Module V

Prototype developing Stages, deploy real-time UI/UX visualizations, Methods and metrics to analyse and convey business outcomes, feedback and data obtained from execution

By

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Prototype developing Stages of IOT

What is Prototyping

- It is to develop the one just to see what the end product looks like, or they may need a complete model to test the user experience
- To understand whether the idea of the project is smaller or complex one.
- It starts once the research about the idea is done
- It tells about
  - IOT hardware
  - Software development
- Advantages of Prototyping
  - Provides pre measurement about cost.
  - Checking our assumptions
  - Hardware
  - prototype development will decide the IoT solution process painless, fast, and yield the information you are looking for.
  - whether the process will take more than six months and more.

IoT Prototyping

- Identifying the problem; what are the various mobile devices to develop the product, product decisions
- A new technical ecosystem solution for the Internet of Things use case or Idea.
- Developing the product
  - technologies used to build and solve the product.
- start building
  - entire prototyping process
- Prototype running, checking bugs related to software and broken features to hardware related.

stages

1. Define the vision
2. Focus on key features
3. Produce
4. Test and refine
5. Present

Define the Vision

an overarching(main) vision for their product
may include sketches, but it can also work as a verbal description as long as a few key questions are answered
•What problem does it solve?
•Who is the key market?
•What other options are available?
•What's the anticipated price point?
•What are the material and labor needs for creation?

Focus on Key Features

Adding one or two features of the product
Should include less critical issues
It includes the questions to answer:

- Hardware Selection and Integration
- Connectivity and Communication Protocols
- Security and Privacy
- Cloud Integration and Data Management
- User Interface (UI) and User Experience (UX).
- Platform and Tools
- Edge Computing
- Power Management
- Scalability

Produce the prototype

building of the prototype
To process the prototype identifying the various options considered.
Some standard prototyping methods
- **3D Printing**
- **CNC Machining**
- **Powder bed fusions**
- **Mold making and casting**

Test and refine

Once the prototype is identified consideration of evaluating it.
 to ensure the prototype is ready to be unveiled to stakeholders.
various testing procedures to validate its functionality, performance, security, and usability

- Functional Testing
- Connectivity Testing
- Performance Testing
- Security Testing
- Usability Testing
- Edge and Cloud Integration Testing:Testing whether the system can handle large volumes of data and make decisions locally when needed
- Power Consumption Testing: Monitoring the battery life of devices, evaluating the power draw of sensors and communication modules

refinement phase is where improvements are made based on the feedback and results gathered during testing
consider update options, and seek out ways to improve the overall process
Key aspects includes:
 it could involve scrapping the whole initial design and starting over from step one

Present

creating multiple models for testing among consumers, sending the design in for patenting, or showing it to potential investors.
It will help gauge interest and guide manufacturing methods for short run and mass production.

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- https://www.pacific-research.com/understanding-the-5-stages-of-prototyping-prl/#:~:text=Regardless%20of%20the%20needed %20fidelity,production%2C%20testing%2C%20an d%20presenting.

Real Time Data Visualization

Data Visualization

- Understanding how to visualize the data.
  - It is the one to collect some cool data from your devices, another is to visualize it and make it accessible for a user.
- UI/UX designer.
- good data visualization to be used as a reference to determine the business direction and make decisions.
- The better the results of the visualization of the data created, the more appropriate the decisions made by the user will be.
- Incorporating data driven initiatives and service providers and end users incorporate tools for data visualization IoT applications

What is real-time visualization?

the process of presenting data through visuals in real-time, allowing users to receive and analyze information the moment it's generated and processed.
real-time data visualizations let you catch trends, spikes, and anomalies in the moment
It helps you to make quick decisions

Benefits of **real-time data visualization?**

Enhanced decision-making ; quicker, [data-driven decisions](#)
Streamlined data analysis: real-time data visualization by eliminating the need for manual data compilation and review
Improved performance monitoring
Proactive problem-solving : identifying issues in real-time, allowing for prompt intervention before problems escalate
Better customer experience. Interactive dashboards and visuals support real-time tracking of customer behavior

8 use cases of real-time data visualization across industries

Contd.,

Fraud Prevention:
- can promptly detect unusual transaction patterns or attempts and help minimize fraudulent activities and reduce risks.

Healthcare data monitoring:
- visualization in healthcare tracks critical patient metrics like heart rate, blood pressure, oxygen levels, and even glucose levels. help in identifying sudden changes in a patient's condition, such as irregular heartbeats or drops in oxygen saturation

Financial trading:
- real-time data visualization offers instant updates on stock prices, currency exchange rates, and other financial metrics **and it** to make quick, informed decisions and seize market opportunities as they arise

Production lines management
- data visualization serves as an efficient tool in manufacturing, facilitating the monitoring of production lines **and help in** can detect anomalies in production metrics like machine performance, temperature fluctuations, or material usage

Data for IoT

- **Visualizing data from connected devices**
  - Fully customized real time IoT dashboard development strategy that visualizes the data coming from the connected wireless sensor devices.
- **Real-time data from key parameters**
  - The key data parameters coming from the sensor modules can be displayed real time in the IoT dashboards
    - the real time temperature, humidity and current soil moisture inside a greenhouse with the help of sensors and gateway
- **Trend Analysis**
  - The trend analysis is very important for farmers as it can make or break their cultivation on that particular area. The weather and environmental trends are analysed deeply and shown to the farmers via dashboard. This can help farmers be ready with proactive actions

Contd.,

- **MAP Based monitoring**
  - Location is monitored continuously and subsequently the trends on sensor node energy levels and network load can be predicted and shown via these IoT dashboards.
- **Transit asset tracking & theft monitoring**
  - can monitor the assets under transit 24*7 through these dashboards
    - These dashboards can alert the user in case of any mishap. If perishable goods are in transit, then the users can [track its conditions](#) live via these dashboards.
- **Multi-tenant Architecture**
  - multiple clients can access their own data from a single dashboard platform. Each user will be provided with valid credentials to access their data. These application acts as a dedicated software as a service applications (SaaS) to their tenants.
- **Responsive Design**
  - Our IoT dashboards are extremely interactive and allow the users to perform various operations that will bring out meaningful insights.
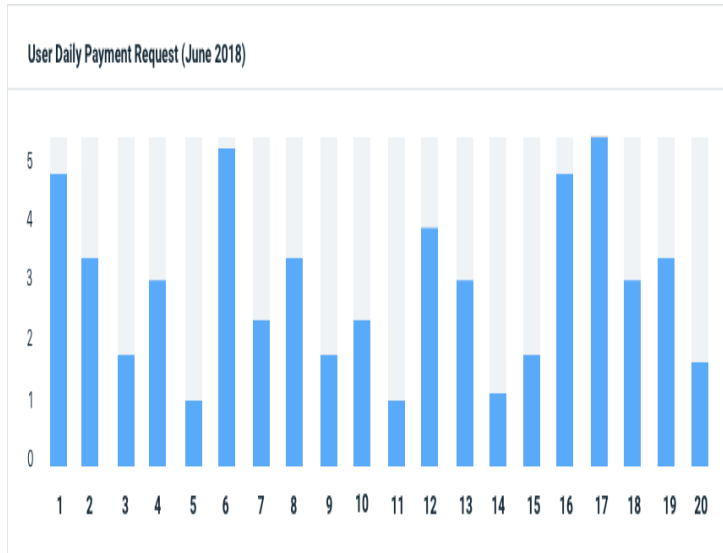
Steps of Data Visualization process

- Types of data Visualization
- Analysis of target of audience
- Sketch the visualization
- Optimize the use of colours
- Make good and optimal Text Settings
- Test & Get Feedback

Types of Data Visualization

- Bar Charts

- Maps

- Line Charts

- Scatterplots

- Pie Charts

- Gauges

- table

Bar Charts

User Daily Payment Request (June 2018)

Line Charts

Server Activity (Last 5 mins)

Max: 29MB — CPU %
Max: 29MB
Max: 29MB
Max: 29MB — Disk Read
Network IN
Network OUT

3:50 3:55 4:00 4:05 4:10 4:15 4:20 4:25 4:50

Pie Charts

Employee Relationship Data

Single 15%
Married 39%
Divorced 22%
Unknown 32%

Maps

Gauges

Tables

User Distribution By Region

Activation Users Data

+3.1k

-1.5k

Active Users
31,542

Inactive Users
1,560

Droplets Usage Data   Manage All

NAME	CPU	MEMORY	DISK	DATE CREATED
● Example-2671573	2	512 MB	20 GB	June 06, 2015, 02:26 PM
● Example-2671573	2	512 MB	20 GB	June 06, 2015, 02:26 PM
● Example-2671573	2	512 MB	20 GB	June 06, 2015, 02:26 PM
● Example-2671573	2	512 MB	20 GB	June 06, 2015, 02:26 PM

Combinations of all

Analysis of target of audience

- Write down who will be the audience for the interface you are building then discuss with your team what improvements you want to target for your audience. Steps to be followed;
  - **Describe the Numeration Level of the Audience**
  - **Describe the Level of Data Visualization for Your Audience**
  - **Describe the Time Your Audience Uses**
  - **Describe What Decisions Your Audience Will Make.**

Sketch the visualization

- Open the dataset that you already have and make its sketch rather than directly designing it on computer software, it will save time and the variations made will be more creative.

- Make as many concepts as possible and discuss with your Peers so that the right and appropriate models are found and will continue to the editing stage using computer software.

Optimize the use of colours

- Use of good colours that attracts the audience.
  - Use one color to represent the same data type
  - Be careful with positive and negative numbers.
  - Make sure there is sufficient contrast between colors
  - Avoid patterns.
  - Choose the right colour.

Make Good and Optimal Text Settings

- Specify the right title for your UI Visualization display

- Use the appropriate branding font

- Don't forget to make a statement.

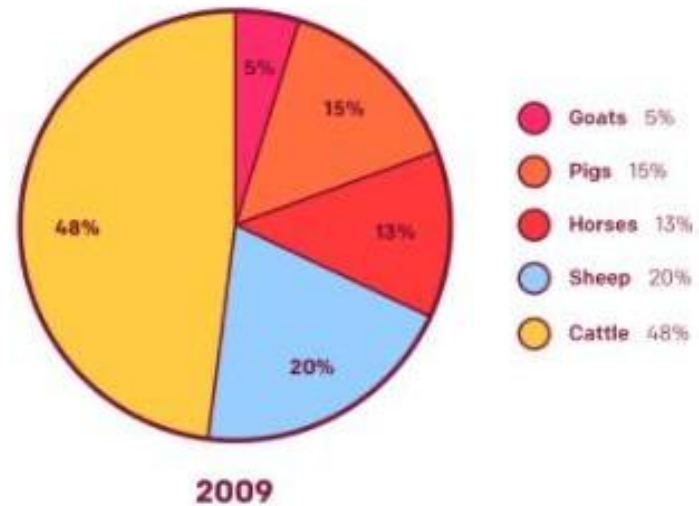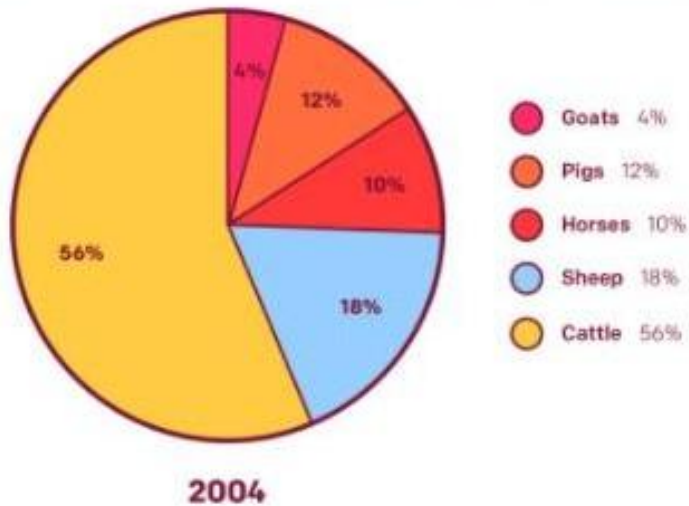- Measuring text readability

Test & Feedback

- Give a draft of your chart to other people or significant colleagues or people who belong to the persona of the user you are aiming for

- Ask, "What is the main message in this chart?"

Effective population of Animal Genetics real-time visualization (Example)

Pie charts with statistics (Easy)
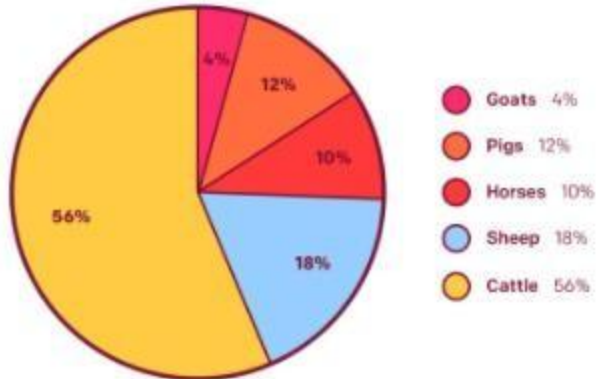

Animal genetic resources

effective population size of Native Breeds at Risk in Great Britain

2004

- 4%
- 12%
- 10%
- 18%
- 56%

Goats 4%
Pigs 12%
Horses 10%
Sheep 18%
Cattle 56%

2009

- 5%
- 15%
- 13%
- 20%
- 48%

Goats 5%
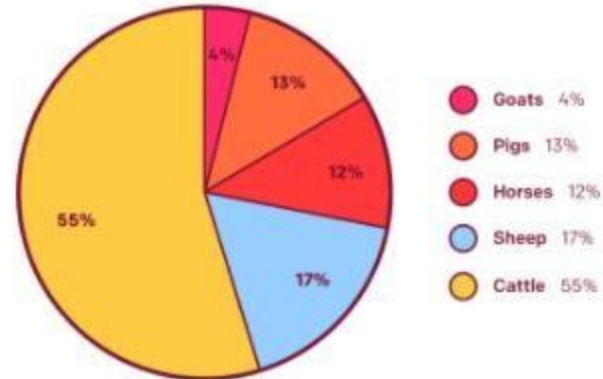Pigs 15%
Horses 13%
Sheep 20%
Cattle 48%

Pie charts with statistics(critical)

Animal genetic resources
effective population size of Native Breeds at Risk in Great Britain

2004

●	Goats 4%
●	Pigs 12%
●	Horses 10%
○	Sheep 18%
○	Cattle 56%

2005

●	Goats 4%
●	Pigs 13%
●	Horses 12%
○	Sheep 17%
○	Cattle 55%

●	Goats 4%
●	Pigs 13%
●	Horses 11%
○	Sheep 18%
○	Cattle 55%

●	Goats 4%
●	Pigs 12%
●	Horses 11%
○	Sheep 19%
○	Cattle 54%
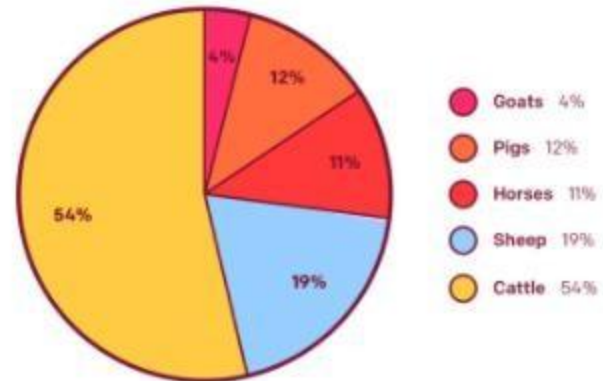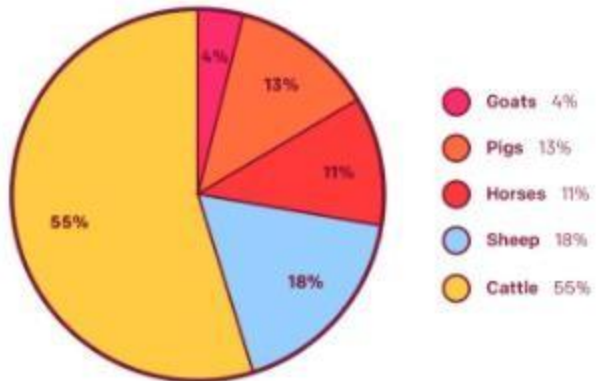
Animal genetic resources

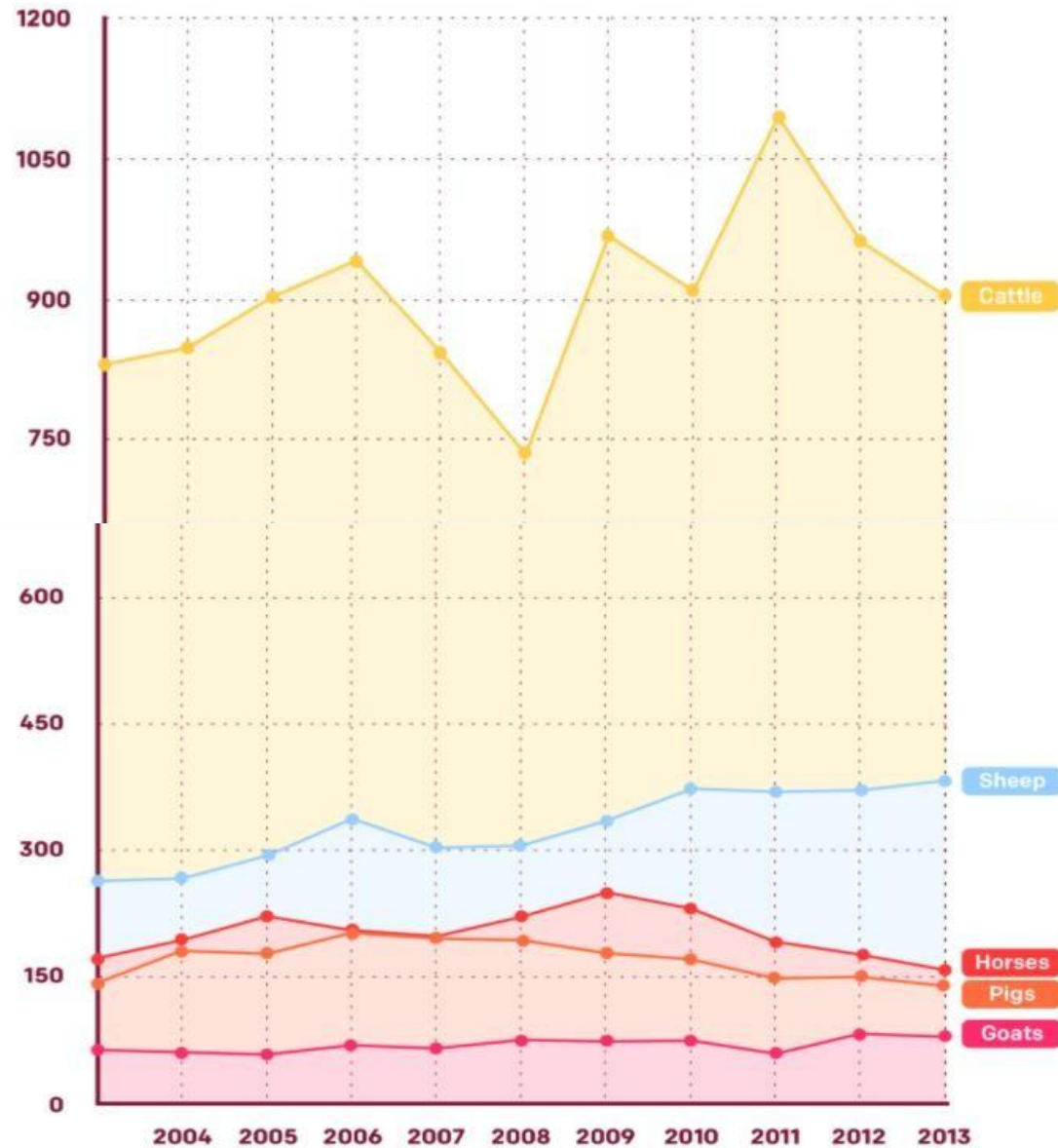effective population size of Native Breeds at Risk in Great Britain

Data Visualization tools for IoT applications

- Power BI, Grafana, and Kibana

- When to use each one of these?

Power BI

- Power BI is a paid service.
- all-inclusive business intelligence tool that enabled companies to visualize a wide range of datasets.
- it has a comprehensive list of integrations, and it can pull data from many sources like **Excel, Google Analytics, Salesforce, and social media platforms**.
- connect any IoT device, sensor, or application to the tool in order to **stream data in real-time**.
- Mostly used for **azure based projects** and other major platforms.
- can use natural language commands to query data ,a Power BI will return relevant visualizations right on the screen.

Benefits of Power BI

- Both streaming and static data

- Short learning curve

- Rich data visualization types

- Natural language data query

- New IoT integrations

Grafana

- [Grafana](#) is a professional data visualization and analytics tool specializing in the visualization of **time-series analysis**.
- It's quite popular in IoT and connectivity-focused verticals
- Grafana was originally designed for CPU and system health monitoring
- Grafana is known for its wide range of data visualization techniques, its vast capabilities for dashboard building and management, and its extensive list of possible data sources (*e.g.* AWS, Prometheus, and Elasticsearch).
- Grafana's outstanding features include complex dashboard building, enabled alerts and notifications, custom filters, and annotation for streaming data.
- Grafana also allows you to personalize dashboards for different users

Benefits of Grafana

- A wide range of data sources

- Perfect for metrics data

- Data management perks: custom filters, annotations, alerts and notifications sent to messengers or email

- Dashboards personalization for various user roles

Kibana

- It is for **logs visualization**.
- [Kibana](#)is a part of the [Elastic Stack data management toolkit](#).
- The tool is nonetheless a good choice for IoT applications that require log visualization.
- Kibana also provides users with advanced visualization and data management features, including machine-learning techniques to detect and explore anomalies in datasets
- It was designed specifically to visualize the time-series data from Elasticsearch clusters.
- It allows a wide range of data representations like maps and allows you to make custom visualizations, build complex dashboards, and share everything easily with teams, management, and even clients

Benefits of Kibana

- Works for any type of time-series data
- Machine learning features
- Fuzzy match for data queries
- Easy setup and sharing
- Direct integration with Elastic Stack

Choosing the right data visualization tool

Power BI	Kibana	Grafana
beyond time-series data visualization	[Elastic Stack for system performance monitoring](),	for projects restricted to metrics visualization
Rich data visualization types	the visualization of logs or metrics, designed for time-series data analysis	for applications that require personalized dashboards for different users, designed for time-series data analysis
Power BI is a paid service	open-source and cost nothing	open-source and cost nothing

Other tools

https://medium.muz.li/top-8-data-visualization-tools-for-ux-designers-in-2022-886bbedb7fb

Development of IoT platforms & Dashboards

- Data acquisition using sensors, visualizing it using IoT platforms and dashboards, analyzing it and actuating based on the actionable information received.
  - Custom visualization dashboards
  - Application-based UI development
  - Cloud setup and integration
  - Rule-based engine and alerts
  - User and device management
  - Control systems and actuation
  - Integration with analytics tools

Real-time data visualization

Steps:

1. **Identify your goals and select toolset**
   - Determine what you want to track. This could include sales, website traffic, performance metrics, etc. Knowing this information, you can move to selecting the tools that align with your objectives
   - Choose data visualization tools : Tableau, Power BI, and Zoho Analytics.
2. **Collect and process your data**
   - collect and aggregate the data you wish to visualize and monitor
   - This may require you to perform data cleansing, normalization, and transformation, among other tasks
3. **Build real-time data infrastructure**
   - Consider implementing data streaming technologies like Apache Kafka and AWS Kinesis
   - select a suitable database optimized for real-time data like InfluxDB, Apache Druid, and Firebase.
4. **Design and implement the dashboard**
   - Plan how to organize the dashboard and choose the appropriate visualizations (e.g., charts, graphs, and maps) for your data
   - create the charts and graphs based on your design.
   - make sure data feeds are correctly connected for real-time update
5. **Test and deploy your dashboards**
   - Test the dashboard thoroughly to guarantee it updates in real-time and displays data correctly.
   - you can deploy your dashboard setting it up on a server or cloud platform

Deploying Real-time UI/UX Visualizations using Grafana/Tableau/Power BI/Kibana

Steps

- How to use that tool
- account creation/download
- Various visualization tools available
- How to construct the visualization process
- Deploy options

References

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- https://www.topcoder.com/data-visualization-guide-for-ui-ux-designers/.

- https://www.monterail.com/blog/2017/how-to-visualize-complex-real-time-iot-data-design-and-ux-principles

- https://pixelplex.io/blog/real-time-data-visualization/

Methods and metrics to analyze IoT business outcomes

Measure for growth – what are the right metrics for every IoT stage?

Proof-of-concept/minimum viable product (MVP) devices
Capturing proposition metrics reveals how the device is being used, so, for example
• Did it get successfully installed?
• Which features are being used, such as which buttons are being pressed?
• Does it get used regularly?

Capturing technology metrics can reveal the underlying function of your devices. Some examples include:

• Battery life and how it varies

• Signal strength – by location, by SIM vendor and other factors

• Application crashes and free memory

3 KEY METRICS EVERYONE IN IOT SHOULD CARE ABOUT

1. % of devices "Up"
2. Active users
3. Your value to the world

1. % of devices "Up"

The hardware in any IoT solution is really just a means of delivering a service, and it's the service that users are paying for.

If you only have 100 devices deployed, then a 5% problem is an annoyance, **but if you have 100,000 devices deployed, then a 5% problem will kill your business**.

The most fundamental metric of any connected device is probably just … **is it connected?!**

Devices usually send back some kind of heartbeat just to say that they've been installed and they're still alive, for example once an hour.

Occasionally these pings will go missing for various reasons, but if you fail to see, for example, three in a row then there's definitely a problem—with connectivity if nothing else—and **you need to be the first to know**.

But remember—you need to measure not just technical functionality, but also that the device is actually delivering service value.

It might be online and healthy enough to send regular pings, but the application may have frozen.

So you should find some metric which shows that the device is actually delivering utility, based on what it is.

And if your devices are delivered in clusters (e.g. ten ticket machines at a railway station) then a related metric you may also want to measure is "site availability" e.g. if there are 10 machines on site, 1 of them is broken and 9 are in use, then there is currently no site availability when someone wants to buy a ticket—and this metric could even help you sell more ticket machines.

Active users

For many IoT systems, pleasure is that they be fully autonomous and not require any user interaction at all, getting on silently with making the world better.
However for the time being in the real world, however wonderful and autonomous any IoT system is, ultimately it's humans that decide its value.
If no one is watching, no one is valuing your IoT solution.
And in any system, including web and mobile apps, **user engagement is the key leading indicator**.

This metric is best measured over a time-period which is long enough to smooth out natural cycles of human activity (i.e. at least a day) yet short enough to provide fast enough feedback.

The two ways to measure user interaction are:

Locally at the device, if it's designed to have user interaction—simply using the device, however that is done.

Remotely via e.g. phone app—are users logging in to check things? Have notifications been set up to send emails? Is just one person watching each account (in which case you're vulnerable to them e.g. moving jobs) or is there a broader set of people engaged (in which case not only is more value being delivered, but also this account is probably "stickier").

Some devices (for example, connected street lights) don't really have local users, so in that case you'll have to make do with remote users (like council employees checking on status, or being notified about outages). Other devices (e.g. a personal appliance) might just have one user, in which case this metric is "1".

Yet other types of device (e.g. EV charging posts) might have multiple local users (the people doing the charging) and remote users (the operations and customer support teams, product managers etc.). In this case you may not be able to identify *unique* users, but you can at least say that e.g. charging point X has served 15 customers today.

Your value to the world

Once you can measure the previous two metrics, you can combine them to produce a metric which all companies want to maximize—the amount of value you're delivering to the world.

In many cases this is as simple as multiplying the first two metrics together ("devices up" x "active users") to measure the total value you're delivering.

Or you could measure "number of device-uses per day" (especially if you charge by the use).

Or even convert that into units specific to your business, such as kWh if you're an energy company.

References:

https://www.devicepilot.com/blog/the-3-key-metrics-every-iot-manager-should-know