

# What are the best practices in eCommerce?

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## Preface

For my individual project I have lots of freedom in the technical choices. However, every technical choice that I make must be validated with sources to prove it is indeed a good decision. To research what choices I should make, I looked for the most important best practises in the context of eCommerce. Here are the most important non-functional requirements according to (Technologies, 2021): **Performance, Scalability, Security, Maintainability, Usability**. These non-functional requirements also allow me to touch all the learning outcomes.

# How can I optimize page loading speed?

In today's competitive e-commerce landscape, page load speed is a critical factor in user satisfaction and conversion rates. According to research about page loading speeds (Wiegand, 2022) an e-commerce website must load within 1 second or less to retain potential customers effectively. Websites that take longer than this threshold risk losing a significant portion of their visitors, as users tend to abandon pages that are slow to load.

Given the importance of swift page loading, this research aims to explore and identify key strategies for optimizing response times in e-commerce applications. By focusing on techniques and best practices that address common performance bottlenecks, this study seeks to provide actionable insights that can help me achieve faster loading speeds and improve overall user experience. This research will cover critical optimization strategies, including image and media management, caching techniques, hosting performance, and the reduction of render-blocking resources.

## Best practices

According to research on page speed optimization (Schaff, 2019) and (MOZ, 2021), several key strategies can significantly enhance your website's performance. The following table outlines these essential optimizations as well as potential upgrades to take your site's speed to the next level.

Table based on the information in (Schaff, 2019)

Criteria	Description	Tier
<b>Browser Caching / Expires Headers / Cache Static Content</b>	Essential for improving performance; prevents re-downloading assets on every page load.	Tier I (Deal-Breaker)
<b>Image Compression and Optimization / Page Size</b>	Critical for reducing download size and improving load times.	Tier I (Deal-Breaker)
<b>Time to First Byte (TTFB) / Page Caching</b>	Vital for improving server response times and reducing load on the server through caching.	Tier I (Deal-Breaker)
<b>Render-blocking Resources / Critical CSS / Async CSS &amp; JS</b>	Newer best practice improves performance significantly when combined with other optimizations.	Tier II (Upgrade)
<b>JavaScript Execution Time / 3rd Party Scripts</b>	Manage JavaScript execution and limit 3rd party scripts to optimize performance.	Tier II (Upgrade)
<b>Unused CSS &amp; JS (Code Coverage)</b>	Further optimization by removing unnecessary global CSS and JS to reduce bloat.	Tier II (Upgrade)
<b>Minification</b>	Important for reducing asset sizes and improving download times.	Tier II (Upgrade)
<b>CDN</b>	Easy win for improving load times and reducing server	Tier II (Upgrade)

	load by using a content delivery network.	
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Table based on the information in (MOZ, 2021)

Criteria	Description
<b>Enable Compression</b>	Use Gzip to reduce the size of CSS, HTML, and JavaScript files. Avoid gzip for images; compress them separately.
<b>Minify and Bundle Resources</b>	Minify CSS, JavaScript, and HTML by removing unnecessary characters and comments. Combine files to reduce the number of requests.
<b>Reduce Redirects</b>	Minimize redirects to decrease wait times for HTTP request-response cycles and speed up loading.
<b>Remove Render-Blocking Resources</b>	Avoid or minimize JavaScript and CSS that blocks page rendering to speed up load times.
<b>Leverage Browser Caching</b>	Set caching to store data so repeat visitors don't reload the entire page. Manage caching expiration using tools like YSlow.
<b>Improve Server Response Time</b>	Optimize server performance to achieve a response time under 200ms. Address issues like slow database queries and insufficient memory.
<b>Use a Content Distribution Network (CDN)</b>	Distribute content across multiple servers globally to enhance speed and reliability.
<b>Optimize Images</b>	Resize and compress images appropriately. Use the right format (PNG for graphics, JPEG for photos) and CSS sprites to reduce HTTP requests.
<b>HTTP/2</b>	Enable HTTP/2 to process multiple requests concurrently, improving page load speed.
<b>Preconnect / Prefetch / Preload</b>	Use techniques to pre-establish connections or fetch resources ahead of time to speed up loading.
<b>First Paint &amp; First Contentful Paint</b>	Track when the first visual change or content appears on the screen to gauge initial load times.
<b>First Meaningful Paint</b>	Measure when the main content of the page becomes visible to the user.
<b>Time to Interactive</b>	Determine when the page is fully interactive and usable by the user.
<b>DOM Content Loaded</b>	Monitor when the HTML document has been completely loaded and parsed.

The website (Pingdom tools, n.d.) can be used to test my website to see if there are any possible performance upgrades. Here are the mentioned techniques from the website.

Criteria	Description
<b>Compress components with gzip</b>	Compress files like CSS, HTML, and JavaScript to reduce size.
<b>Add Expires headers</b>	Set expiration dates for cacheable resources to reduce load times.
<b>Use cookie-free domains</b>	Serve static content from domains that don't send cookies, reducing data overhead.
<b>Avoid URL redirects</b>	Minimize redirects to improve page load times.

<b>Reduce DNS lookups</b>	Reduce the number of domain name system queries to speed up the page load.
<b>Avoid empty src or href</b>	Ensure all src or href attributes are filled to prevent unnecessary requests.
<b>Put JavaScript at the bottom</b>	Move JavaScript to the bottom of the page to prevent it from blocking page rendering.

Table based on the information on (Tips to improve website speed | How to speed up websites, n.d.) and (What is lazy loading?, n.d.).

<b>Criteria</b>	<b>Description</b>
<b>Optimize Images</b>	Reduces image load time by compressing images and lowering their resolution and dimensions. This minimizes the size of the image files, improving overall page load speed.
<b>Limit the Number of HTTP Requests</b>	Fewer HTTP requests mean fewer round trips to the server, reducing load times. Minimizing the number of assets loaded (images, scripts, etc.) boosts the page's loading performance.
<b>Use Browser HTTP Caching</b>	Saves static files in a temporary cache, allowing returning visitors to load pages faster without fetching all assets again. This shortens load time for repeat visitors.
<b>Remove Unnecessary Render-blocking JavaScript</b>	Prevents the loading of non-essential code before the important page content, ensuring the main page elements load quicker, reducing initial load time.
<b>Limit the Use of External Scripts</b>	Reduces reliance on third-party scripts, which can delay page loading and cause layout shifting. By limiting external scripts, the page loads more smoothly and faster.
<b>Limit Redirect Usage</b>	Reducing the number of redirects prevents additional delays in reaching the final destination page, speeding up the time it takes for a user to access the desired content.
<b>Minify CSS and JavaScript Files</b>	Eliminating unnecessary characters and whitespace from code reduces file sizes, resulting in faster loading times and lower bandwidth usage.
<b>Use Effective Third-party Services</b>	Ensures that key functions such as hosting, DNS resolution, caching, and cybersecurity are handled efficiently. Fast hosting, DNS services, and CDN caching help deliver content quickly.
<b>Lazy Loading</b>	Defers loading of certain resources (like images) until needed, improving initial page load speed. Reduces load times for images

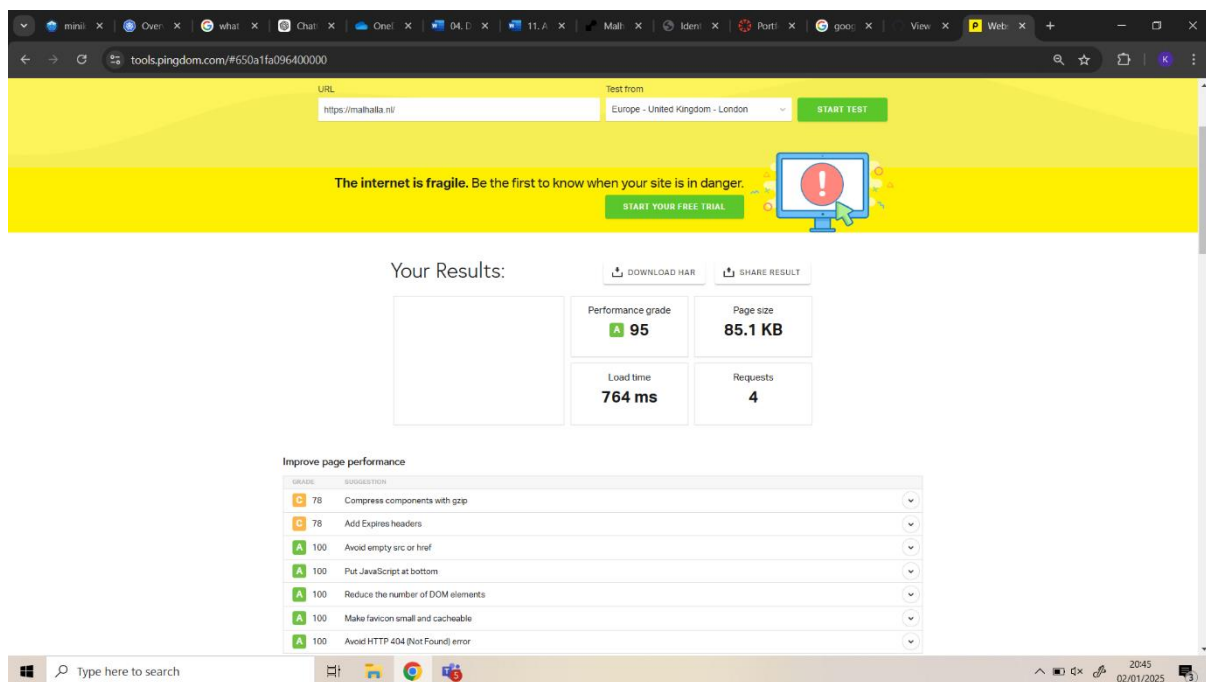
below the fold, saving bandwidth and improving performance.

With all this information it makes it easier to optimize my page loading speeds. By for example starting with the most appearing criteria such as image compression and caching and slowly working my way through the list of all the optimizations.

## Performance test (page loading speeds)

According to the research I did, I need to achieve page loading speeds of below 1 second (<1000ms). I tested the page loading speeds using the following website <https://tools.pingdom.com/>. Here are the results.

UK London 764ms.



DE Frankfurt 650ms.

The screenshot shows the Pingdom website performance test results for the URL `https://malhalla.nl/` tested from Europe - Germany - Frankfurt. The results are as follows:

Metric	Value
Performance grade	A 95
Page size	85.2 KB
Load time	650 ms
Requests	4

Below the results, there is a section titled "Improve page performance" with a table of suggestions:

GRADE	SUGGESTION
C 78	Compress components with gzip
C 78	Add Expires headers
A 100	Avoid empty src or href
A 100	Put JavaScript at bottom
A 100	Reduce the number of DOM elements
A 100	Make favicon small and cacheable
A 100	Avoid HTTP 404 (Not Found) error

AU Sydney 736ms

The screenshot shows the Pingdom website performance test results for the URL `https://malhalla.nl/` tested from Pacific - Australia - Sydney. The results are as follows:

Metric	Value
Performance grade	A 95
Page size	85.2 KB
Load time	736 ms
Requests	4

Below the results, there is a section titled "Improve page performance" with a table of suggestions:

GRADE	SUGGESTION
C 78	Compress components with gzip
C 78	Add Expires headers
A 100	Avoid empty src or href
A 100	Put JavaScript at bottom
A 100	Reduce the number of DOM elements
A 100	Make favicon small and cacheable
A 100	Avoid HTTP 404 (Not Found) error

## Japan Tokyo 514ms

The screenshot shows the Pingdom website performance test interface. The URL being tested is `https://maihalla.nl`. The test location is set to "Asia - Japan - Tokyo". The results show a Performance grade of **A 95**, Page size of **85.2 KB**, Load time of **514 ms**, and Requests of **4**. Below the results, there is a section titled "Improve page performance" with a list of suggestions:

GRADE	SUGGESTION
C 78	Compress components with gzip
C 78	Add Expires headers
A 100	Avoid empty src or href
A 100	Put JavaScript at bottom
A 100	Reduce the number of DOM elements
A 100	Make favicon small and cacheable
A 100	Avoid HTTP 404 (Not Found) error

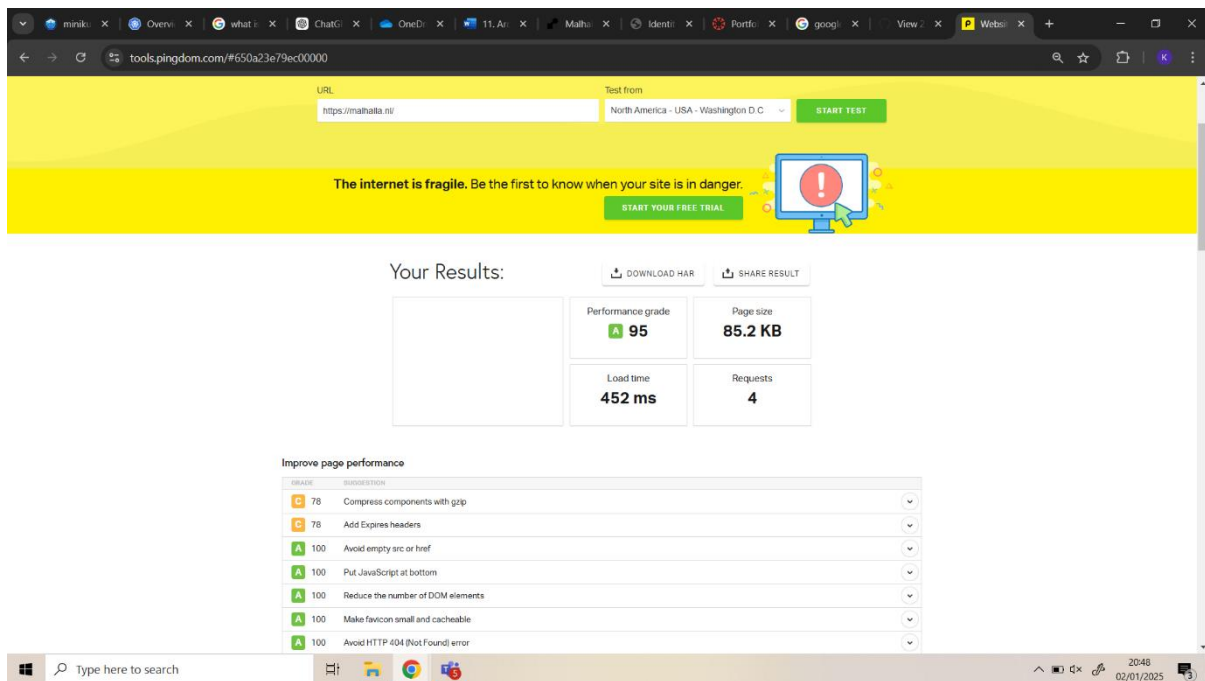
## Brazil Sao Paulo 1160ms

The screenshot shows the Pingdom website performance test interface. The URL being tested is `https://maihalla.nl`. The test location is set to "South America - Brazil - São Paulo". The results show a Performance grade of **A 95**, Page size of **85.2 KB**, Load time of **1.16 s**, and Requests of **4**. Below the results, there is a section titled "Improve page performance" with a list of suggestions:

GRADE	SUGGESTION
C 78	Compress components with gzip
C 78	Add Expires headers
A 100	Avoid empty src or href
A 100	Put JavaScript at bottom
A 100	Reduce the number of DOM elements
A 100	Make favicon small and cacheable
A 100	Avoid HTTP 404 (Not Found) error



USA Washington 452ms



The goal was to reach loading speeds below 1000ms. From most of the locations my production does manage to reach this goal, except for the region South Africa.

Conclusion, the page loading speeds are looking very good for my ecommerce website. Only South Africa has loading speeds above 1 second, but this also brings up questions such as:

1. Do I even want to market in South America? (English isn't too well known in SA so I would most likely also need to translate the website)
2. What is the max distance for delivery? (If I just want to deliver inside the Netherlands there will probably be different services/platforms I should use to enhance speeds in the Netherlands)

# How many concurrent users should my website be able to handle?

## Competitive analysis

In the area of scalability there are 2 main factors: Hosting and Architecture. But before getting into that, how many users should my website be able to handle? Here is a comparison of different eCommerce websites and their average visits per day

eCommerce Website	Average Visits per Day
<b>Bol.com</b>	576.700
<b>Amazon.com</b>	27.400.000
<b>Aliexpress.com</b>	2.300.000
<b>Raphnet-tech</b>	143
<b>Azerty.com</b>	4.800
<b>Marktplaats.nl</b>	270.000

I was originally thinking to make something like raphnet-tech. But this would be no challenge in scalability. Therefore, I will challenge myself and choose something more difficult, like bol.com.

With the following formula from the source (Dehran, 2024). I can calculate the concurrent users bol.com handles. The values I input in the formula are found on (Bol.com Website Traffic, Ranking, Analytics [August 2024], 2024)

Concurrent Visitors = Per Day visits / Peak hours \* (60/Average duration per visit in minutes)

Concurrent Visitors = 576,700 / 4 \* (60 / 8) = 1,086,562.5

So roughly a million. I will try to build a website that can scale out to handle one million users at the same time.

# Which software architecture provides performance and efficient scalability up to one million concurrent users?

I am looking for an architecture which can scale out efficiently to handle one million concurrent users. With that in mind, it could help filter out architectures.

Best architecture practises according to (Perco, 2024). Marked in green are the pros which I look for in an architecture. Marked in red are the cons which are a dealbreaker for my project.

Architecture Type	Pros	Cons
Monolithic Ecommerce Architecture	<ul style="list-style-type: none"><li>- <b>Simplicity</b>: Easy to develop, deploy, and manage.</li><li>- <b>Reliability</b>: Predictable with tight integration.</li></ul>	<ul style="list-style-type: none"><li>- <b>Scalability issues</b>: Hard to scale specific parts.</li><li>- <b>Rigidity</b>: Changes affect the entire system.</li></ul>
Microservice Ecommerce Architecture	<ul style="list-style-type: none"><li>- <b>Scalability</b>: Independent scaling of services.</li><li>- <b>Flexibility</b>: Easier to update and maintain specific parts.</li></ul>	<ul style="list-style-type: none"><li>- <b>Complexity</b>: Requires managing multiple services.</li><li>- <b>Resource-intensive</b>: Higher overhead.</li></ul>
Two-Tier Ecommerce Architecture	<ul style="list-style-type: none"><li>- <b>Performance</b>: Improves performance by distributing tasks.</li><li>- <b>Easily manageable</b>: Separation of client and server logic.</li></ul>	<ul style="list-style-type: none"><li>- <b>Limited scalability</b>: Can become a bottleneck as user base grows.</li><li>- <b>Security risks</b>: More exposure points.</li></ul>
Three-Tier Ecommerce Architecture	<ul style="list-style-type: none"><li>- <b>Scalability</b>: Each layer can be scaled independently.</li><li>- <b>Flexibility</b>: Easier to modify individual layers.</li></ul>	<ul style="list-style-type: none"><li>- <b>Complexity</b>: Harder to manage with more components.</li><li>- <b>Cost</b>: Potentially higher operational costs.</li></ul>
Headless Ecommerce Architecture	<ul style="list-style-type: none"><li>- <b>Flexibility</b>: Use any frontend for different devices.</li><li>- <b>Enhanced user experience</b>: Quick updates to frontend.</li></ul>	<ul style="list-style-type: none"><li>- <b>Complexity</b>: Requires advanced skills to manage.</li><li>- <b>Integration challenges</b>: Connecting multiple frontends to the backend.</li></ul>
SaaS Ecommerce Architecture	<ul style="list-style-type: none"><li>- <b>Cost-effective</b>: Low initial investment.</li><li>- <b>Maintenance-free</b>: Provider manages updates and security.</li></ul>	<ul style="list-style-type: none"><li>- <b>Limited control</b>: Dependent on third-party provider.</li><li>- <b>Customization limits</b>: Less flexible than other architectures.</li></ul>

Here are the most common types of eCommerce architecture according to (BigCommerceTeam, Ecommerce Website architecture (Best Practices + Your Options), 2024).

Architecture	Pros	Cons
Two-tier	<ul style="list-style-type: none"><li>- <b>Simplicity</b>: Easy to implement for smaller businesses.</li><li>- <b>Performance</b>: Allows fast</li></ul>	<ul style="list-style-type: none"><li>- <b>Limited scalability</b>: Struggles with handling larger data or complex logic.</li></ul>

	client-server communication.	- <b>Performance:</b> Can degrade as demands grow.
Three-tier	<ul style="list-style-type: none"> <li>- <b>Scalability:</b> Independent scaling of presentation, business, and data layers.</li> <li>- <b>Flexibility:</b> Each layer can be developed and maintained separately.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Complexity:</b> More challenging to set up and maintain.</li> <li>- <b>Cost:</b> Requires more infrastructure, leading to higher expenses.</li> </ul>
SaaS	<ul style="list-style-type: none"> <li>- <b>Quick setup:</b> Easy to launch for new businesses.</li> <li>- <b>Low maintenance:</b> Provider handles hosting, updates, and security.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Limited control:</b> Customization and configuration options are limited.</li> <li>- <b>Dependence:</b> Relies on the SaaS provider for updates and performance.</li> </ul>

With my preferences we can narrow down the decision to the following architectures:

**Microservice Architecture, Three-Tier Architecture, Headless Architecture.** Here is a closer look on those 3 architectures.

Approach	Pros	Cons
<b>Headless E-commerce</b>	<ul style="list-style-type: none"> <li>- <b>Flexibility and Agility:</b> Enables quick adaptation to customer expectations and market trends.</li> <li>- <b>Seamless Omnichannel Experiences:</b> Delivers consistent shopping experiences across multiple channels.</li> <li>- <b>Scalability and Performance:</b> Allows independent scaling of front-end and back-end systems, improving performance during high traffic.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Complex Implementation:</b> Requires integration of various technologies and can complicate the development process.</li> <li>- <b>Dependency on APIs:</b> Relies heavily on APIs, which can lead to issues if not managed properly.</li> <li>- <b>Increased Maintenance:</b> Requires ongoing management of multiple technologies and platforms.</li> </ul>
<b>Microservices</b>	<ul style="list-style-type: none"> <li>- <b>Scalability and Resilience:</b> Allows independent scaling based on demand, improving resource allocation.</li> <li>- <b>Agility and Innovation:</b> Fosters an autonomous development approach, accelerating innovation and deployment.</li> <li>- <b>Fault Isolation:</b> Issues in one service do not affect the entire system, enhancing reliability and maintenance ease.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Higher Complexity:</b> Managing multiple microservices can lead to increased architectural complexity. Inter-service</li> <li>- <b>Communication Overhead:</b> Requires efficient communication between services, which can introduce latency.</li> <li>- <b>Deployment Challenges:</b> Managing deployments of numerous independent services can be cumbersome.</li> </ul>

Information based off (Hasan, 2023).

Architecture	Pros	Cons
3-Tier	<ul style="list-style-type: none"> <li>- <b>Scalability:</b> Independent scaling of each tier.</li> <li>- <b>Maintainability:</b> Better organization improves maintainability.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Scalability:</b> Centralized design can introduce bottlenecks.</li> <li>- <b>Complexity:</b> Complexity in managing interactions between tiers.</li> </ul>
Microservices	<ul style="list-style-type: none"> <li>- <b>Scalability:</b> Highly scalable; individual services can be scaled independently.</li> <li>- <b>Maintainability:</b> Loose coupling allows independent updates.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Complexity:</b> Increased complexity in managing numerous services.</li> <li>- <b>Performance:</b> Communication overhead can introduce latency.</li> </ul>

Info based off (Tozzi, 2023)

Criteria	Three-Tier Architecture	Microservices Architecture
<b>Modularity</b>	More modular than monolithic architecture.	Highly modular, with each service focusing on a specific function.
<b>Codebase Separation</b>	Allows separation of application codebase into distinct parts.	Enables high separation between application parts, enhancing flexibility.
<b>Deployment Independence</b>	Components can be deployed independently, simplifying the deployment process.	Components can also be deployed independently, but requires more complex management.
<b>Security Benefits</b>	Separation reduces the impact of breaches on other components.	Offers security benefits, as issues in one microservice won't necessarily affect others.
<b>Performance</b>	Issues in one layer can affect overall app performance.	Performance is improved; issues in one service do not cause the entire app to fail.
<b>Complexity</b>	Simpler to build, deploy, and manage.	More complex to create and manage due to numerous individual components.
<b>Scalability</b>	Scalable, but less efficient than microservices for complex apps.	Highly scalable with granular scaling capabilities for individual components.
<b>Deployment Environment</b>	Suitable for applications deployed on one or a few servers.	Best for distributed environments that maximize scalability and resilience.

<b>Development Processes</b>	Suitable for teams with simpler development operations.	Ideal for teams with advanced CI/CD pipelines capable of managing multiple services.
<b>IT Team Readiness</b>	Better fit for small or less experienced IT teams.	Requires a more experienced IT team to support the complexity of microservices.

Information based off (BigCommerceTeam, Ecommerce Microservices vs. Monolith Models vs Headless Commerce, 2024)

Architecture Type	Pros	Cons
<b>Microservices</b>	<ul style="list-style-type: none"> <li>- <b>Independent Scaling:</b> Each service can scale individually, preventing back-end slowdowns from front-end traffic.</li> <li>- <b>Customization Opportunities:</b> Businesses can select specific services tailored to their needs, enabling better personalization.</li> <li>- <b>Rapid Implementation:</b> Decentralized teams can deploy updates faster, improving responsiveness to market changes.</li> <li>- <b>Best-of-Breed Solutions:</b> Allows the use of specialized services from different providers rather than a single, all-in-one solution.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Requires Organizational Changes:</b> Moving to microservices may necessitate restructuring teams for better collaboration.</li> <li>- <b>May Need Infrastructure Updates:</b> New tools may be required for managing microservices, adding complexity.</li> <li>- <b>Potential High Costs:</b> Fully decoupled systems can be expensive due to multiple service providers.</li> </ul>
<b>Headless Commerce</b>	<ul style="list-style-type: none"> <li>- <b>Flexible Content Delivery:</b> Front-end and back-end can operate independently, enabling easier updates.</li> <li>- <b>Agility in Customer Service:</b> Brands can quickly adapt to customer expectations and market trends.</li> <li>- <b>Multiple Front-End Options:</b> Different user interfaces can be created while using a single back-end system, enhancing the customer experience.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Incremental Transition Challenges:</b> Transitioning can be complex, as it requires gradual separation of components.</li> <li>- <b>Potential Complexity:</b> Managing multiple front-ends can introduce operational challenges.</li> <li>- <b>API Dependency:</b> Reliance on APIs can lead to risks if any API issues occur.</li> </ul>

In conclusion, I have the option of choosing either a **Microservice Architecture, Three-Tier Architecture** or a **Headless Architecture**. While the microservice architecture excels in scalability, based off my research, all three options score similarly on the non-functional requirements I was considering. I could consider not choosing a **Three-Tier** because it is inefficient to scale, and efficient scalability is one of my main focusses in this project which would leave the decision between a **Microservice Architecture** or a **Headless Architecture**.

# Which type of hosting provides high performance and automatic scaling?

## Best Practices

The type of hosting not only impacts the performance but also the scalability. With a good host you will be able to easily scale your application automatically. I compared hosting services while looking for eCommerce best practises.

Best hosting options according to (Newland, 2024)

Hosting Option	Description
Cloud Hosting	Offers flexibility and scalability, allowing resources to be adjusted as needed. Ideal for sites with fluctuating traffic or rapid growth. Options include VPS, managed cloud, or PaaS. Cost-effective with a pay-as-you-go model.
Dedicated Server	Provides maximum control and performance, ensuring consistent operation for large B2B sites with complex requirements. A dedicated server is more expensive but guarantees high uptime and performance.
Enterprise-grade Hosting	Included with many B2B SaaS platforms, this hosting simplifies setup and reduces in-house technical needs. Scaling is automatic, and costs are predictable as part of a subscription fee.

Best hosting options according (Low, 2024)

Hosting Type	Description
Shared Hosting	Limited scaling options, usually better for small sites.
VPS Hosting	Easier to scale by adding more resources to your virtual server.
Cloud Hosting	Designed for scaling, allows you to add or remove resources quickly.
Dedicated Hosting	High scalability by upgrading hardware, best for large sites with heavy traffic.

Hosting options according to this ecommerce blog (Samuelito, 2024)

Hosting Type	Description
Shared Hosting	Most affordable option, but performance may suffer under high traffic, making it unsuitable for large eCommerce sites.





We start to see that the backend starts to scale out to 3 pods.

NAME	REFERENCE	TARGETS	MINPODS	MAXPODS	REPLICAS	AGE
product-management	Deployment/product-management	cpu: 0%/50%	1	10	1	3h50m
product-management	Deployment/product-management	cpu: 10%/50%	1	10	1	3h56m
product-management	Deployment/product-management	cpu: 114%/50%	1	10	1	3h57m
product-management	Deployment/product-management	cpu: 114%/50%	1	10	3	3h57m
product-management	Deployment/product-management	cpu: 32%/50%	1	10	3	3h58m

I tried to load test with more requests per second. I tried 300 requests per second, but there was no difference in pod amount or cpu % meaning my hardware is too limited.

So, we do know that my current setup does allow my backend to scale, but number-wise I am not able to hit crazy numbers because my hardware is too limited to reach higher numbers for both sending load and scaling out.

# What are the best practices for enhancing and maintaining security in eCommerce platforms?

## Best Practices

To find the best practises for security I checked multiple websites and listed the best practises they mention.

Here are the best practises according to (Elitery, 2022)

E-Commerce Security Tips	Description
Use SSL and Follow PCI DSS Security Standards	Secure Socket Layers (SSL) are essential for website authentication and data protection. Adhering to PCI DSS security standards enhances the security of financial transactions, helping validate credit card payments and preventing fraudulent transactions.
Complete Website With DDoS and Firewall Application	DDoS attacks can render online banking sites inaccessible. Utilizing reliable third-party applications like CloudFlare and Sucuri can mitigate DDoS attacks. Firewalls are also critical for protecting against SQL Injection and cross-site scripting (XSS) attacks.
Always Update	Many security incidents arise from outdated systems. Regular updates are necessary to safeguard your e-commerce site against vulnerabilities that intruders can exploit through old code.
Have Layered Security	Implementing multi-factor authentication, stronger passwords, address verification systems (AVS), and security warning systems can enhance e-commerce security. If your site integrates with external APIs, ensure verification and encryption measures are in place at each gateway.
Selected Data Selection	Not all data should be stored in the backend, especially sensitive information like customer credit card data. Compliance with PCI DSS certification requires that sensitive data not be stored on the transaction site, even if encrypted.

Best practises according to (Derachits, 2024)

Best Practice	Description
Embrace Multi-Factor Authentication	Implement multi-factor authentication methods like 2-step verification to enhance access security.

<b>Use Stronger Passwords</b>	Require strong passwords for accounts, incorporating special characters, numbers, and varying letter cases.
<b>Keep Your E-commerce Website Up-to-Date</b>	Regularly update software to patch vulnerabilities and maintain the latest security measures.
<b>Use HTTPS Security</b>	Switch from HTTP to HTTPS by using SSL to encrypt sensitive customer data during transactions.
<b>Use a Firewall</b>	Employ firewalls to monitor and block suspicious traffic while allowing authorized access to your site.
<b>Only Store Necessary Customer Data</b>	Limit the collection and storage of customer data to only what is essential for business operations.
<b>Have a Secure E-commerce Platform</b>	Choose an e-commerce platform that supports robust security measures and integrates well with security tools.

The OWASP top 10 web application security risks (OWASP Top Ten | OWASP Foundation, n.d.). For more elaborate information about each risk, there are sub-pages for each of the risk explaining how I can tackle them.

<b>OWASP Category</b>	<b>Relevance to E-commerce</b>	<b>Actions to Mitigate</b>
<b>A01:2021 - Broken Access Control</b>	Critical for preventing unauthorized access to user accounts, payment information, and admin functions.	Implement role-based access control (RBAC), conduct regular access reviews, and use secure coding practices.
<b>A02:2021 - Cryptographic Failures</b>	Essential for protecting sensitive data such as credit card details and personal information from exposure.	Use strong encryption standards (e.g., AES, RSA), employ secure protocols (e.g., TLS), and regularly audit cryptography practices.
<b>A03:2021 - Injection</b>	Vulnerabilities like SQL injection and XSS can compromise sensitive data and manipulate application behaviour.	Use prepared statements and parameterized queries, validate and sanitize user input, and implement Content Security Policy (CSP).
<b>A04:2021 - Insecure Design</b>	Flaws in design can introduce vulnerabilities; secure design practices help identify risks early.	Conduct threat modeling, apply secure design patterns, and involve security teams in the design phase.
<b>A05:2021 - Security Misconfiguration</b>	Misconfigurations during deployment can expose the application; regular audits are necessary.	Regularly review and test configurations, automate configuration management, and implement least privilege principles.

<b>A06:2021 - Vulnerable and Outdated Components</b>	Using outdated libraries can expose the application to known vulnerabilities; regular updates are critical.	Maintain an inventory of components, apply security patches promptly, and use tools for vulnerability scanning.
<b>A07:2021 - Identification and Authentication Failures</b>	Flaws can lead to account takeovers; robust authentication mechanisms are necessary.	Implement multi-factor authentication (MFA), enforce strong password policies, and use secure session management.
<b>A08:2021 - Software and Data Integrity Failures</b>	Ensuring the integrity of software updates and data is crucial to prevent manipulation and vulnerabilities.	Use checksums or digital signatures for updates, implement secure CI/CD practices, and regularly audit data integrity.
<b>A09:2021 - Security Logging and Monitoring Failures</b>	Effective logging is vital for detecting fraud and responding to security incidents.	Implement comprehensive logging of critical actions, utilize centralized log management solutions, and regularly review logs for anomalies.
<b>A10:2021 - Server-Side Request Forgery</b>	SSRF vulnerabilities can lead to unauthorized access to internal resources, making them a concern for e-commerce platforms.	Validate and sanitize user-supplied URLs, implement network segmentation, and monitor server-side requests.

I plan to categorize security practices and risks using the MoSCoW method, prioritizing them from "must" to "could." This approach will help me implement the most critical measures first, followed by the less essential ones.

## Automated Security Assessments

For my python backend I have setup a tool called bandit. Bandit makes sure my code doesn't get pushed to GitHub (from vs code) if it contains security breaches. Think of API Tokens in code, hardcoded IP addresses etc. Also in the GitHub pipeline bandit runs checks. It checks the code for the same security breaches. This can be useful if I would change IDE.

## Security Testing

The security measures that I have implemented are the following:

- DDoS protection
- Brute Force Attack Prevention (MFA, Google Login)
- All sensitive variables in the Environment

This would make the following attacks relevant and interesting

- DoS attack

And the following useless

- Brute Force Attack

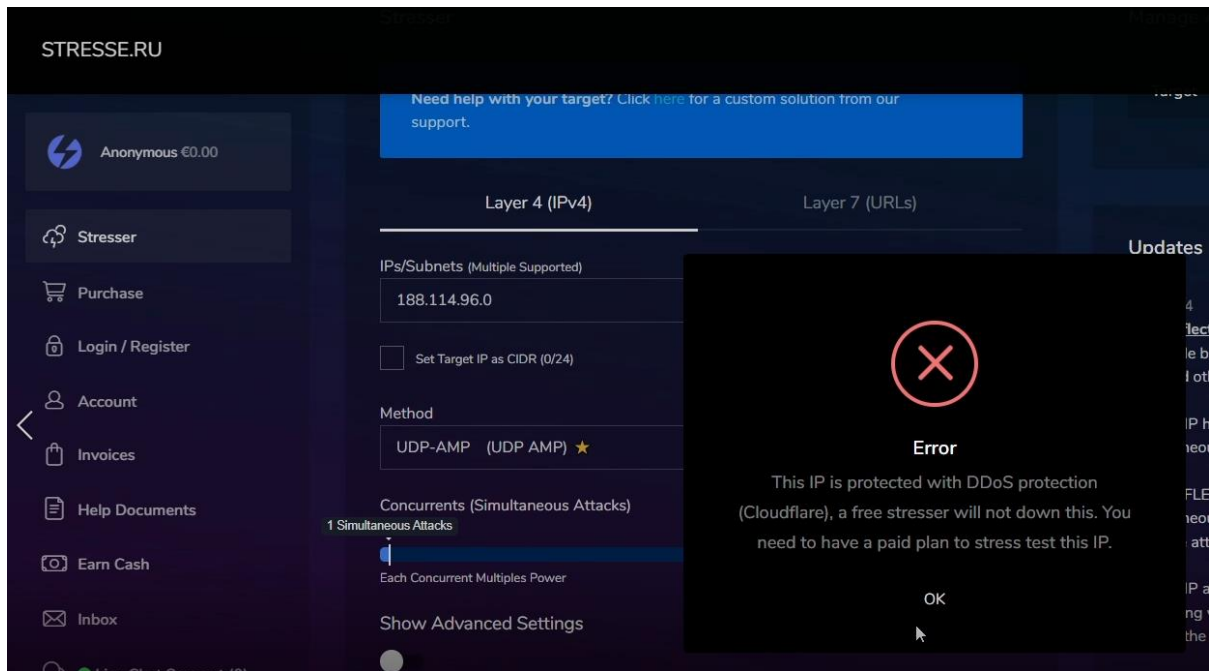
## DoS Attack

Before I started I set up a small flask server and flooded it with HTTP requests. The output confirmed that the DoS tools were working.

```
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /CCUACQ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /AVSLUT HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /EQEKXU HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /FOJHFO HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /BBJYHW HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /TLJBXZ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /IQYYTD HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /MWGUQ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /GHHNQB HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /WVHTRV HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /ZCSFKM HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /JVRGBX HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /BYEVZH HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /SDGLMO HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /JTBVZP HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /MMQMCJ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /RAWZDJ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /IXJDZV HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /HXDQCB HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /NPWVIB HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /IGTEDE HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /IMJGZJ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /JVSJX HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /BRVIVJ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /YGPNRD HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /UDUXHH HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /KNCLKU HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /FAKJLT HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /GWEPTB HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /BDJNCX HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /PVTANJ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /EMWVZN HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /PKSAYX HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /DRXNUC HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /SKWQZX HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /CDYMDN HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /JAEMVD HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /KBPPDE HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /EZVWGF HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /URVTSU HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /YGGJBN HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /AUXALV HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /NUFAFA HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /SHWTTV HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /IQJUAJ HTTP/1.1" 404 -
127.0.0.1 - - [05/Jan/2025 15:27:20] "HEAD /HVXHCX HTTP/1.1" 404 -
```

First I tried dosing my website down. My website gets DDoS protection from both Render (the hosting platform) and Cloudflare (my reverse proxy).

First of all I tried a Russian website called [stresse.ru](https://stresse.ru). But I got the following error. From one side this is a success since the software is admitting that my website is protected.



Next I tried the DoS tool Low Orbit Ion Cannon. Inside this tool I tried to TCP flood and HTTP flood my website. Here are some screenshots of the attacks.



Low Orbit Ion Cannon

github.com/NewEraCracker/LOIC

Manual Mode (Do it yourself)

IRC Mode (HiveMind)

DAMN OverLord

IRC server

Port

Channel

Disconnected.

Up?

Interval: 30

Disconnected.

1. Select your target

URL

malhalla.nl

Lock on

IP

188.114.96.0

Lock on

3. Ready?

IMMA CHARGIN MAH LAZER

Selected target

188.114.96.0

2. Attack options

Timeout

30

HTTP Subsite

/

Append random chars to the URL

TCP / UDP message

U dun goofed

Append random chars to the message

use GET

use gZip

443

HTTP

50

Wait for reply

25

Sockets / Thread

<= faster

Speed

slower =>

Attack status

Idle	Connecting	Requesting	Downloading	Downloaded	Requested	Failed
50	0	0	0	23216	23216	0

Low Orbit Ion Cannon

github.com/NewEraCracker/LOIC

Manual Mode (Do it yourself)

IRC Mode (HiveMind)

DAMN OverLord

IRC server

Port

Channel

Disconnected.

Up?

Interval: 30

Disconnected.

1. Select your target

URL

malhalla.nl

Lock on

IP

188.114.96.0

Lock on

3. Ready?

Stop flooding

Selected target

188.114.97.0

2. Attack options

Timeout

30

HTTP Subsite

/

Append random chars to the URL

TCP / UDP message

U dun goofed

Append random chars to the message

use GET

use gZip

443

HTTP

50

Wait for reply

25

Sockets / Thread

<= faster

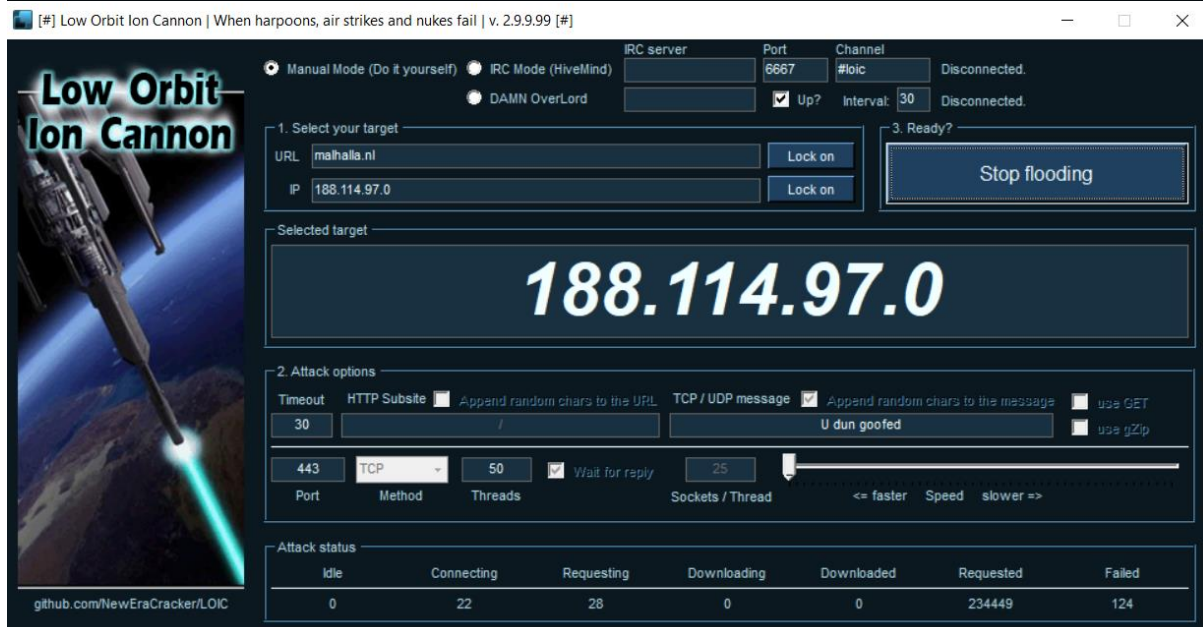
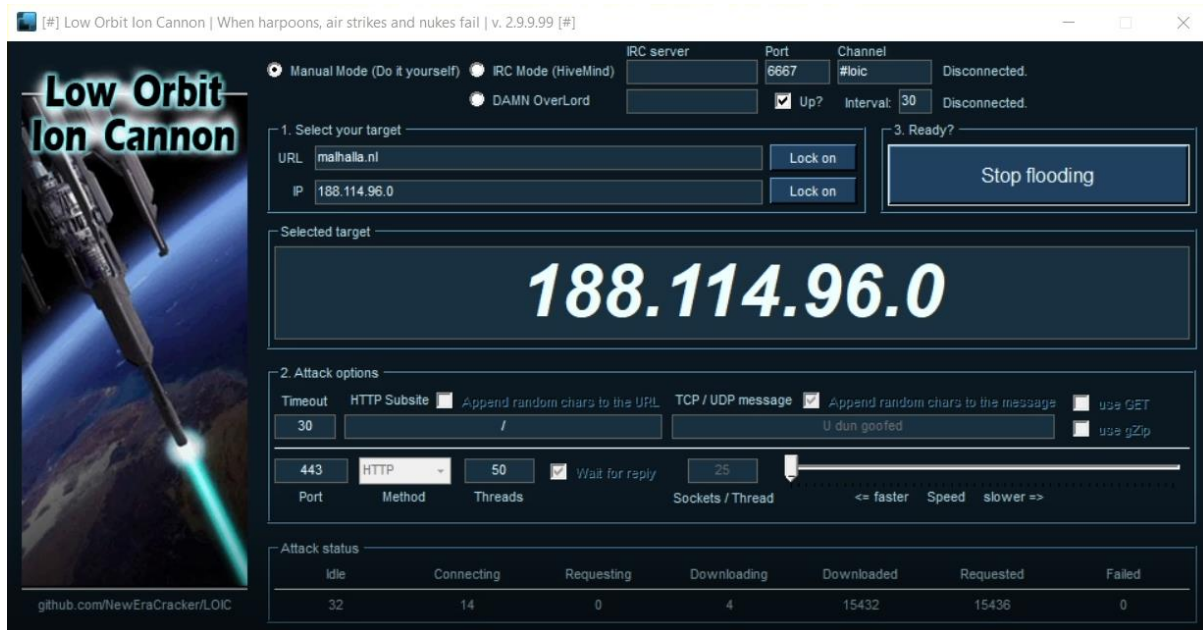
Speed

slower =>

Attack status

Idle	Connecting	Requesting	Downloading	Downloaded	Requested	Failed
37	5	0	8	39743	39751	3595





and here are the ping results

# Pingdom Website Speed Test

Enter a URL to test the page load time, analyze it, and find bottlenecks.


URL

Test from

[START TEST](#)

The internet is fragile. Be the first to know when your site is in danger.

[START YOUR FREE TRIAL](#)



Your Results:

	<a href="#">DOWNLOAD HAR</a>	<a href="#">SHARE RESULT</a>
	Performance grade <b>A 94</b>	Page size <b>88.5 KB</b>
	Load time <b>89 ms</b>	Requests <b>4</b>

# Pingdom Website Speed Test

Enter a URL to test the page load time, analyze it, and find bottlenecks.


URL

Test from

[START TEST](#)

The internet is fragile. Be the first to know when your site is in danger.

[START YOUR FREE TRIAL](#)



Your Results:

	<a href="#">DOWNLOAD HAR</a>	<a href="#">SHARE RESULT</a>
	Performance grade <b>A 95</b>	Page size <b>85.2 KB</b>
	Load time <b>607 ms</b>	Requests <b>4</b>

And from the ping results in the page loading speeds we can see that the results are similar meaning the DoS attack has no effect on the website.

I can also try to attack the backend. The backend is reachable online which is a bad security practice. The backend is only protected by Render rather than Render + Cloudflare. The backend does have two IPs which it can run on. I will first attack a single IP using stresser.ru.

**Manage Attacks (1)** Stop All Attacks

1000 Q

Target	Method	Attacks	Time Remain	Stop
216.24.57.4:443	UDP-AMP	1	00:33	Stop

Showing 1 to 1 of 1 entries

← 1 →

This results in no difference, the website still pings fast and the images still load on the website

URL Test from

Europe - United Kingdom - London START TEST

**The internet is fragile.** Be the first to know when your site is in danger.

START YOUR FREE TRIAL

## Your Results:

DOWNLOAD HAR SHARE RESULT

Welcome to Flask App

Performance grade

**A 100**

Page size

**1.4 KB**

Load time

**359 ms**


Requests

**2**


URL  Test from  [START TEST](#)

**The internet is fragile. Be the first to know when your site is in danger.**

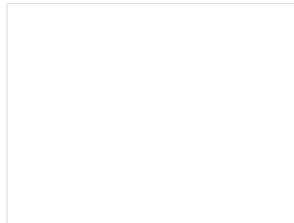
[START YOUR FREE TRIAL](#)



Your Results:

 DOWNLOAD HAR

 SHARE RESULT



Performance grade

**A 100**

Page size

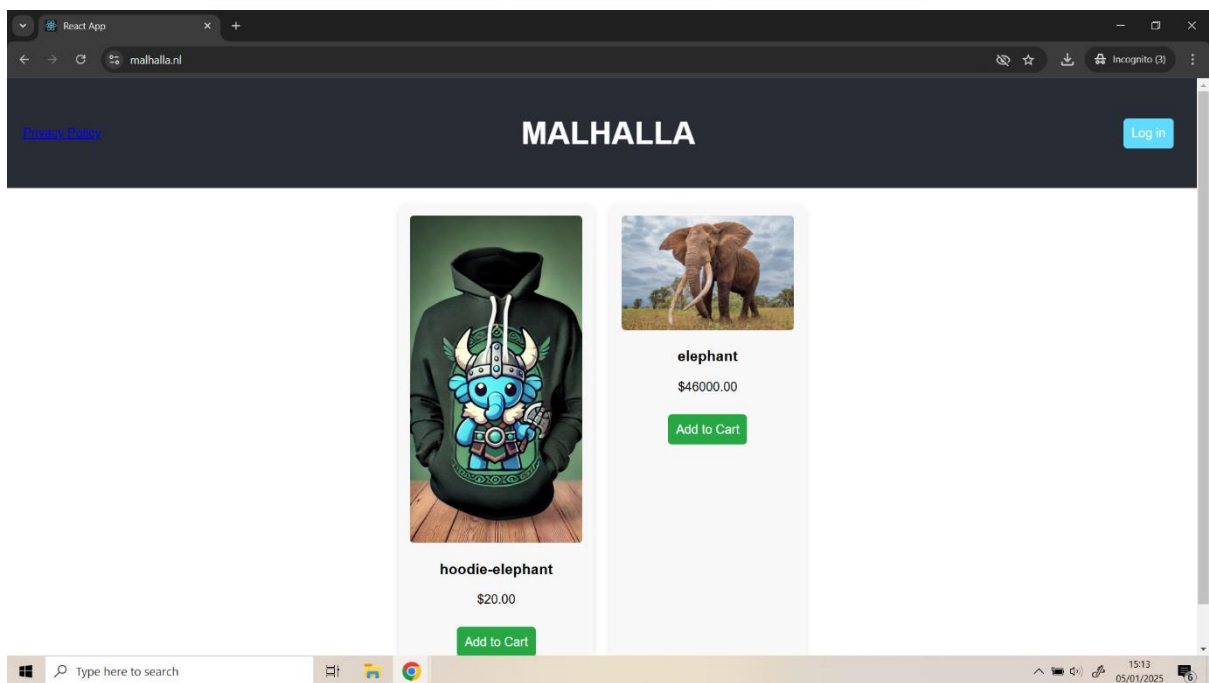
**1.4 KB**

Load time

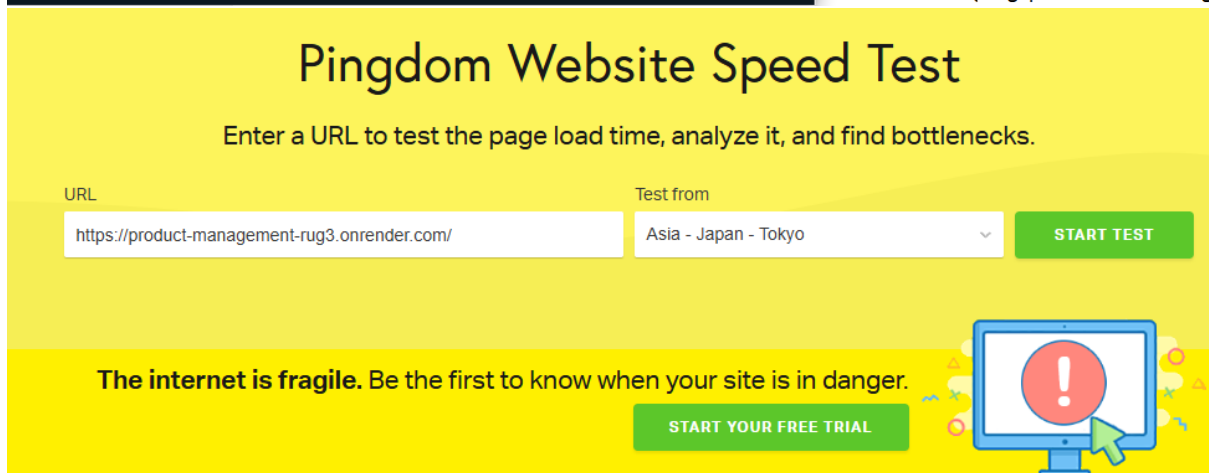
**130 ms**

Requests

**2**

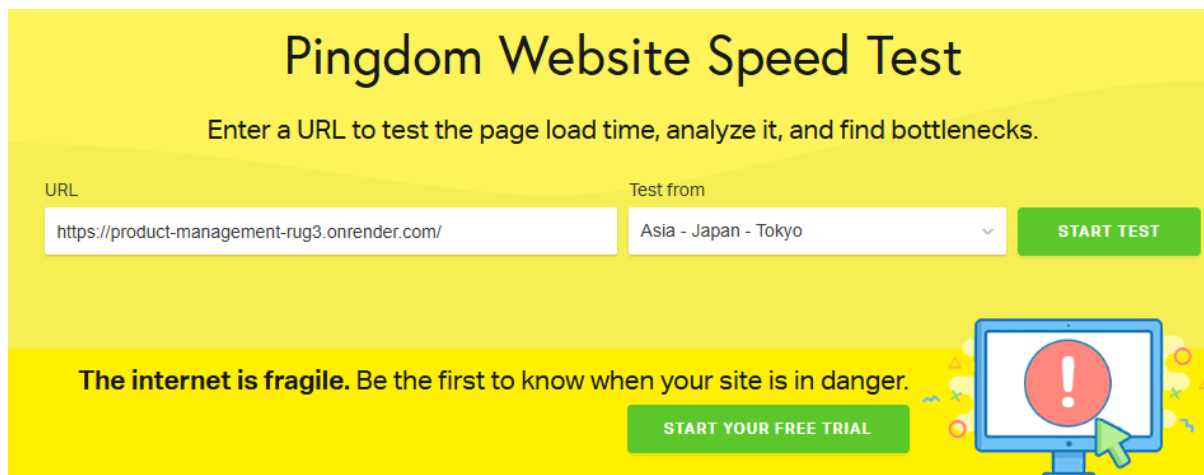


I will now try attacking both IPs.

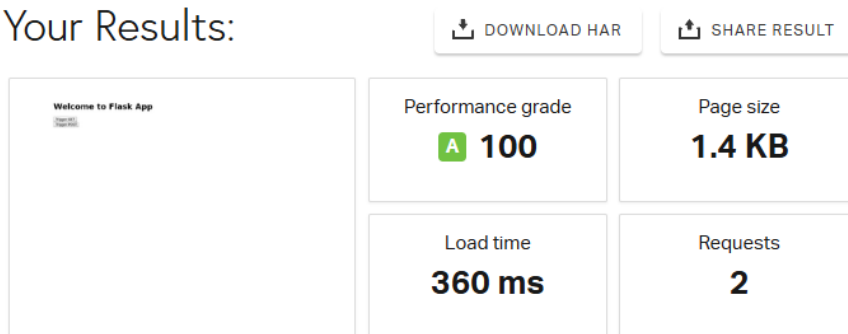
 SHARE RESULT

The dashboard displays four performance metrics in a 2x2 grid. The top-left card shows the 'Performance grade' as 'A 100' with a green 'A' in a square. The top-right card shows the 'Page size' as '1.4 KB'. The bottom-left card shows the 'Load time' as '338 ms'. The bottom-right card shows the number of 'Requests' as '2'.

Metric	Value
Performance grade	A 100
Page size	1.4 KB
Load time	338 ms
Requests	2



## Your Results:



and again, there is no difference in load time. Which is expected since the deployments are protected against DDoS attacks, and I tried a DoS attack.

After some time I could find back the attacks I performed in the metrics tab of Cloudflare and Render. You can see an obvious spike during the attack

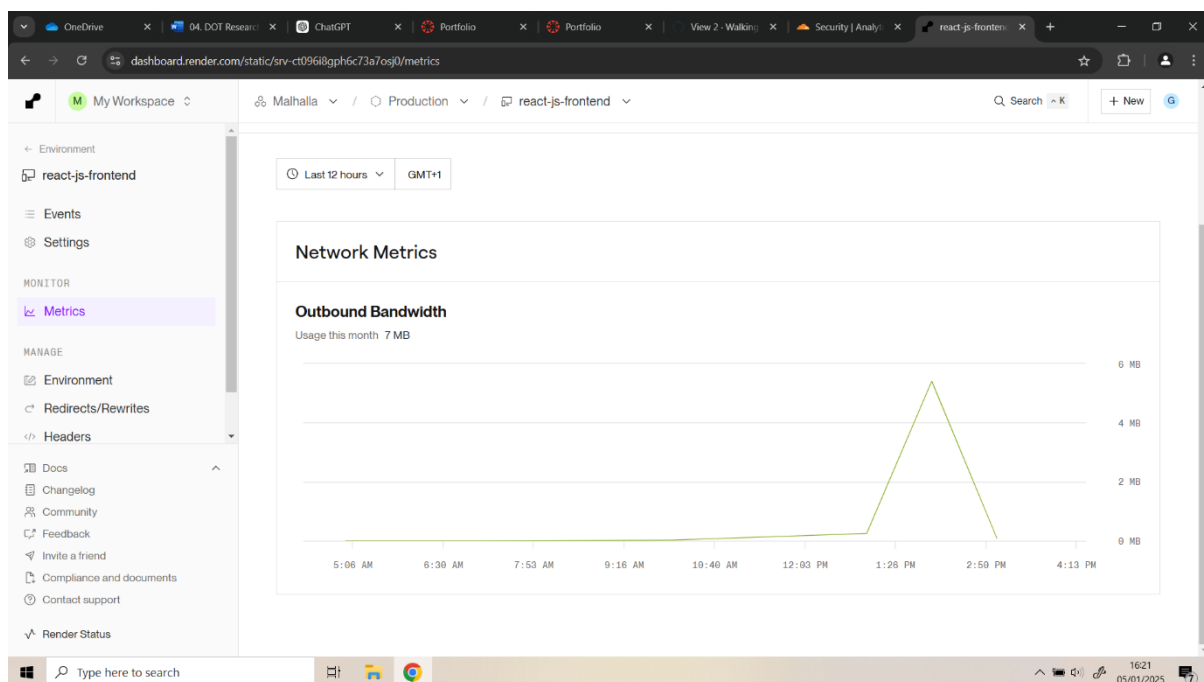


Figure 1: Production Frontend metrics

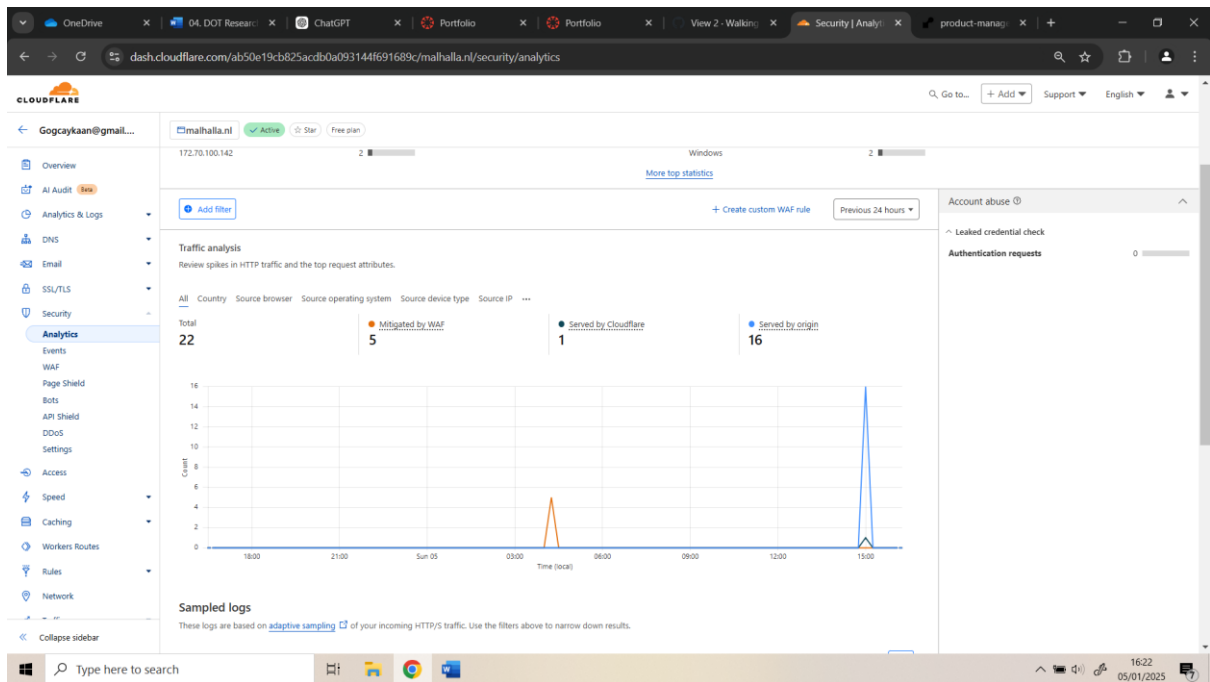


Figure 2: Cloudflare analytics

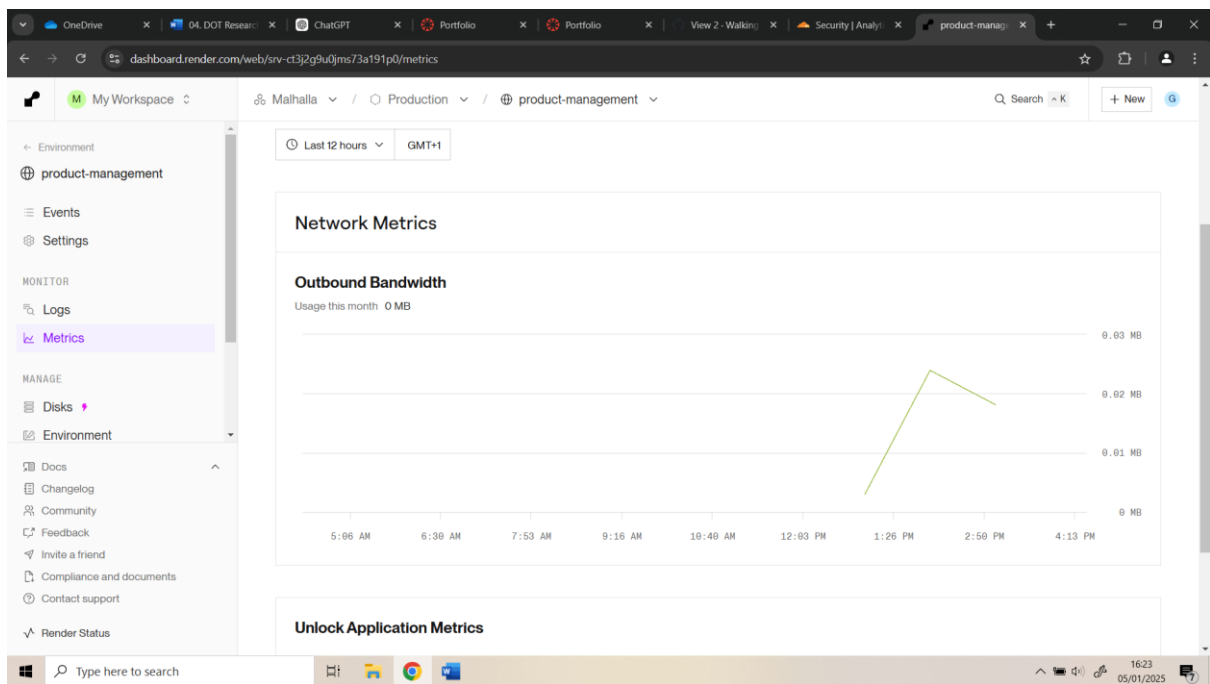


Figure 3: Production Backend metrics

# What are the best practices for ensuring maintainability in eCommerce platforms?

## Best Practices

Maintenance plays a crucial role in the success of any eCommerce platform. According to (BigCommerceTeam, Ecommerce Website Maintenance Generates Wins Now and for Later, 2024), here are some essential maintenance tasks that should be prioritized once the project is live

Aspect	Description	Importance
Mitigating cyber threats	Regular updates to security software and plugins to protect customer data from hackers.	Reduces chances of cyber attacks and data breaches.
Maximizing website uptime	Ensuring the site remains live and accessible for customers.	Prevents costly downtime and loss of business.
Preventing data loss	Regular backups of databases and key systems.	Safeguards data in case of a catastrophe.
Maintaining compliance	Staying updated with legal standards like PCI-DSS and GDPR.	Ensures compliance with regulations, avoiding penalties.
Uptime consistency	Ensuring site availability for users at all times.	Crucial for seamless customer transactions and user experience.
Website security	Applying security patches and maintaining an SSL certificate.	Protects the site from emerging security threats.
Data backups	Taking regular snapshots of databases and key systems.	Provides insurance against data loss and improves recovery from cyber attacks or system failures.
Broken links	Running reports to find and fix broken links.	Improves site quality and customer experience.
Page speed	Optimizing load times to make the site faster.	Impacts conversion rates and customer satisfaction; slow load times reduce sales.
Updating outdated content	Regularly auditing and updating content to maintain accuracy.	Increases customer confidence and reflects business professionalism.
Priority keyword rankings (SEO)	Reviewing and retooling SEO to keep high search engine rankings.	Helps attract more customers through better search visibility.
Promotions and price changes	Regularly adjusting pricing to stay competitive.	Ensures the business remains competitive in an open market.
More prone to cyber attacks	Neglecting updates makes ecommerce sites attractive targets for hackers.	Increases the risk of data breaches and theft of sensitive information.



<b>Slow website load times</b>	Poorly maintained sites have slower load times.	Conversion rates drop significantly with every extra second of load time.
<b>Higher costs due to recurring bugs</b>	Neglected websites are more prone to bugs and crashes.	Results in higher costs for fixing issues and lost opportunities during downtime.
<b>Loss in customer trust</b>	Regular site issues erode customer confidence.	Customers are less likely to buy from a site they don't trust, especially with personal and financial information.
<b>Outdated and misleading content</b>	Inaccurate information discourages purchases and leads to customer dissatisfaction.	Regular content audits maintain accuracy and customer satisfaction, especially with new product launches.

Best practices according to (Rawat, 2024)

<b>Best Practice</b>	<b>Description</b>
<b>Understanding Your Website's Needs</b>	Regularly assess your website for outdated content, security vulnerabilities, and performance issues.
<b>Setting Concrete Objectives</b>	Define specific goals for your website maintenance, such as boosting sales, enhancing user experience, or improving search rankings.
<b>Prioritizing Critical Components</b>	Focus on the most important aspects of the website, including backups, security, and user experience, to save time and resources.
<b>Creating a Consistent Maintenance Schedule</b>	Establish a regular routine for updates, security checks, and backups to ensure consistent performance.
<b>Delegating Tasks Effectively</b>	Assign maintenance responsibilities to team members or specialists to ensure tasks are handled efficiently.
<b>Documenting Procedures for Clarity</b>	Create step-by-step documentation for maintenance tasks to maintain clarity, consistency, and ease of training new team members.
<b>Budgeting Wisely for Tools and Resources</b>	Allocate a budget for necessary tools, plugins, or services that support website maintenance and deliver a strong return on investment.
<b>Ensuring Robust Security Measures</b>	Implement security protocols such as SSL encryption, regular audits, and timely updates to protect customer data and enhance credibility.

After reviewing both sources, I noticed that the non-functional requirement maintenance involves various other nonfunctional requirements like performance, security, and usability. Many of these practices have already been covered in their own sections of the research, and most are primarily relevant once the project is live.

# What are the best practices for improving usability in eCommerce platforms?

## Best Practices

Usability plays a major factor in conversion rate. Therefore, it's important to make the website as attractive and user friendly as possible. Here are some best practises on the field of usability according to (Markovich, 2024)

Best Practice	Description
Attractive Product Display	Display products in a visually consistent and attractive way.
Personalize Suggestions	Tailor product suggestions and deals to individual customers.
Implement clear navigation	Make it easy for customers to find what they're looking for with intuitive navigation.
High-quality images	Use professional, high-quality images that capture attention.
Insert enticing calls to action	Include clear and persuasive calls to action to encourage customers to make a purchase or explore more. ("Shop Now", "Buy Now", "Add to Cart", "Learn More" etc.)

"Personalize Suggestions" is an interesting best practice because it needs to be considered before I begin the project, unlike the other practices that can be implemented at a later stage.

Here are most best practices according to (Cooper, 2023)

Best Practices for Optimizing Website Usability	Details
Ease Navigation	User-friendly navigation is essential for driving conversions. Ensure visitors can easily find what they need. Consider implementing a sitewide search function and navigation tools that are easy to locate. Use a simple navigation bar with practical categories. The checkout button should be displayed on all pages.
Streamlined Checkout	Lengthy checkout processes can lead to cart abandonment. Minimize the required information from users, such as using a checkbox to autofill shipping details. Allow guest checkouts to simplify the process and provide an option to save credit card information for returning customers. Carewell’s case study shows a direct correlation between stored payment options and a <b>200% increase in conversion rates</b> .
Search Engine Optimization	Optimize site search functionality to enhance product findability. Most users expect a search box in the top right corner. Use pre-filling based on popular searches and keep search input visible during results display. Implementing effective SEO strategies can also drive relevant traffic to your site, thereby increasing conversion rates.
Optimized Page Load Speeds	Fast loading times are critical for retaining customers. Ensure images are appropriately sized (under 1000 pixels) and consider

	compressing them to improve load speed. Reduce unnecessary redirects as they slow down the website.
<b>Optimize for Mobile use</b>	A mobile-friendly interface is essential for modern e-commerce. Ensure compatibility with mobile technologies and optimize for mobile usability by increasing button sizes, simplifying navigation, and offering features like credit card scanning. Maintain a single domain for both mobile and desktop versions to avoid confusion. Successful mobile optimization has led to significant increases in conversion rates for companies like Ice Jewellery.
<b>Accessible for all Users</b>	Accessibility is key for a usable e-commerce experience. Implement features like voice search, keyboard navigation, and alt-tags for images. Use high-contrast color schemes and provide text alternatives for media. Testing accessibility through crowdsourcing can identify challenges and improve user experience. Accessibility upgrades can be low-cost and enhance overall usability, thus increasing conversions.
<b>Design your pages better</b>	Ensure a clear and straightforward pathway to products. Differentiate information between the homepage and product pages. Highlight product information effectively and organize content clearly. Including customer ratings and reviews can help inform potential buyers, increasing the likelihood of purchase. Skullcandy's award-winning design focuses on clarity and user engagement.
<b>Focus on A/B Testing</b>	A/B testing allows you to identify usability issues through randomized experiments comparing two variants. This cost-effective method can help you understand user reactions to changes in design or functionality, thus minimizing the risk of negative impacts on user experience. Insights from A/B testing and other usability testing methods can inform improvements aligned with consumer needs.

## Usability testing

Currently my website doesn't have too much functionality which can be tested by a user. But whatever can be tested will be tested.

Here is the usability test that I wrote.

- Test 1: Login using your google account
- Test 2: Find and read our privacy policy
- Test 3: After Logging in, try to check your order history

## Usability Test 1: Desktop Test

Here is the usability test performed by Furkan U, a friend of mine:

<https://youtu.be/yGRHAhnfpNo>



Post Commentary from Furkan U.

**Test 1:** It is easy to find the login button. It is easy to login with google. It was kind of confusing how I wasn't logged in after going through the login process.

**Test 2:** The Privacy Policy button is really sketch. It looks like you are trying to hide it. I can imagine that someone cannot find it.

**Test 3:** The order history is easy to find.

## Usability Test 2: Mobile Test

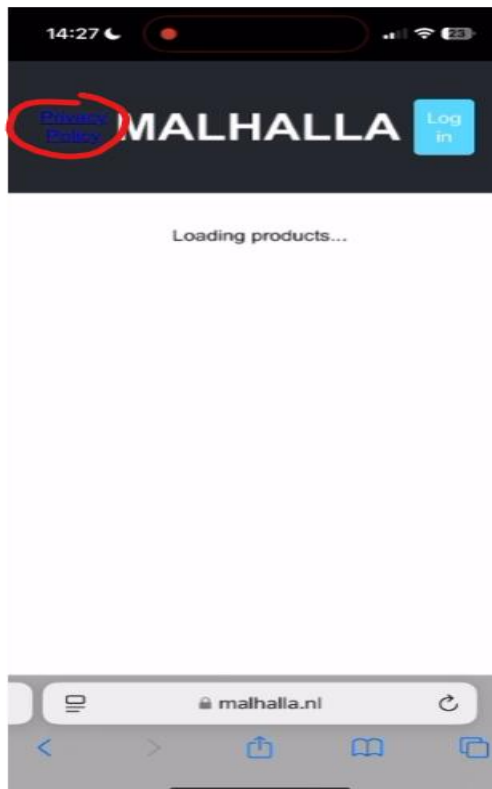
I performed the test on mobile myself.

Post Commentary from me.

**Test 1:** Easy to find the login button. The button says Log-in which is a bit off but not terrible. After clicking on login button i am confronted with a privacy policy which I can't fully read for some reason. The top part is cut off on mobile which is a pretty big issue since you cannot read what you are agreeing to. After that the same issue where you have to click the login button after logging in to see the logged in state.



**Test 2:** The Privacy Policy button is a bit harder to find.



**Test 3:** Also, on mobile it is easy to find the order history button.

# Postface and Conclusions

So, what are the best practices in eCommerce? Each sub question contributed to answering this question. Here are the conclusions for each sub question.

## Page Loading Speeds

### Best Practices

For page loading speeds there are many tips in its dedicated section. I would recommend going through them and prioritizing them using the MoSCoW method. Something noticeable from this section of the research is that **I want my pages to load within 1 second** (with a maximum of 2 seconds if it really doesn't work out). This is based on research on conversion rates. See the dedicated section on page loading speeds for more details.

### Validating with Performance Testing

I tested the loading speed of my website from multiple locations and got a response faster than 1 second from most areas. However, not from South America. This opens questions such as: Do I want to market in South Africa? Do I want to deliver only in the Netherlands? Only in Europe? Everywhere? These are interesting questions to be asked if the project would continue.

## Concurrent Users / Scalability

### Competitive Analysis

I've decided to build a website with the scalability of Bol.com. Based on my calculations, this means the website needs to be capable of **handling 1 million concurrent users**.

### Best Practices for Hosting

For hosting, the three hosts left were: **Cloud Hosting**, **Enterprise-Grade Hosting** and **VPS Hosting**. I decided that it would be more convenient to choose **Cloud** or **Enterprise-Grade** hosting because they usually have auto-scaling built in which is amazing in my case. Therefore VPS hosting is more of a last resort.

In the end **I chose a shared-cloud host**. This combines a bad practise (shared hosting) with a good practise (cloud hosting). The reason for this is because it is free. It is almost impossible to find a cloud host for free, so **the good outweighs the bad**.

### Best Practices for Architecture

My choice for the architecture should be one of the following: **Microservice Architecture**, **Three-Tier Architecture**, **Headless Architecture**. In short, scaling a **Three-Tier** is not as convenient as scaling a microservice architecture, but it's simpler to develop and manage. The headless architecture is completely different than these two architectures, and shines in its omnichannel possibility. However, I don't need that, but that doesn't make it a bad choice.

Meaning the decision is between **Microservice Architecture** and **Headless Architecture**. I am choosing for the Microservice Architecture for the sake of that I want to learn better how to implement it.



In the end I chose microservice architecture. In retrospect, this is overkill. I am a small startup ecommerce company. Usually, you would start with a smaller less scalable architecture since it simply not needed to be able to scale out since you are still small. As the audience grows and especially the team grows it might be a good decision but for now, in the current state I am at with this project, it is definitely overkill.

## Validating with Load Testing

I tried to load test my backend locally and found out that **my hardware is too limited to send more than 100 requests per second**. Because of this, it is impossible to load test my website for one million concurrent users. However, I did do research into making my application more scalable. I made a theoretical architecture which would be able to handle more load than my current application does. Also is this validate-able if I switch to a cloud host, since then I am able to use better hardware.

## Security

### Best Practices

For security I collected many tips and best practices I could work on later after the project has a walking skeleton. Something to keep in mind in the project starting phase is to pick a host with many built in security functionalities so that I don't have to implement them myself (Think of DDoS protection for example). And for example, for authentication, choose a technology that allows Multi Factor Authentication. More tips in its own dedicated section

## Validating with Security Testing

I stress tested my website and backend with multiple tools and came to the conclusion that it can indeed withstand DoS attacks.

## Maintainability

### Best Practices

I researched best practices to improve the maintainability of my project. Same for the best practices in performance, scalability, usability and security, it would be nice to start prioritizing them in a MoSCoW manner.

## Usability

### Best Practices

For usability I mainly found tips and best practices to enhance the user experience, but I can also derive design choices from the tips I found, such as: Show Personalised Products, Optimize Search Engine, Mobile and PC interface.

## Validating with Usability Testing

By letting users test the web app I found some smaller and more problematic bugs. Also, little things such as the privacy policy being hard to locate.

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