detailed information source of electronic components, including specifications, pricing, and availability, following these steps:

- API Access: We connected to the Nexar API by using the `shared_auth.py` script, where OAuth 2.0 generated an access token that would help us make authenticated queries.
- Searching for Components: Using the `generic_search.py` script, we searched for parts by submitting a generic keyword, such as ”Arduino Uno,” to obtain basic information, including the Manufacturer’s Part Number (MPN), part designation, and manufacturer information.
- Retrieving Detailed Information: Using the MPN value returned by the generic search, we used the `detailed_queries.py` script to extract the following:
  - Availability information: The `fetch_availability` function provided current inventory levels.
  - Pricing data: Detailed price information was fetched, including tiered pricing by quantity, currency, and exchange rates, through the `fetch_pricing` function call.

2.2 Data Cleaning and Structuring

Once all data was fetched, it was cleaned and structured for analysis:

- Removing Duplication: We ensured through the script `parse_data.py` that no duplicate entry was added; before adding a new record, it checked if the record already existed in the database.
- Structured Data Storage: We designed an SQLite database, `electronic_parts.db`, to store data in an organized manner. It contains three principal tables as shown in figure 1:
  - Parts Table: Stored basic information such as MPN, part name, and manufacturer.
  - Prices Table: Recorded details of prices, including dates, quantities, and costs.
  - Availability Table: Tracked the level of stock for each part over time.

Parts	
Column Name	Data Type
mpn (PRIMARY KEY)	STRING
keyword	STRING
part_id	STRING
part_name	STRING
manufacturer_name	STRING
manufacturer_id	STRING

Prices	
Column Name	Data Type
price_id (PRIMARY KEY)	INTEGER
date	TEXT
keyword	STRING
company_name	STRING
quantity	INTEGER
currency	REAL
Price	REAL
conversionRate	REAL
convertedCurrency	TEXT
convertedPrice	REAL
mpn (FOREIGN KEY)	STRING

Availability	
Column Name	Data Type
id (PRIMARY KEY)	INTEGER
date	TEXT
total_availability	INTEGER
mpn (FOREIGN KEY)	STRING

Fig. 1: Database structure

2.3 Database Management

The data were collected and saved in the database and can be created, viewed, or edited when required:

- Creation of the Database: The `create_sql_table.py` script set up the SQLite database and defined the structure for the tables.
- Data Insertion: The `parse_data.py` script added new entries while ensuring no duplicates were inserted.

2.4 Data Visualization

To uncover trends and insights, we visualized the data using R, which is well-suited for creating graphs and tables:

- Data Querying and Cleaning: The `Visualization.R` script pulled relevant data from the SQLite database and prepared it for visualization.
- Price Trends: Facet Grid showed how the price changed over time for different quantities and manufacturers, showing market behavior.
- Availability Trends: A line chart with trend lines showed how stock levels changed over time.
- Visualization Tools: We utilized R libraries such as `ggplot2` for plots and `gt` for clean, formatted tables to make our findings visually attractive and easy to read.

2.5 Docker Containerization

To make our workflow reproducible and sharable, we containerized it using Docker:

- Setting Up the Environment: The `Dockerfile` included all necessary tools for the project, such as Python, R, and required libraries, along with our scripts and data.
- Simplified Execution: The `docker-compose.tar` file automated the building and running of the container, ensuring the database and outputs remained accessible even after the container stopped.

2.6 Verification and Quality Checks

We ensured the accuracy and reliability of our workflow through several validation steps:

- API Validation: API responses were individually checked to verify they contained expected data.
- Database Integrity:
  - Queries were run to ensure correct storage of data.
  - No duplicates were found within the database records.
- Visualization Accuracy: Each generated plot or table was validated against raw data to assure accuracy in showing information.

2.7 Tools and Technologies Used

This list shows what our workflow employed:

- Programming Languages: Python for data collection and cleaning, and R for analysis and visualizations.
- Database: SQLite for efficient, structured data storage.
- Visualization Libraries: `ggplot2`, `gt`, `Viridis`, and `gridExtra` in R for clear, professional graphics.
- Containerization: Docker, which made our process portable and reproducible.

3 RESULTS

The Electronic database file has the information of **Prices, Parts and Availability** tables which is visualized in R programming using **gt library**. The depicted in price table **Fig.2** has information of the prices,columns in the Table includes **Date**:Displays the dates from Tue, Jan 7th, 2025 to Jan 9th 2025. **Quantity**:Shows the quantity of items sold (all entries here indicate a quantity of 1). Price (Euros): Displays the price per unit in euros. **Company Name**: Indicates the company selling the product (e.g., Mouser, Jameco, RS) it has the information of quantities sold with highest prices by top four companies on the respective days.

Prices Table

Displaying unique entries for each company, sorted by descending prices for each date

Date	Quantity	Price (Euros)	Company Name
Tue, Jan 7, 2025	1	22.78	Mouser
Tue, Jan 7, 2025	1	22.77	Jameco
Tue, Jan 7, 2025	1	22.39	RS
Tue, Jan 7, 2025	1	19.41	Rapid Electronics
Wed, Jan 8, 2025	1	22.78	Mouser
Wed, Jan 8, 2025	1	22.77	Jameco
Wed, Jan 8, 2025	1	22.39	RS
Wed, Jan 8, 2025	1	19.41	Rapid Electronics
Thu, Jan 9, 2025	1	22.78	Mouser
Thu, Jan 9, 2025	1	22.77	Jameco
Thu, Jan 9, 2025	1	22.39	RS
Thu, Jan 9, 2025	1	19.41	Rapid Electronics

Fig. 2: Table containing Prices

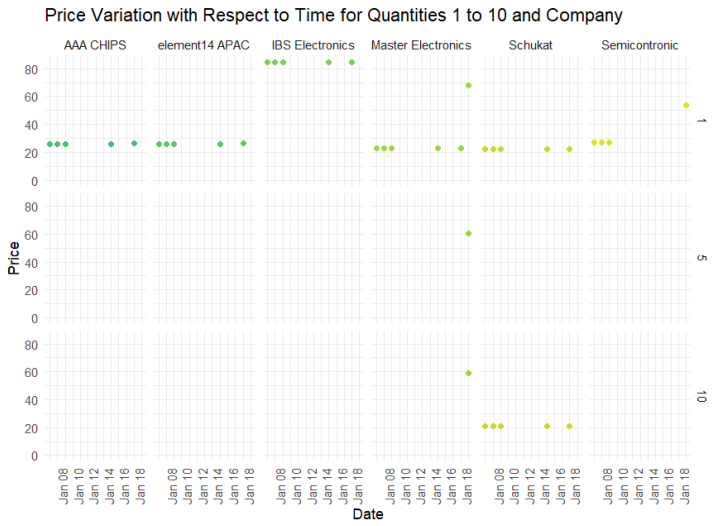

Fig. 3: Facet Grid Scatter Plot of Price variation to Time

The Facet Grid Scatter plot in **Fig.3 X-axis**: Represents the Date (from January 8 to January 18). It shows the time period over which the price variations are tracked. **Y-axis**: Represents the Price. It represents the price values for the products being analyzed, which ranges approximately from 0 to 80. Prices vary significantly across companies, with **Semicontronic** and **IBS Electronics** showing higher price compared to others. The data is well-categorized, making it easier to compare trends across companies and quantities.

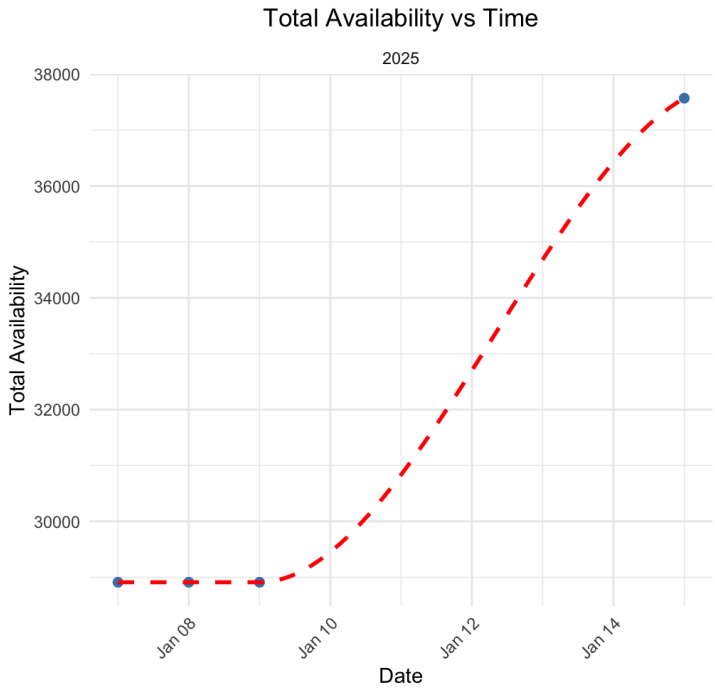

Fig. 4: Total Availability vs Time

The graph depicted in **Fig.4 X-axis**:Date, **Y-axis**: Total Availability,shows the growth in availability of products over time which helps stakeholders to understand supply dynamics,this makes easy to forecast future availability or investigate.

4 DISCUSSION

The objective of this study is to predict market trends where the data is collected from the **Nexar** API. This study explored the following research question,How do price trends, sales volumes and availability of Arduino UNO components vary across different suppliers and what insights can be derived to optimize purchasing, pricing, inventory and supply chain management decisions? Using the Nexar API for real-time data collection, SQLite for data storage and R programming for visualization. The vase study sheds light on granular component-level market dynamics. The analysis revealed critical insights into the Arduino UNO market,Price Trends: The scatter plot demonstrated a stable pricing range (20–30 Euros) for companies like **AAA CHIPS** and **element14 APAC**, whereas **IBS Electronics** has significantly higher prices above 80 Euros which indicates premium pricing strategies. Price consistency across most companies suggests a competitive market but the outliers (e.g., IBS Electronics) indicate opportunities for further exploration of niche premium segments. Availability:The total availability of components remained constant across the observed dates, as shown by the red dashed line in the availability graph.

Strengths This stability suggests a well-managed supply chain for Arduino-compatible components, ensuring consistent availability for stakeholders. Company Performance:The price table highlighted that specific companies consistently sold items at the highest prices, revealing their competitive positioning and market dominance in specific regions or segments. Comprehensive visualizations using R provided an intuitive understanding of pricing and availability patterns. The methodology is scalable and can be applied to other components or markets **Limitations** The Nexar API focuses on real-time data. The data obtained was limited to 100 API requests every month, which may have impacted the analysis's comprehensiveness. If historical data is not stored locally, analyzing long-term trends or seasonality becomes challenging. The API's data may focus on specific regions, which could limit its applicability for global or regional analysis in undeserved markets.Limited supplier data for some companies (e.g., Newark) may impact to generalize the insights,

Future Research Future Research AI-powered personalization algorithms analyze large datasets to provide personalized content, product recommendations, and user experiences. This review examines how AI-driven personalization can improve customer engagement, satisfaction and loyalty. Machine learning could be used in future forecasting to predict prices and demand, as well as to improve inventory and pricing strategies. Scenario analysis could help assess supply chain risks, while incorporating external factors and real-time data (such as blockchain) would improve forecasting accuracy. Furthermore, segmenting markets and examining component correlations could optimize purchasing and cross-selling strategies.

To **summarize**, the research effectively answered the research question by providing actionable insights into price trends, sales volumes and availability of Arduino UNO components. Stable pricing and availability trends underscore a competitive and reliable market, while outliers like **IBS Electronics** highlight opportunities in premium segments. These findings can guide stakeholders in optimizing purchasing, pricing, inventory and supply chain strategies contributing to the broader goal of advancing technological innovation and IoT applications.

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Accessed: 2025-01-19.

5 APPENDIX

Availability Table

Displaying rows for Total availability per date

ID	Date	Total Availability	MPN
1	Tue, Jan 7, 2025	28,911	A000066
2	Wed, Jan 8, 2025	28,911	A000066
5	Thu, Jan 9, 2025	28,911	A000066
6	Wed, Jan 15, 2025	37,573	A000066
7	Sat, Jan 18, 2025	37,241	A000066
8	Sun, Jan 19, 2025	6,463	ABX00062

Fig. 5: Table Availability

Parts Table

Displaying all columns from the Parts table

mpn	keyword	Part ID	Part Name	Manufacturer Name	Manufacturer ID
A000066	Arduino Uno	21222240	Arduino A000066	Arduino	3012
ABX00062	Arduino Uno	123063789	Arduino ABX00062	Arduino	3012

Fig. 6: Table Parts

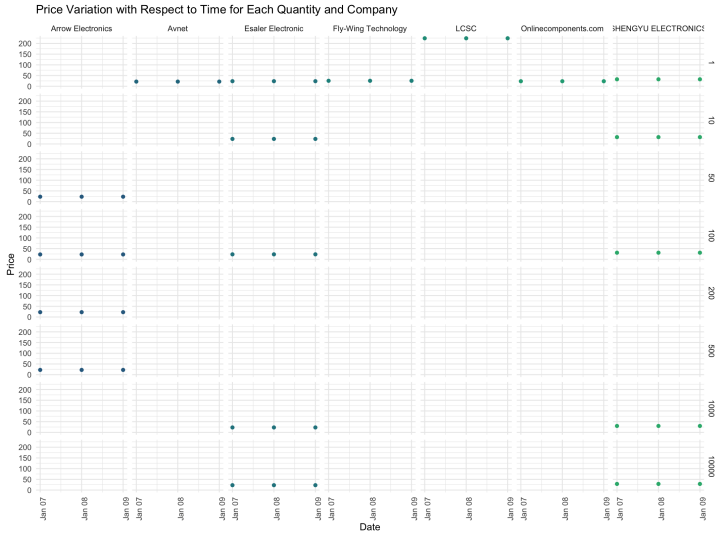

Fig. 7: Facet grid scatter plot of Date in X-axis and Price in Y-axis for quantities 1 to 10,000

6 ACKNOWLEDGMENTS

Technical Contributions			
Student Name	Contributions	Date	Signature
Neethu Raman Bojanapati	Data Handling: Collection, Data visualization, Docker Containerization , Automation through docker hub.	21.01.25	
Shashank Sakhala	Data Handling: Pre-processing, Data parsing, Data Storage, Data visualization, Automation through docker hub.	21.01.25	
Samyuktha Maddela	Data visualization in R programming	21.01.25	
Sandeep Das	Data Visualization in R programming	21.01.25	

Report Contributions			
Student Name	Contributions	Date	Signature
Neethu Raman Bojanapati	Abstract and Introduction	21.01.25	
Shashank Sakhala	Materials and Methods	21.01.25	
Samyuktha Maddela	Results and LaTeX layout	21.01.25	
Sandeep Das	Discussion and Conclusion	21.01.25	