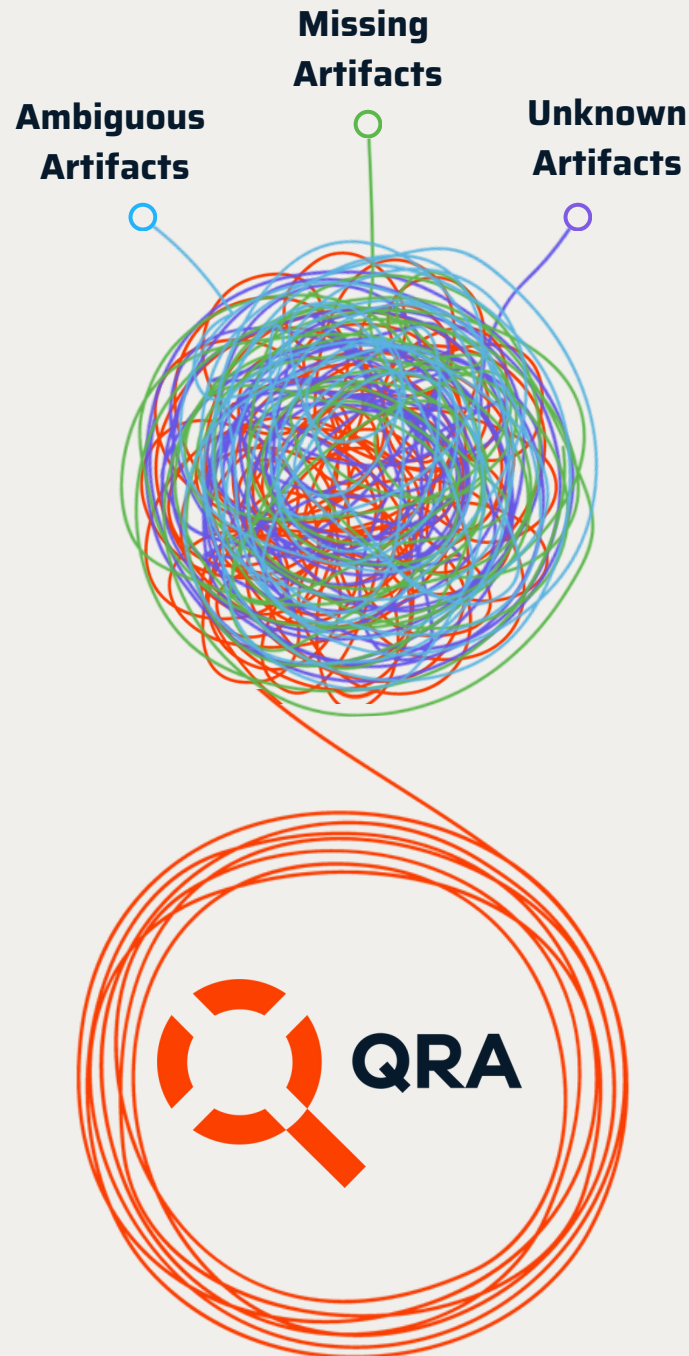

Generate. Evaluate. Predict.



Requirements Index and Insights

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At QRA, data underscores our commitment to developing products that streamline the intricate processes of specifying, designing, and certifying the extraordinary systems our customers create. This document offers a snapshot of our findings from the past 12 months, helping to shape the evolution of our solutions.

REQUINSIGHTS SUMMARY

An extensive internal analysis of over **12,000** requirements across multiple sectors revealed a new perspective on the barriers to project success.

50

Documents Analyzed

12,955

Requirements Analyzed

Across Various Industries

- Oil & Gas
- Telecommunications
- Medical Devices
- Government
- Shipbuilding
- Automotive
- Electrical Manufacturing
- Defense & Space
- Software Development
- Chemical
- Utilities

QVscribe Starting Configurations

This analysis used the **QV1 System Requirements (default)** configuration.

QV1 System Requirements	QV2 Project Requirements	QV3 Atomic Statements	QV4 Clear Statements
<p>To clarify singular mandatory requirement statements that describe specific actions to be taken under specific conditions.</p> <hr/> <p>System Requirements Subsystem Requirements Functional Requirements ONLY Mandatory Requirements ONLY</p> <hr/> <p>QV1 is the strictest of the four configurations. Requirement sets suitable for the QV1 configuration describe the specific actions that a system is required to perform under specific conditions.</p>	<p>To clarify singular mandatory requirement statements that may describe specific actions or the attributes of a particular project or product.</p> <hr/> <p>Project Requirements Product Requirements Business Requirements Functional and Non-Functional Mandatory Requirements ONLY</p> <hr/> <p>The QV2 configuration requirement sets can be a mixture of high level and low level, functional and non-functional requirements but each statement describes a feature or function that must be part of the final product.</p>	<p>To clarify singular mandatory statements that may include non-mandatory recommendations and permissions along with the requirements.</p> <hr/> <p>User Stories Stakeholder Needs Company Standards Industry Standards Recommendations Mandatory and Optional</p> <hr/> <p>Like QV1 and Qv2, the QV3 configuration will ensure that each statement includes one and only one imperative, but it also allows optional provisions like the ones used in ISO standards.</p>	<p>To clarify statements that may not be singular and may be written in paragraph form.</p> <hr/> <p>Legacy Requirements External Requirements Contracts Statements of Work Standard Operating Procedures Mandatory and Optional</p> <hr/> <p>QV4 is the lightest of the four configurations. It can be used to check technical documents other than requirements. This configuration is not recommended for developing new requirements.</p>

PROBLEM TYPES

Of all the requirements we analyzed for this report...

27% had **no Imperatives**

● QUALITY SCORE | NO IMPERATIVES

Enhance requirement completeness by including an acceptable imperative such as **“shall”**, **“must”**, and **“will”** in between the entity responsible and the action that is required.

Incorrect Example While in Daylight Mode, when the Ambient Light Reading measures below 400 lx the Control System goes into Night Mode.

Correct Example While in Daylight Mode, when the Ambient Light Reading measures below 400 lx the Control System **shall** enter Night Mode.

19% used **multiple imperatives**

● QUALITY SCORE | MULTIPLE IMPERATIVES

shall

Work toward a unitary requirement by including only one imperative such as **“shall”**, **“must”** or **“will.”** Split compound requirements into separate singular requirements.

Incorrect Example When the Mobile App User selects Intercom, the Control System **shall** turn on the Indoor Microphone and **shall** turn on the Outdoor Microphone.

Correct Example When the Mobile App User selects Intercom, the Control System shall enter Two-Way Mode.

● QUALITY SCORE | CROSS-REFERENCING PRONOUNS

it

Reduce ambiguity by replacing pronouns such as **“it”**, **“other”** and **“both”** with the proper unique name for the entity being referenced.

Incorrect Example If **it** drops below 6%, then the Alert System shall send a notification to the Mobile App.

Correct Example If the Backup Battery Level drops below 6%, then the Alert System shall send a Low Battery notification to the Mobile App.

25% used **cross-referencing pronouns**

Missing Imperatives or Multiple Imperatives

Words and phrases that command an action are missing. A proper requirement has exactly one imperative.

Recommendation: Ensure a single imperative is present in the requirement.

Cross-Referencing Pronouns

Words and phrases to reference a person or object without specifying who or what it is; for example, words such as **“it”**, **“this”**, **“he”**, **“she”**, **“they”**, **“them”**, **“other”**, or **“both”**.

A proper requirement should avoid the use of pronouns or cross-referencing pronouns.

Recommendation: Repeat nouns in full instead of using pronouns to refer to nouns in other requirements.

OVERALL RESULTS

QVscribe Quality Analysis Score Distribution

Average of **2/5** QVscribe Quality Score.

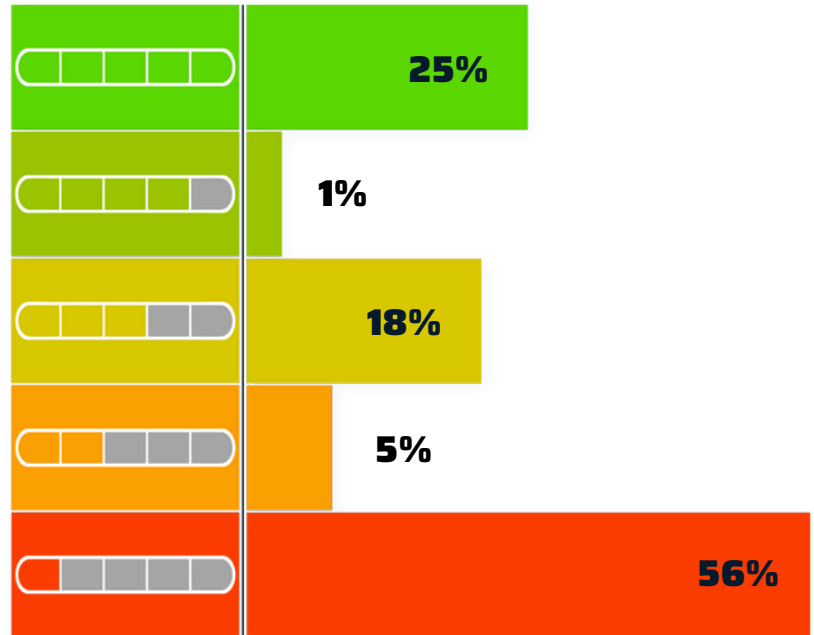
5/5, Very Low Risk: includes clear and unambiguous terminology to express the requirement.

4/5, Low Risk: may include excessive use of continuances and/or no directives.

3/5, Medium Risk: includes a single instance of a vague, subjective, or weak term, and/or a single negative imperative.

2/5, High Risk: includes multiple instances of vague, subjective, or weak terms, and/or negative imperatives.

1/5, Very High Risk: includes problems imperatives or more than two instances of problematic language. It is likely that important information will be missed in the execution of the project.



EARS, Consistency, and Similarity



41% average Easy Approach to Requirement Syntax (EARS) conformance.



37,336 potentially conflicting terms.



2,642 potential duplications.



Length was the top cause of inconsistent units.



6,667 potential contradictions.

EASY APPROACH TO REQUIREMENTS SYNTAX (EARS)

There are **five** fundamental EARS patterns.

Four of these are used to author requirements for normal conditions, i.e., what we want the system to be and to accomplish.

Ubiquitous

State-Driven

Event-Driven

Optional

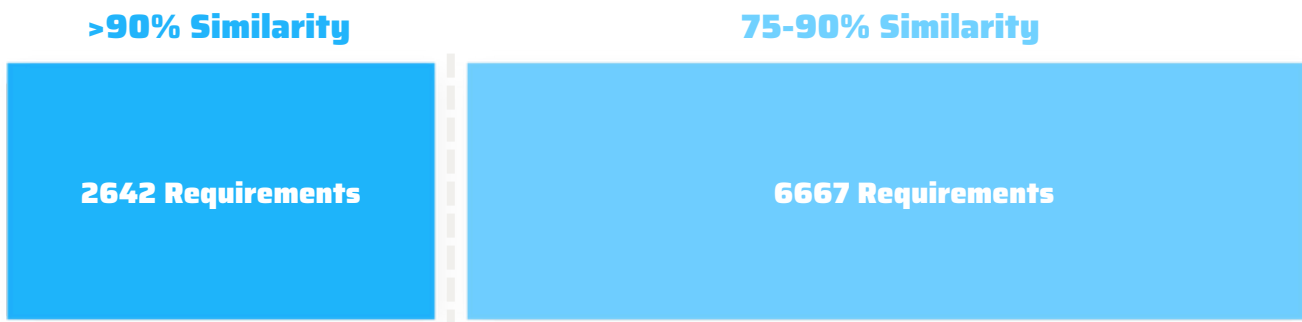
The fifth pattern is used for requirements to mitigate unwanted events or user behavior.

Unwanted Behavior

Name	Template	Description
Ubiquitous	The <system> <imperative> <system response>.	Requirements that are always active.
State-Driven	While <pre-condition(s)>, the <system><imperative> <system response>.	Requirements that are active during a defined state.
Event-Driven	When <trigger>, the <system> <imperative> <system response>.	Requirements that require a response only during a specific event.
Optional Feature	Where <feature is included>, the <system> <imperative> <system response>.	Requirements that only apply when an optional feature is present.
Unwanted Behavior	If <trigger>, then the <system> <imperative> <system response>.	Requirements that outline situations that are undesirable.

For more information on how you can implement EARS into your requirements authoring process, visit our [EARS Resource Hub](#).

SIMILARITY ANALYSIS



***This includes both duplicate and contradicting requirements.**

Duplicate Requirements

Duplicate requirements can confuse stakeholders and developers, leading to misunderstandings about the intended functionality of the system and might inadvertently inflate the scope of the project if not properly identified. This can lead to scope creep, where the project gradually expands beyond its original boundaries, resulting in increased costs and timelines.

Clarity is essential for ensuring everyone is on the same page regarding what needs to be built.

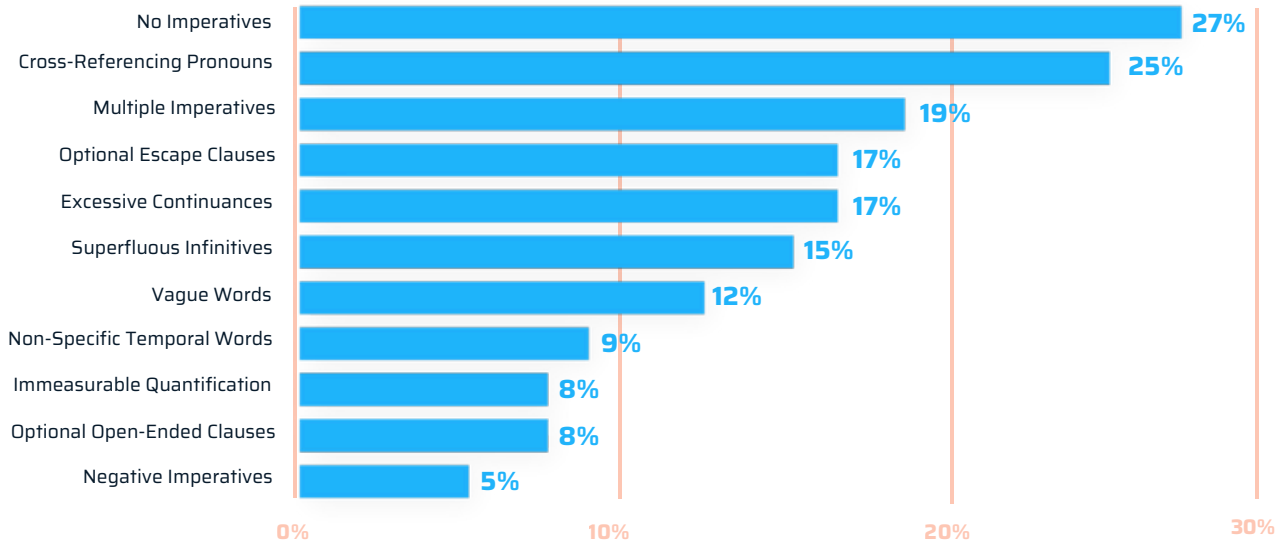
Contradicting Requirements

Contradicting requirements can waste time and resources during the development process and lead to compromised quality in the final product. When a project has requirements that contradict, there is potential for inconsistency in the implementation of the system, potentially resulting in errors, inefficiencies, or even system failures.

Consistency ensures that the system behaves predictably and reliably across different scenarios.

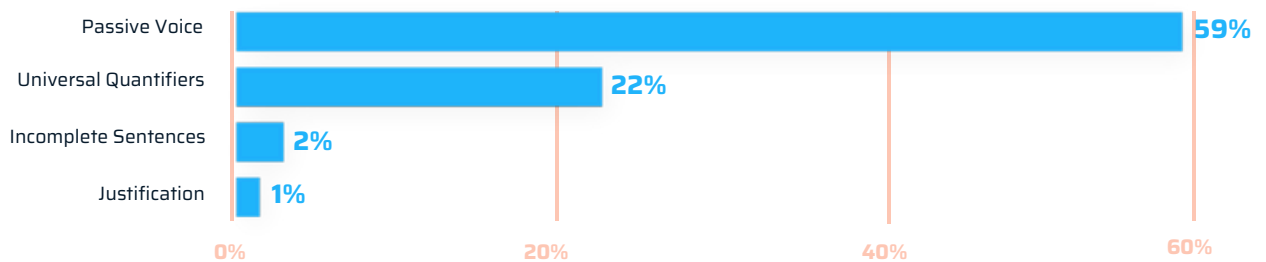
QVSCRIBE PROBLEM TYPES AND QUALITY WARNINGS

Problem Types (%)



***These Problem Types each have a negative impact on the QVscribe Quality Score.**

Quality Warnings (%)



***Quality Warnings do not impact the overall score but do pose potential risks depending on the context of usage.**

PROBLEM WORDS

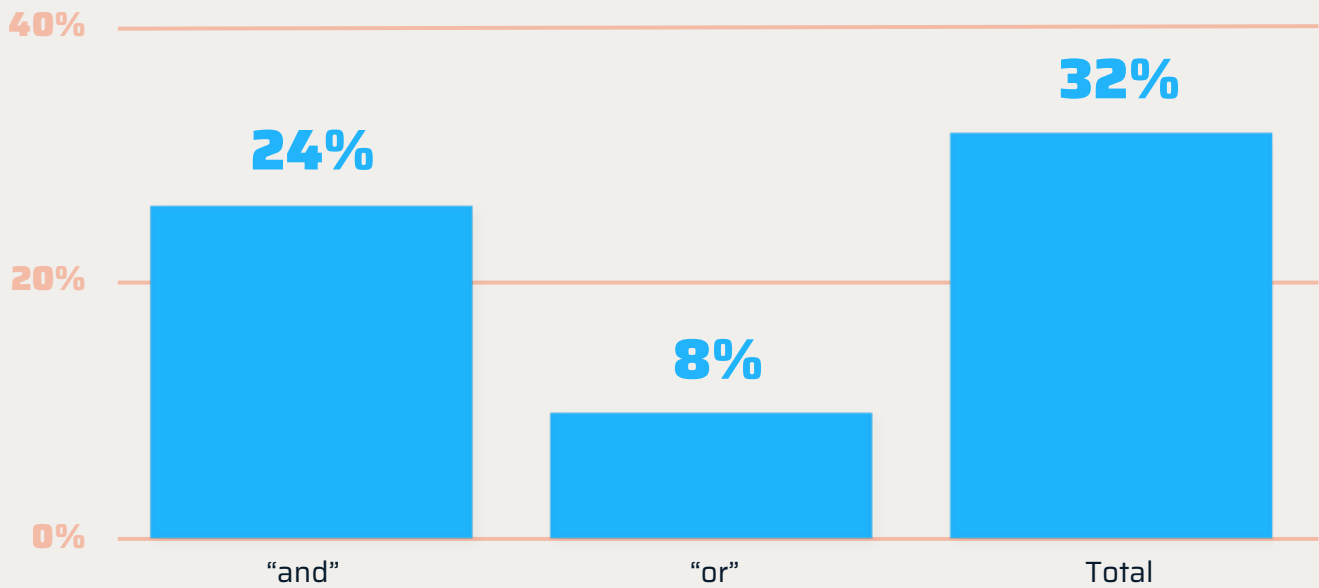
55 “Problem Words” were identified based on the top three Problem Types for each document. These words were repeated throughout thousands of requirements.

Total number of problem words counted: 8033

EXCESSIVE CONTINUANCES

Excessive Continuances are words or phrases that follow the requirement’s imperative and introduce more detail to the specification. A proper requirement avoids excessive use of continuances and combinators (generally no more than two).

This was not included in the results, as “or” and “and” are not problem words in themselves, it is the excessive use within a single requirement that is an issue.



***Only instances where excessive continuances were triggered in an individual requirement were counted.**

INCORPORATING INCOSE RULES

INCOSE’s forty-two rules for requirement statements and sets of requirements are grouped into fourteen categories. QVscribe automatically measures requirements against these categories to ensure alignment.

INCOSE RULES FOR REQUIREMENT STATEMENTS				
Rule Category	Rule	Code	Handled By	
Accuracy	Structured complete sentence	R01	Quality Analysis - EARS & Incomplete Sentences	
Singularity	Use single thought sentence	R18		
Singularity	Avoid parentheses and brackets	R21		Quality Analysis - EARS Conformance
Realism	State applicability conditions explicitly	R27		Quality Analysis - EARS Conformance
Uniform Language	Use a project-wide style guide	R39		Quality Analysis - EARS & Configurations
Modularity	Conform to a defined structure or template	R42		Quality Analysis - EARS & Configurations
Accuracy	Use active voice	R02		Quality Analysis - Passive Voice
Accuracy	Avoid vague term	R07		Quality Analysis - Vague Words
Accuracy	Avoid escape clauses	R08		Quality Analysis - Optional Escape Clauses
Accuracy	Avoid open-ended clauses	R09		Quality Analysis - Optional Escape Clauses
Concision	Avoid superfluous infinitives	R10		Quality Analysis - Superfluous Infinitives
Concision	Use a separate clause	R11		Quality Analysis - Multiple Imperatives
Non-Ambiguity	Use correct grammar	R12		Quality Analysis - Incomplete Sentences
Non-Ambiguity	Avoid the use of “not”	R16		Quality Analysis - Negative Imperatives
Singularity	Avoid combinators	R19		Quality Analysis - Continuances
Singularity	Avoid phrases of purpose or reason	R20		Quality Analysis - Justification
Singularity	Enumerate sets explicitly	R22		Quality Analysis - Vague Words
Singularity	Supporting diagram or model	R23		Quality Analysis - Directives
Completeness	Avoid pronouns & indefinite pronouns	R24		Quality Analysis - Pronouns
Realism	Avoid using achievable absolutes	R26		Quality Analysis - Universal Quantifiers
Quantifiers	Use “each” for universal quantification	R32	Quality Analysis - Universal Quantifiers	
Quantifiers	Define quantities with a range of values	R33	Quality Analysis - Non-Specific Temporals	
Quantifiers	Specific measurable performance target	R34	Quality Analysis - Immeasurable Quantification	
Quantifiers	Define temporal dependencies explicitly	R35	Quality Analysis - Non-Specific Temporals	
Accuracy	Define terms	R04	Term Consistency	
Uniform Language	Use terms & units of measure consistently	R36		
Uniform Language	Use a consistent set of acronyms	R37		
Uniform Language	Avoid the use of abbreviations	R38		
Accuracy	Use appropriate units	R06	Unit Consistency	
Completeness	Avoid relying on headings	R25	Similarity Analysis	
Uniqueness	Express once & only once	R30		
Non-Ambiguity	Use correct spelling	R13	Other Tools	
Non-Ambiguity	Use correct punctuation	R14		
Uniqueness	Classify by type or category	R29		
Modularity	Group related needs and requirements	R41		
Accuracy	Use appropriate subject verb	R03	The Professional	
Accuracy	Use definite article “the” versus “a”	R05		
Non-Ambiguity	Logical expressions	R15		
Non-Ambiguity	Avoid the oblique (“/”) symbol	R17		
Realism	Single condition for a specific action	R28		
Abstraction	Avoid stating a solution	R31		
Modularity	Use a consistent format for the specification of decimal numbers	R40		



QRA & THE ENGINEER SURVEY: THE CURRENT STATE OF REQUIREMENTS

159

Survey Responses

19

Participating Industries

21

Questions

Technology is transforming requirements, enhancing their functionality. Mapping this evolving landscape is crucial for successfully navigating the growing complexity of development.

QRA partnered with The Engineer to launch a research survey to understand the dynamic relationship between engineers and quality requirements.

The survey explores challenges and opportunities in requirements, providing an in-depth, comprehensive view of their current state.

We have transformed the results into **industry-specific infographics** and a comprehensive market research paper, offering actionable insights for organizations to enhance their approach.

SURVEY METHODOLOGY

The survey was sent out through three eblasts promoting this survey over a period of a month to The Engineer's audience of magazine readers & bulletin subscribers. The survey was also promoted by a series of posts on The Engineer's social media pages. To encourage responses, The Engineer offered the respondents the opportunity to enter a prize draw to win a £250 voucher.

About The Engineer

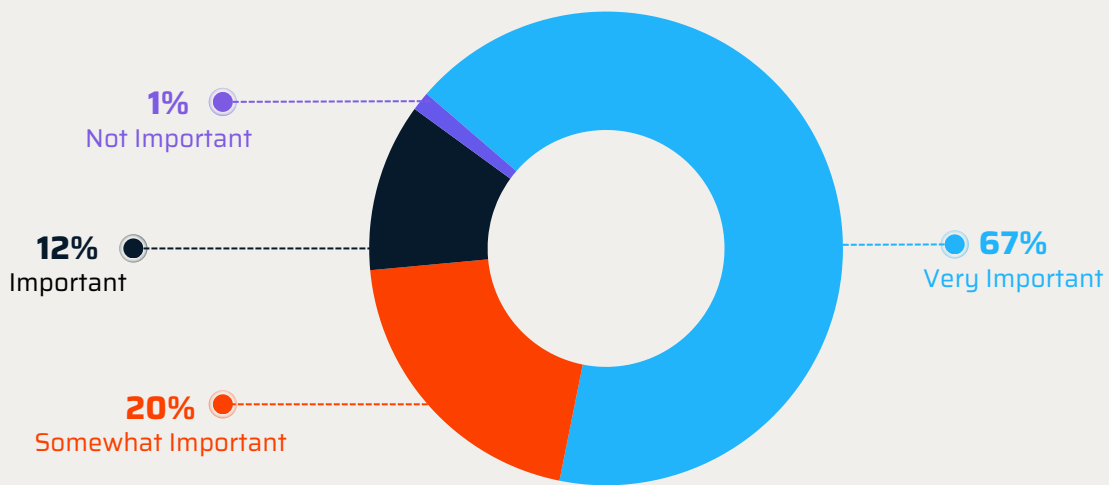
Founded in 1856 by Edward Charles Healey, The Engineer is a London-based monthly magazine covering the latest innovations in engineering and technology in the UK and internationally.



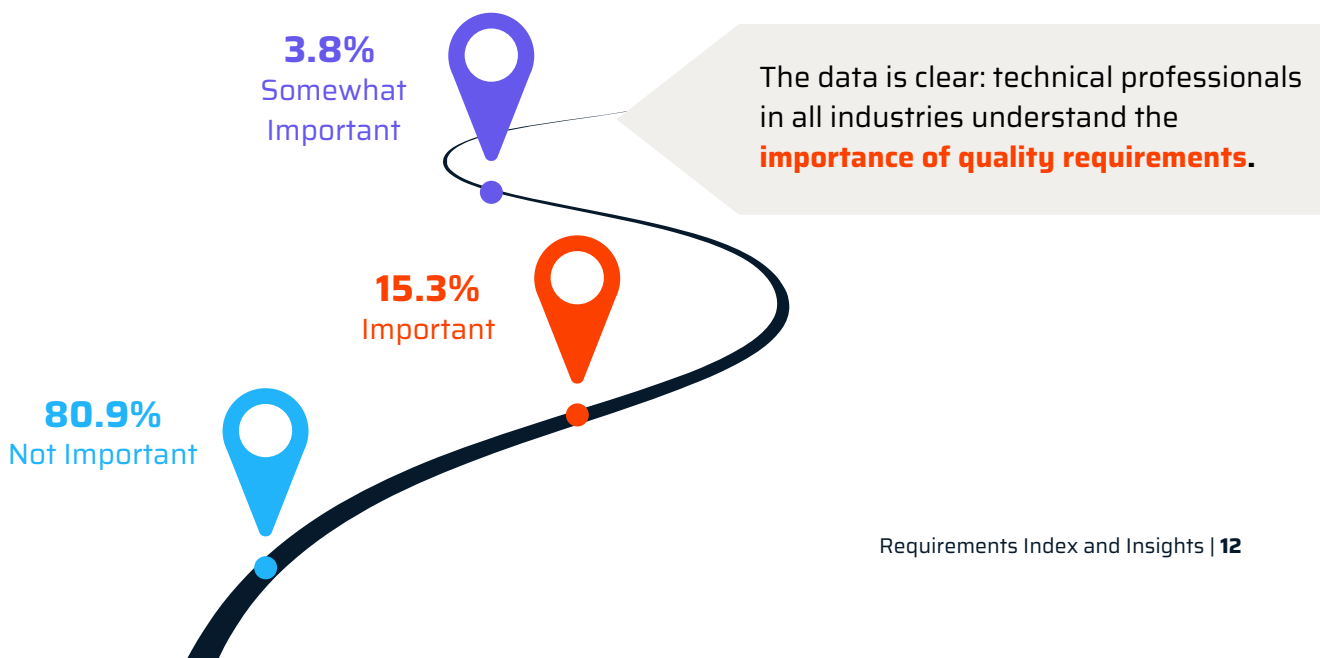
THE ENGINEER

A PREVIEW FOR REQUIREMENTS LEADERS INTERESTED IN UNDERSTANDING INDUSTRY NORMS

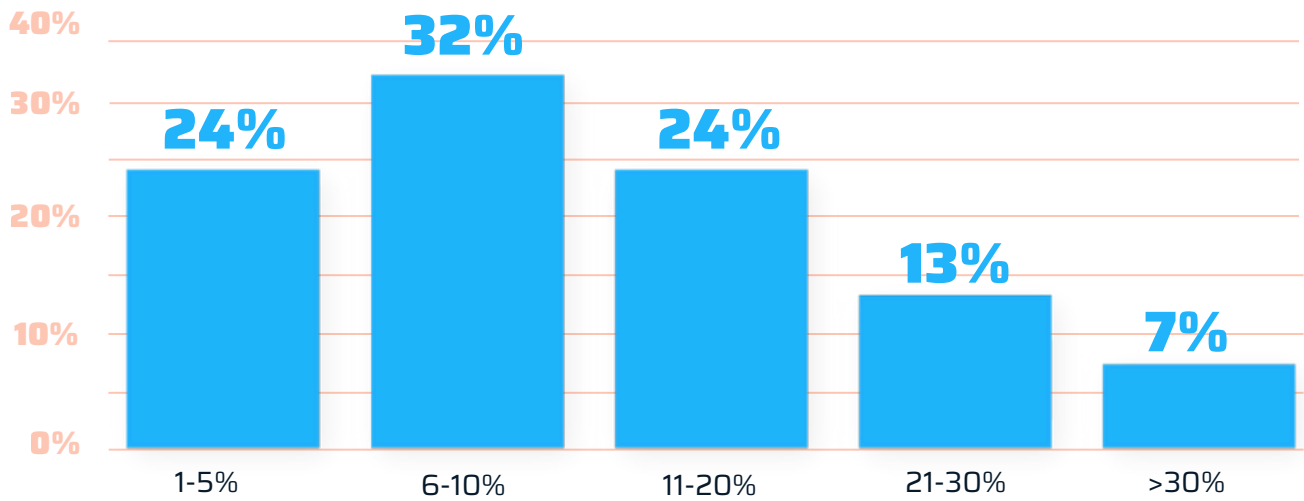
How Important to a Successful Product or Project Outcome Does **Your Organization** Consider the Quality of the Technical Requirements?



How Important to a Successful Product or Project Outcome Do **You** Consider the Quality of the Technical Requirements?

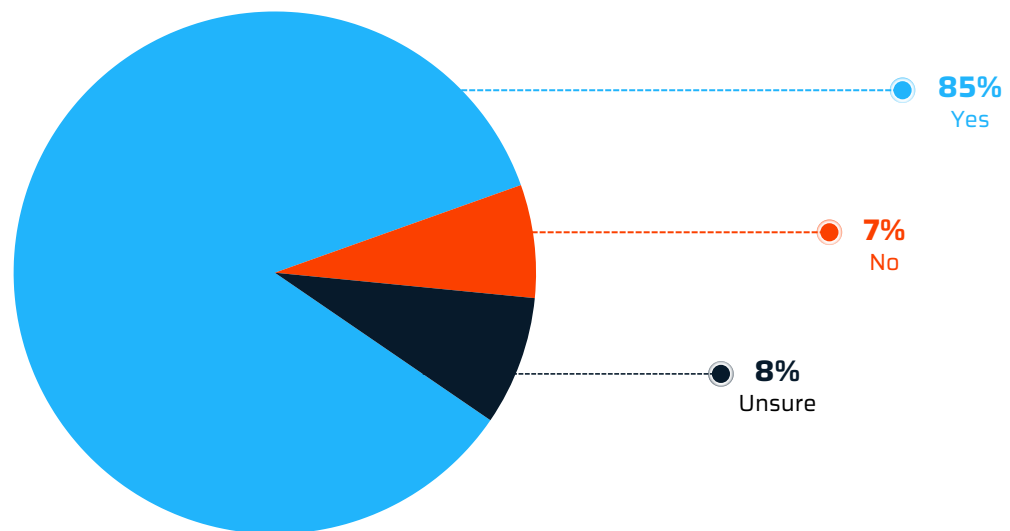


What Percentage of the Total Project Budget Is Allocated to Creating and Maintaining Requirements?



Industry leaders invest in **human capital and technology at the requirement stage**, embedding innovation throughout every stage of the engineering process.

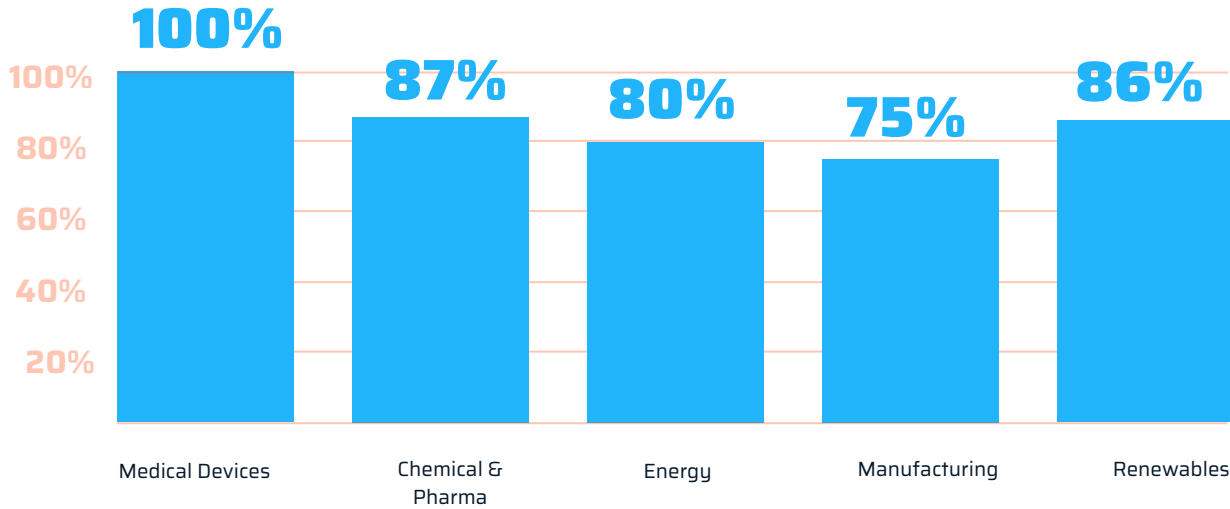
Do You Have Tools and Processes in Place to Manage and Process Technical Requirements?



INDUSTRY BREAKDOWN

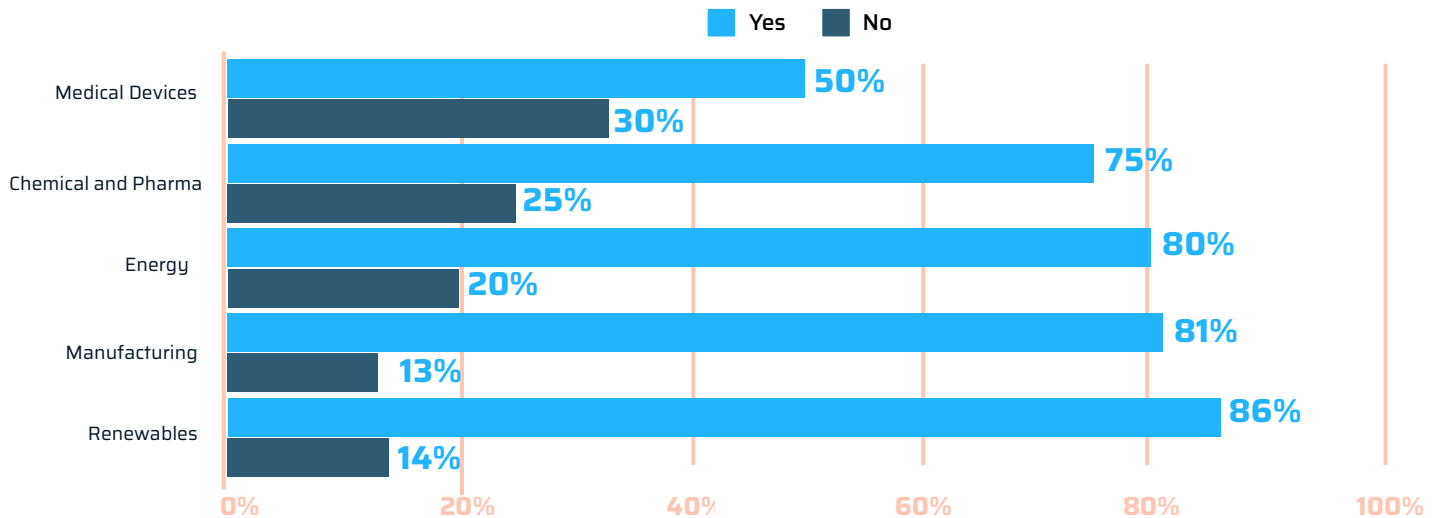
Segmenting the data by industry results in tailored insights and statistical benchmarks allowing your team to navigate the specific dynamics of your industry.

How Important to a Successful Product or Project Outcome Do You Consider the Quality of the Technical Requirements?



Engineers in the medical device industry prioritize **high-quality technical requirements** due to the critical need for regulatory compliance, patient safety, and managing the complexity of their products. However, the industry might need a software upgrade.

Do you have Tools and Processes in Place to Manage and Process Technical Requirements?



INDUSTRY BREAKDOWN, CONTINUED

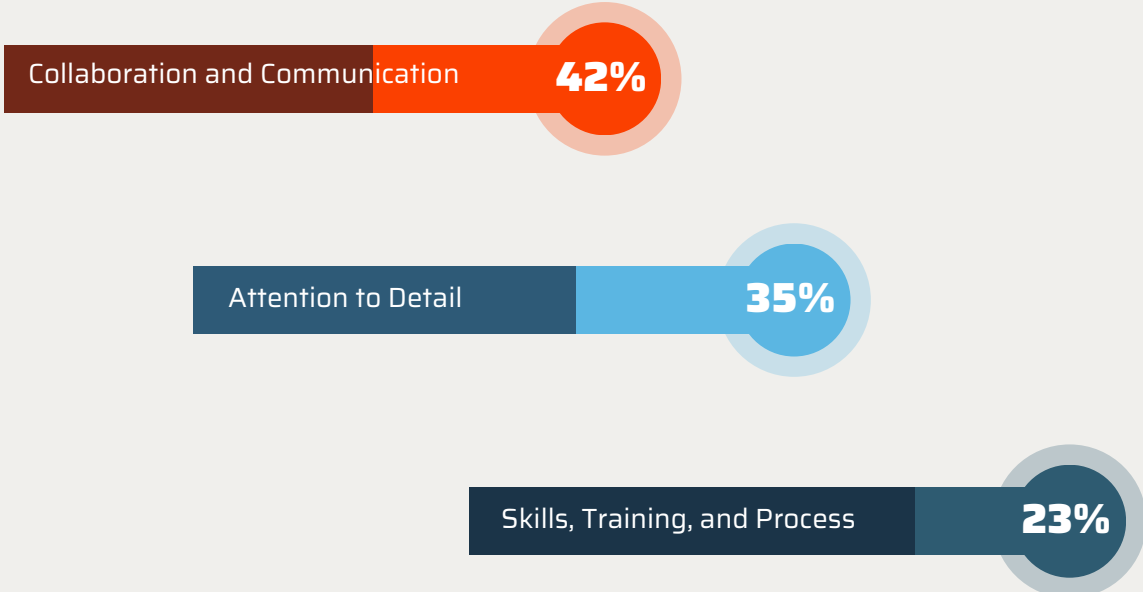
Each industry is different and pinpointing those differences and how they impact requirement quality is essential to engineering success.

From our automotive-specific infographic, “**Navigating the Road Ahead**” we get a better, industry-specific understanding of what makes a successful requirement author.



Automotive Results

What Would You Consider To Be the **Most Significant Differentiator** Between Requirements Writers That Produce Top Quality and Those That Produce Low Quality?



The automotive industry must prioritize communication and collaboration to enhance their requirements process.

Investing in communication tools and fostering a collaborative culture will significantly improve the quality of requirements and lead to a comprehensive understanding of engineering project needs.

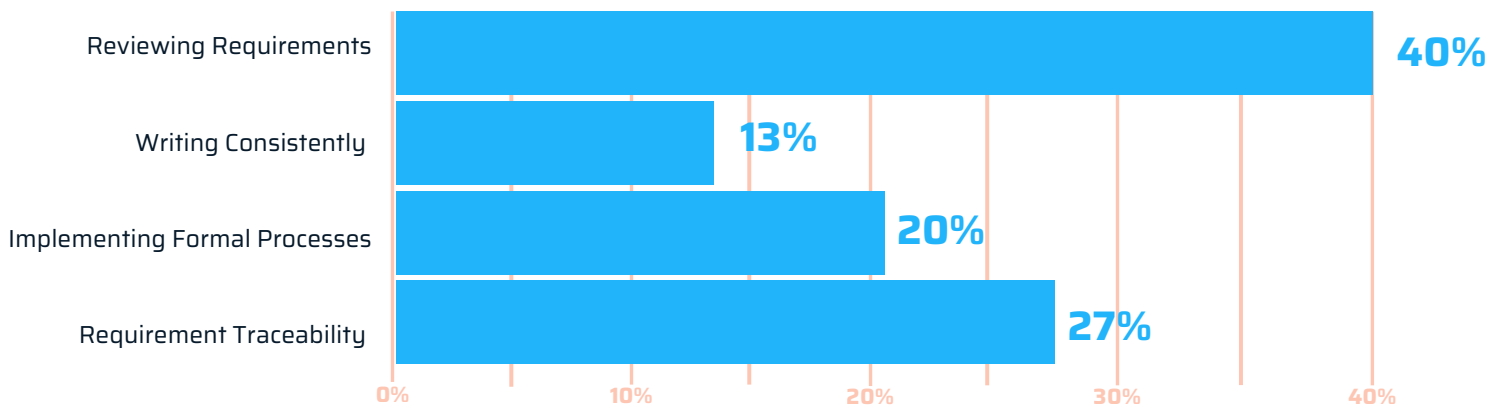
INDUSTRY BREAKDOWN, CONTINUED

“Navigating the Skies and Beyond” our Aerospace infographic, highlights gaps in the current requirement authoring process illustrating that this industry specifically could benefit from a stronger requirement review process.



Aerospace

For Which Aspects of the Requirements Process Would Your Team Benefit From Having Additional Support?



Creating quality requirements goes beyond just following standard protocols. It requires a deep understanding of the unique challenges and nuances within your specific industry that might prevent achievement.

By implementing tools that improve communication, setting up a thorough review process, and maintaining high-quality assurance standards, you can develop a well-rounded strategy for long-term success.



DIVE INTO THE DETAILS: LEARN MORE ABOUT YOUR INDUSTRY'S REQUIREMENTS



Automotive



Medical Devices



Renewables



Civil & Structural



Aerospace

Navigating the Skies and

A Comprehensive Look at The Current State of Requirements in the Aerospace Industry

QRA and The Engineer partnered to conduct a comprehensive research survey aimed at illuminating the intricate relationship between organizational processes and quality requirements.

Drawing insights from the responses of more than 150 engineering professionals across diverse industries, this survey delves into the challenges and opportunities surrounding requirements, offering a nuanced understanding of current landscapes.

Segmenting the data by industry results in tailored insights and statistical benchmarks allowing your team to navigate the specific dynamics of your industry.

Do You Have Tools and Process In Place to Manage and Process Technical Requirements?

100% YES

How Important to a Successful Product or Project Outcome Does Your Organization Consider the Quality of the Technical Requirements?

75% Very Important, 25% Somewhat Important

How Important to a Successful Product or Project Outcome Do You Consider the Quality of the Technical Requirements?

13% Somewhat Important

Fuel for Thought

A Comprehensive Look at The Current State of Requirements in the Energy Sector

QRA and The Engineer partnered to conduct a comprehensive research survey aimed at illuminating the intricate relationship between organizational processes and quality requirements.

Drawing insights from the responses of more than 150 engineering professionals across diverse industries, this survey delves into the challenges and opportunities surrounding requirements, offering a nuanced understanding of current landscapes.

Segmenting the data by industry results in tailored insights and statistical benchmarks allowing your team to navigate the specific dynamics of your industry.

Do You Have Tools and Process In Place to Manage and Process Technical Requirements?

80% Yes, 20% Not Sure

How Important to a Successful Product or Project Outcome Does Your Organization Consider the Quality of the Technical Requirements?

60% Very Important, 40% Important

How Important to a Successful Product or Project Outcome Do You Consider the Quality of the Technical Requirements?

20% Important

Navigating the Road Ahead

A Comprehensive Look at The Current State of Requirements in the Automotive Industry

QRA and The Engineer partnered to conduct a comprehensive research survey aimed at illuminating the intricate relationship between organizational processes and quality requirements.

Drawing insights from the responses of more than 150 engineering professionals across diverse industries, this survey delves into the challenges and opportunities surrounding requirements, offering a nuanced understanding of current landscapes.

Segmenting the data by industry results in tailored insights and statistical benchmarks allowing your team to navigate the specific dynamics of your industry.

Do You Have Tools and Process In Place to Manage and Process Technical Requirements?

94% Yes, 6% Not Sure

How Important to a Successful Product or Project Outcome Does Your Organization Consider the Quality of the Technical Requirements?

69% Very Important, 25% Important, 6% Somewhat Important

How Important to a Successful Product or Project Outcome Do You Consider the Quality of the Technical Requirements?

13% Somewhat Important



Defense & Security



Oil & Gas



Manufacturing



Energy



Pharmaceuticals

ABOUT QRA CORP

At QRA, we believe that too many high-value engineers spend too much time on low-value work. This underemployment restricts progress and ultimately limits society. Our central conceit is that recent technology, purposely applied, can expand humankind's reach, can wield complexity, and can help bring to life the most advanced cyber-physical systems. This fuels our mission to increase productivity in complex product development by 10x.

We build software tools that automate the generation, evaluation, and prediction of engineering artifacts necessary to specify, design, and certify the remarkable systems our customers build. Armed with our unwavering mission, and our core values of Tenacity, Agency, and Openness, we aim to deliver the right information, to the right people, at the right time. This is our path.

OUR INTEGRATIONS




IBM Rational
DOORS Next Generation



POLARION





For more information about QRA
and how we can help your
requirements process, visit

[gracorp.com/eds](https://www.gracorp.com/eds)