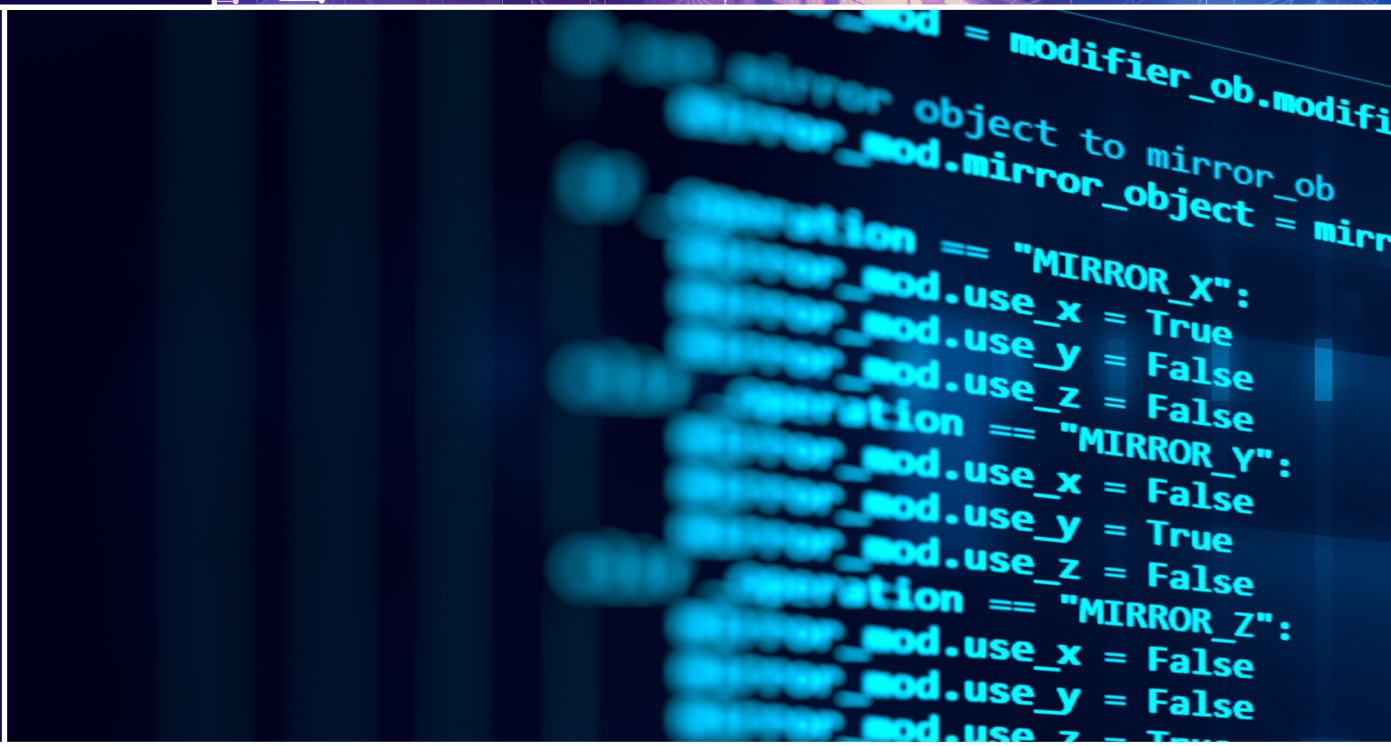
BlueOptima Global Benchmark Report

July to September 2021

Key Trends in the Global Software development Industry



Introduction

Welcome to the BlueOptima Global Benchmark (BGB) Report which provides insights into key trends from across the software development industry. The Report consists of data extracted from hundreds of thousands of software developers located in more than 30 countries, providing a quantitative analysis of their performance.

This Report is published quarterly with each Report containing data from the preceding 12 months. The data is analysed using BlueOptima's Developer Analytics platform to calculate Coding Effort (CE), which sets a global standard for measuring software developer productivity. Coding Effort is a metric derived from objectively measuring a software developer's work outputs, specifically changes in static source code metrics[1], and the context within which that output was delivered then benchmarking that against all other developers.

Coding Effort is used by large global enterprises to compare the productivity of software engineers across technologies and software development methodologies to deliver actionable insights to optimise the software development lifecycle.

Alongside productivity, the maintainability of source code changes delivered by software developers are measured using BlueOptima's Analysis of Relative Thresholds (ART). Analysis of Relative Thresholds is an objective measure of source code maintainability obtained by

1 Static Source Code Metrics are a family of software programming language metrics obtained from source code before a program is run. These metrics are gathered by analyzing source code before a program is compiled or executed.

using static source code metrics to evaluate how easy it is for a developer unfamiliar with the source code to deliver change into that source code. ART is described as 'quality' in this report. It is the proportion of Billable Coding Effort (BCE) hours spent delivering maintainable source code change.

The analysis within this report deliberately excludes part-time and hobbyist software developers. For example, those contributing to open source projects, as the economic cost and impact of their participation in these projects are indirect and unclear. The data employed in this analysis represents an approximated 2% sampling of the global enterprise software developer population.

About BlueOptima

BlueOptima's analytics platform empowers software developers and their companies to create better software in the most time and cost-efficient way.

The first solution of its kind, BlueOptima provides insight based on the world's only objective software developer productivity metrics: Coding Effort. It's a breakthrough for software development.

BlueOptima's SaaS platform facilitates analysis of productivity, together with quality, in enterprise software development, in terms of individuals, teams, tasks, projects, divisions, and outsourced suppliers. Understanding variations in performance across an enterprise empowers managers to optimize efficiency. BlueOptima is proven to identify savings of up to 20% for software budgets.

BlueOptima's further offerings around benchmarking and recruiting allow organizations to cost-optimize as early as possible in software initiatives.

Global Software Development Productivity Declines 4% in Q3 2021

The BlueOptima Global Benchmark shows that the software development industry continues to suffer from turbulence, with Q3 of 2021 reversing the recovery seen in Q2.

The industry leading quarterly Global Benchmark Report from BlueOptima is a quantitative analysis on the performance of the software development industry. Download the report at blueoptima.com/bgb-report.

Key findings:

- Global productivity has slowed, declining by 4% to 1.75 hours of Billable Coding Effort (BCE) / Day, reversing the previous gains and shows that the level of disruption hitting the software development industry is not yet over.
- Eastern Europe continues to be the most productive region, and increased the average BCE / Day by 2% in contrast to the second highest performing region (Western Europe), which dropped by 6%.
- Java continues to dominate enterprise applications, gaining an additional 3.5% of the overall share of language used this quarter at 28.5%.

The Global Trend

This quarter has seen a decline in productivity from the previous period, reversing the gains. There are a number of factors that may have influenced this, including the gradual opening up of economies and the disruption inherent in adapting to the new ways of working.

The quality of code delivered shows incremental improvement on the previous quarter, with the level of maintainable code reaching 94.22%, indicating that organisations are continuing to adhere to best practices and maintain their standards, even in the face of a decline in productivity. Historical trends indicate a continued decline due to the holiday season. In the next data set, it will be intriguing to see how the year-on-year trends compare.

Trends by Industry

Nearly all the economic sectors have decreased their productivity compared to Q2 2021, with the Healthcare sector declining once again from the prior quarter (-14.55%). Consumer Cyclicals bucked the overall trend by improving productivity by 11.53% to 1.67 BCE/Day, although it remained 4.5% below the global average BCE / Day.

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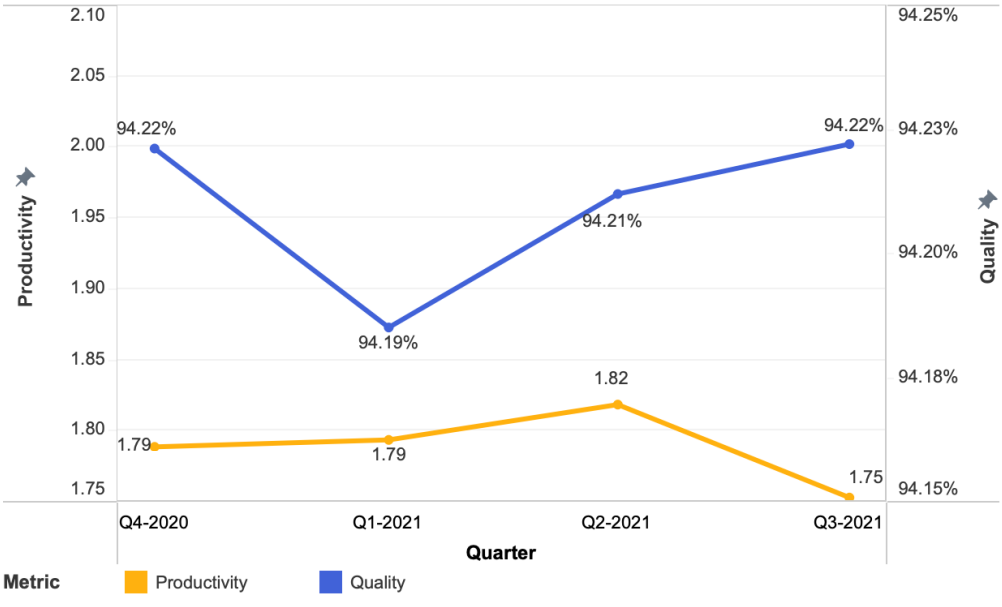
Global Trends

Global trends for this quarter have shown a drop in productivity and an increase in quality.

It is interesting to see that although software enterprises around the globe have started working on their "Back to Office" programmes, the productivity of developers hasn't yet reached pre-pandemic levels which is about 8% higher than the levels currently observed.

In fact, productivity has declined by a further 4% from what it was 12 months ago, which was during the middle of the pandemic. However, although quality has fluctuated over the past 12 months it has returned to the same level it was 12 months ago (i.e. Q4 2020). This suggests that the maintainability of source code delivered by developers return to pre-pandemic levels faster than productivity. Large scale studies show that better maintainability of source code is proven to result in greater productivity, perhaps this is the beginning of the return to productivity.

Figure 1 (below): Shows the Global Productivity and Quality Trend in Software development over the last four quarters. Productivity (Yellow) is expressed in Billable Coding Effort per Developer per Day. Quality (Blue) is expressed as the percentage of maintainable code delivered.



Economic Sector Performance

Over the last quarter, nearly all economic sectors saw a decrease in productivity compared to Q2 2021. The previous quarterly report demonstrated a tight clustering of all economic sectors. However, in this report we have seen both Consumer Cyclicals and Healthcare move away from the other sectors with quite significant changes, particularly in productivity. A notable movement for this data set was Consumer Cyclicals, which is now the most productive economic sector, delivering 2.07 Billable Coding Effort (BCE) /Day (14.55% increase compared to Q2 2021).

Healthcare showed the second largest drop for the quarter but in a less desirable direction than Consumer Cyclicals, with a decrease of 11.53% to 1.67 BCE/Day. Interestingly, for the past three quarters Healthcare has continued to decline in both productivity and quality. In this quarter, Healthcare has the lowest productivity and the least maintainable code compared to all other economic sectors.

The Technology and Industrials sectors show similar drops in productivity compared to one another, of 5.34% and 6.66% respectively. Whereas the sector showing the greatest stability is Financial Services, although it did see a fall of 2.71% from the previous quarter but this is only slight compared to the other sectors.

As for quality, each economic sector has seen a relatively minor change with Healthcare and Technology experiencing minor drops compared to the other three sectors (Consumer Cyclicals, Financial Services and Industrials), which have demonstrated a marginal increase of less than 0.50%.

Overall, we have seen the Financial Services sector demonstrate fairly consistent results from the prior quarter to this quarter, this might reflect broader stability in that economic sector through the pandemic. Healthcare, on the other hand, have probably been more directly affected by the

pandemic going into 'crisis mode' at the outset and therefore are most likely over committed during COVID in order to keep up. Perhaps we are now seeing the sector slow down as it starts to recover which would suggest it will eventually rise again to a new normal. The economic recovery has been strong across the Organisation for Economic Co-operation and Development (OECD) and Consumer Cyclicals could be exhibiting uplift as they move into the recovery.

Figure 2 (below): The size of the bubbles represents the global population of software developers in each industry. The colour represents the different economic sectors.

Greatest Changes

14.55%

increase compared to Q2 2021

CONSUMER CYCLICALS

-11.53%

change from the previous quarter to 1.67 BCE/Day

HEALTHCARE

Regional Performance

When considering geographical regions, this quarter's results demonstrate minor fluctuations across regions in both quality and productivity.

Notably, all regions have experienced a drop in productivity, with the exception of the Eastern European region, which has seen a 2% increase in productivity compared to the last quarter. The Eastern European region, consisting of 1.8M developers or 8% of the global total, continues to be the most maintainable and productive region. A trend that has been observed for over two years and an area that has had little fluctuation.

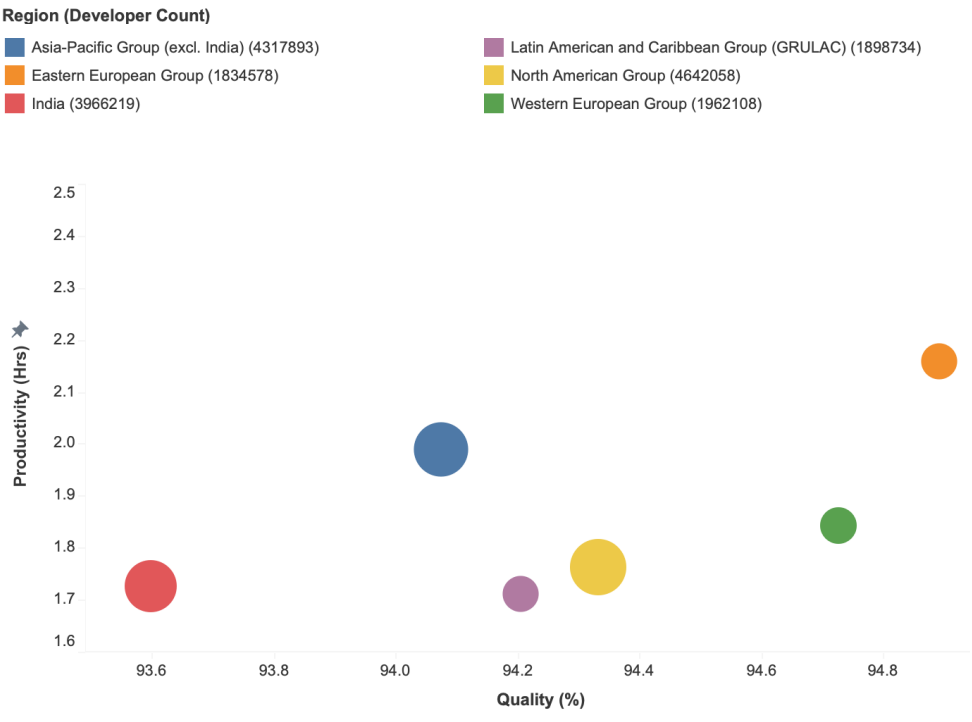
This quarter we have seen a drop in productivity (5.69%) for the Asia-Pacific group (4.3M developers) yet it is still the second most productive region.

Meanwhile, India (with 3.9M developers) has maintained largely consistent productivity compared to the previous quarter. However, their code delivery is the least maintainable of all the regions at 93.67%.

Unfortunately, the North America, Western European and the Latin American and Caribbean Group (GRULAC) regions have all experienced a drop in productivity. North America has seen a decline from 1.83 BCE/Day to 1.76 BCE/Day which equates to a 3.81% drop. Western Europe fell by 6.08% with a quarterly result of 1.84 BCE/Day. GRULAC exhibited the lowest productivity across all regions for the quarter but not the greatest decline, yet their quality score (94.21%) saw no significant change for the period.

Overall, the regions have seen a decline in their productivity this quarter although their quality has remained stable.

Figure 3 (next page): The size of the bubbles represents the global population of software developers in each region. The colour represents the different geographical regions.



Top three most productive regions

2.15

hours of coding effort delivered per day per developer

EASTERN EUROPE

1.99

hours of coding effort delivered per day day per developer

ASIA-PACIFIC

1.84

hours of coding effort delivered per day day per developer

WESTERN EUROPE

Regional Cost Efficiency

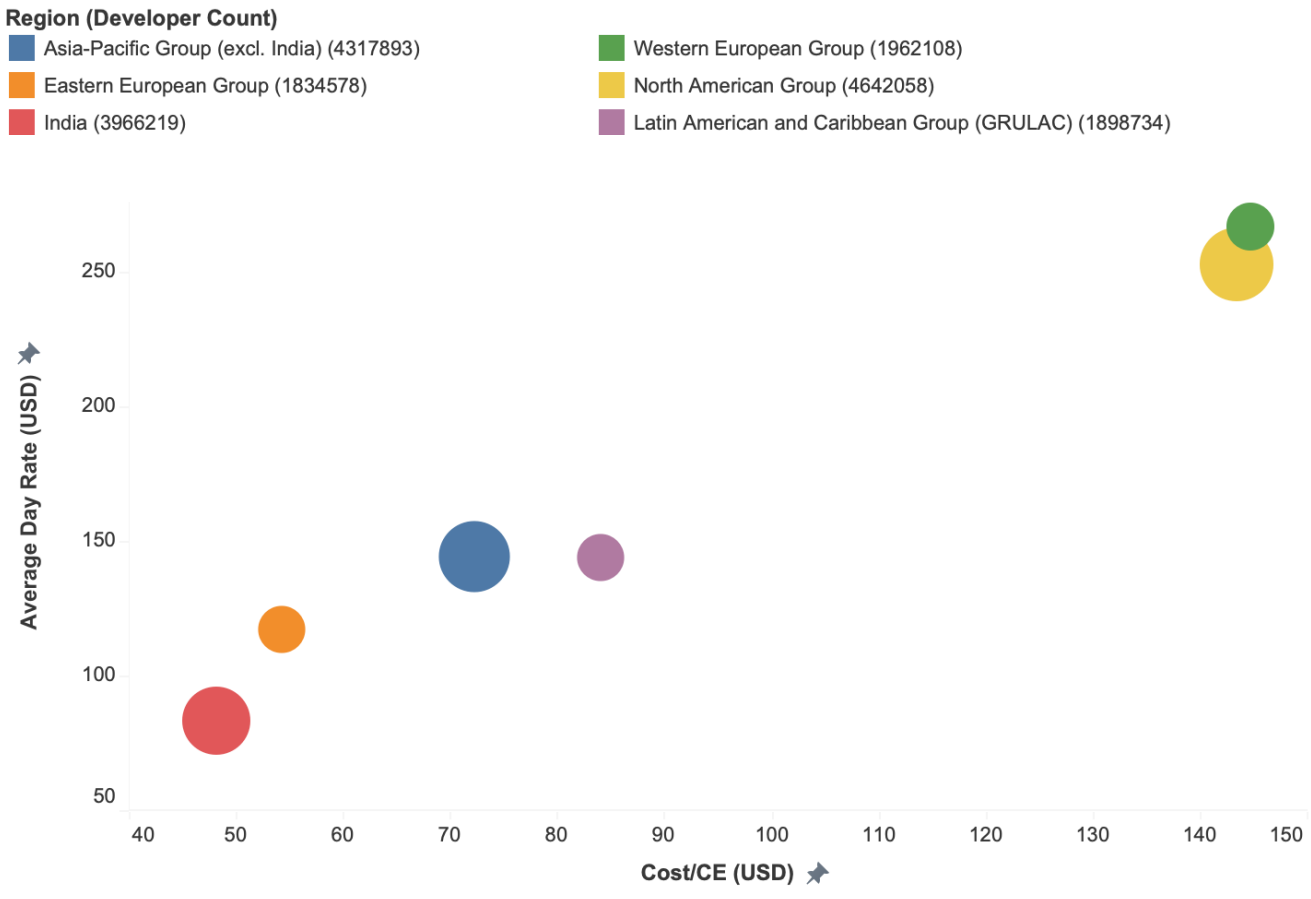
In this section we will further elaborate on the above regional breakdowns and take a dive into the cost efficiency for each region. Cost efficiency is measured by evaluating the cost of paying developers (USD/Day) and their cost per unit of Coding Effort delivered.

In the previous report for Q2 2021, Western Europe had the highest Average Day Rate (ADR), which remains true for this quarter at $144.77, a 6.47% increase from the previous period. Unlike the previous quarter there is only a $1.35 (USD) difference between the cost per Coding Effort (CE) hour for Western Europe and North America ($143.41). Comparing the region's results for the previous quarter, North America experienced a 3.96% increase, which encompassed 4.6M developers.

In the Asia-Pacific region (4.3M developers), we saw a 6.03% increase in cost per Coding Effort hour to $72.34 CE/hour. Similarly, the Latin American and Caribbean Group (GRULAC) region has demonstrated a gain of 5.66% across a developer population of 1.8M. There has only been a slight variation compared to the prior quarter for both Eastern Europe and India. Eastern Europe has seen a reduction in the region's cost per hour to $54.30 CE/hour. Alternatively India has demonstrated a slight gain of 1.29% to $48.22 CE/hour.

Overall, Eastern Europe and India remain the regions with the lowest cost to deliver an hour of Coding Effort. Eastern Europe has the highest productivity whereas India has the second lowest level of productivity. Interestingly, this would suggest that in Eastern Europe fewer developers are required for project deliveries to execute the same amount of code, which in turn would positively impact managers as well as overhead costs.

Figure 4 (below): The size of the bubbles represents the global population of software developers in each industry. The colour represents the different geographical regions.



Top Enterprise Technologies

This section discusses developer languages and the top nine languages with the greatest market share.

In the previous quarter we saw Java as the language of choice across enterprise software development, which remains true for this quarter too. It accounts for over a quarter of Coding Effort (CE) delivered globally within our sample size at a use rate of 28.5%, an increase of 1.4pp from the previous period.

Interestingly, XML remains the dominant mark-up format convention for configuration although it has decreased slightly compared to the previous quarter from 8.5% to 7.9%.

This period we saw the popularity of YAML continue to rise as it slowly inches closer to XML every quarter. YAML increased from 5.9% in Q2 to 6.5% for this quarter.

JSON has moved several places in popularity from eighth place to five, although there was only a slight fluctuation of 0.40pp from the previous quarter. Whereas C# has seen a significant drop from fourth place all the way down to eighth place, demonstrating the highest fluctuation for the period with a drop of 2.4pp.

Overall the top three languages have remained consistent from the previous quarter. The languages to watch are JSON and C# as they have shown quite a bit of movement lately. If this quarterly snapshot is anything to go by, JSON is on the rise and C# is falling fast in popularity.

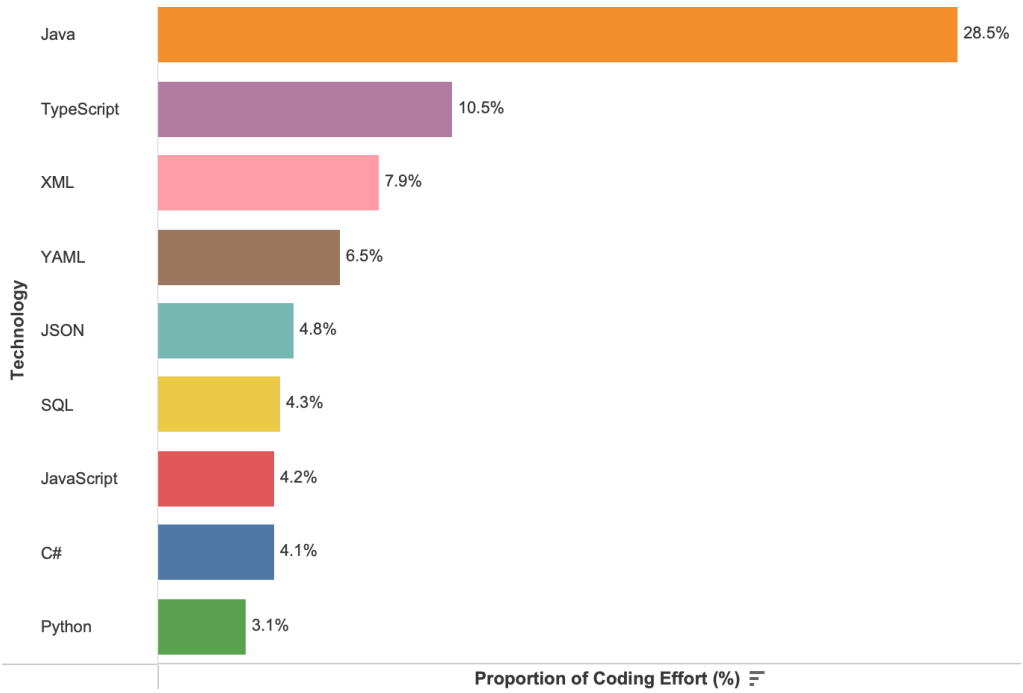
Top three languages

28.5% development done using **JAVA**

10.5% development done using **TYPESCRIPT**

7.9% development done using **XML**

Figure 5 (below): Shows the source file types within which Coding Effort (CE) is invested by enterprise software developers.



Languages to Watch?

JSON

moved up four places this quarter

C#

dropped from fourth to eight this quarter

Let's set the scene...

How have you and your team established standards for authentication and identification of Git committers? Interestingly, many organisations have enabled an environment where identification is not always connected to commits that are made within their Version Control System (VCS). An important aspect which can often be overlooked by organisations although the attribution of code to a professional identity is crucial to enabling efficient, precise and well managed code.

Whilst most enterprises tightly monitor access to their systems, and who can make commits to their code base through stringent authentication processes, many companies overlook identity management. An incredibly crucial aspect of any software team's processes. Why? This could potentially be due to the default configuration of Git, which allows developers to commit code with an arbitrary identity after they have moved through the authentication process. This is a configuration capability with Git that is not appropriate in an enterprise software development context.

Unfortunately, it requires a significant amount of configuration effort in large-scale Git deployments to change this so that code is only committed using a company-approved email or ID as your identity. In an enterprise software development setting, the audit trail is of the utmost importance. Employees will join and leave an enterprise every two to three years and the roles and projects that they carry out throughout their time with an enterprise will change. In a knowledge intensive endeavour such as software development an absence of accountability and traceability of team members leaves systems open to error and lack of reliable history hampers attempts to rectify those errors or make it more resilient to errors in the future.

BlueOptima's Data Science team analysed over 600,000 enterprise developers worldwide, and identified that a significant proportion of code delivered by them is committed using a personal email address as an identity, effectively allowing anonymous commits to the VCS. The study showed that on average, 11% of an organisation's identities which are used to commit code are personal email addresses, a number which can have a significant impact on the ability of an organisation to efficiently deliver code change in a traceable and accountable fashion. As software becomes an increasing systemic risk for businesses this is a considerable liability.

What is the impact?

The impact of anonymous or untraceable commits will vary within each organisation but there are a couple of underlying issues that consistently contribute to the phenomena. First, a lack of identity management results in being unable to identify and hold developers, project managers, scrum masters, and configuration managers accountable for the changes that have been made. Second, unidentified commits impair team collaboration as people are unsure of who to discuss certain actions with, which can range from learning and development opportunities through to understanding alternative perspectives on systems architectures or managing joint tasks.

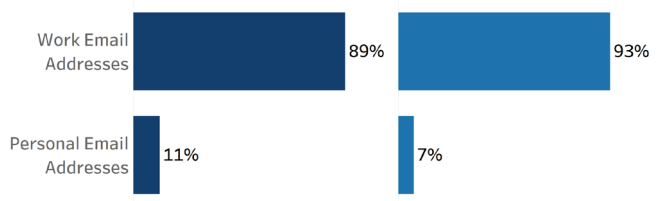


Figure 1 (above): Percentage of logins using a personal email address as their identity and percentage of Coding Effort (CE) from those logins.

Strong processes enhance the security, efficiency, quality and productivity of a team. Findings showed that 11% of logins and 7% of all Coding Effort hours were delivered by anonymous or personal email addresses. Whilst there was no indication that these commits were made anonymously deliberately or with malicious intent, it does impact the team's ability to manage and maintain their code base.

Finding the Solution:

The answer is implementing tools that increase transparency, and putting in place governance around Git commits. For example, implementing BlueOptima's Developer Analytics (DA) tool increases transparency by consolidating commits across multiple identifiers to individual contributors, and Git pre-commit hooks enable you to programmatically prevent commits being made unless the identity of the committer is from an approved domain.

Through this combination we have seen BlueOptima clients improve the percentage of logins via work email addresses drastically, resulting in a reduction of 12 points. Initial results showed that 13.5% of commits

were made anonymously, whereas after implementing the changes to mitigate the issues identified by Developer Analytics, anonymous commits reduced to 1.8%, which was an astounding 87% decrease in the share of unidentified commits.

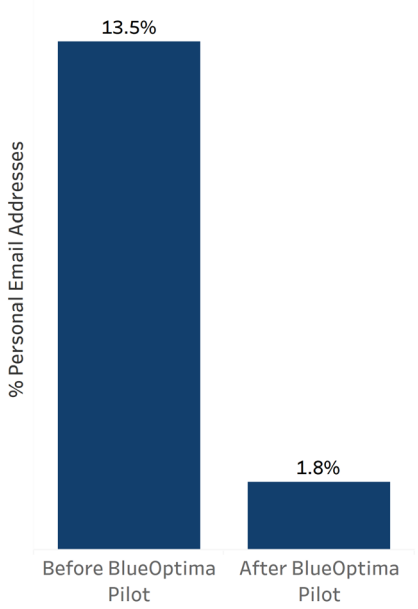


Figure 2 (above): Percentage Git identities using a personal email address.

The transparency driven by BlueOptima's analytics allows organisations to not only take steps to mitigate the issue of incorrectly-identified commits, but in many cases, bring to light the extent and potential impact of the issue.

Why and how will this add value?

The benefits seen by our clients have included greater visibility of the changes made and this value can be seen through:

- Managers are able to empower staff through identifying issues or areas of improvement and take action to support staff.
- Variations to best-practice can be reviewed and improved for the future, possibly through education or perhaps this provides an alternative method that might help to improve future practices.
- Credit and recognition can be given to outstanding individuals, who might have been overlooked in the past.

Afterall, if you don't have full visibility across the work that is being completed, how can you improve for the future?

More about the Report's Data

Proration Methodology Changes

BlueOptima has made significant improvements to our proration logic, particularly when handling infrequent committers or those with an extended break from the code base, this change significantly increases productivity. In order to ensure the comparison between the two quarters is statistically justifiable the previous quarters data has been recalculated in this report so both quarters are using the same proration methodology and hence a comparison on productivity can be made.

Coding Effort

Coding Effort is calculated by statistically evaluating every source code change made by developers in terms of 36 static source code metrics measuring various aspects of Volume, Complexity, and Inter-relatedness while considering the context worked in e.g. a complex legacy software component or a brand new project.

Analysis of Relative Thresholds (ART)

ART is a measure of the quality (specifically: maintainability) of source code. It is calculated by evaluating the proportion of code which is aberrant, relative to the codebase in which it sits. Code is flagged as aberrant when it violates certain internally benchmarked statistical thresholds, across a number of static source code metrics.

BlueOptima Population Sample

The analysis in this report is based on a sample of nearly 100,000 software developers across the world, including 40,000 in India, 15,000 in North America, 12,000 in Western Europe, 4000 in Eastern Europe, 5,000 in the APAC region (excl. India & China), 3,000 in China, and 6,000 in Latin America and the Caribbean. Africa and the Middle East, which represent an estimated 6.8% of the global developer population, have been omitted from this analysis due to insufficient sample size. All data used is anonymised and aggregated.

Global Software Developer Population

BlueOptima uses a sampling technique in calculating the performance of software engineers across various geographical regions and industries globally. BlueOptima has estimated the global software developer population using a combination of accredited sources and predictive modelling.

The global population of software engineers across various geographical regions according to the BlueOptima Global Benchmark are 3,966,219 in India, 4,642,058 in North America, 1,834,578 in Eastern Europe, 1,962,108 in Western Europe, 4,317,893 in the APAC region (excl. India), and 1,898,734 in Latin America and the Caribbean. Africa and the Middle East, which represent an estimated 6.8% of the global developer population, have been omitted from this analysis due to insufficient sample size. All data used is anonymised and aggregated.

Estimates of the total number of developers per region are derived from the following sources using a process of harmonising the data sources and arriving at a best-estimate across all sources: IDC Worldwide Developer Census, Evans Data Global Developer Population and Demographic Study, Stack Overflow State of European Tech, Statista, and World Bank Open Data.

Business Classification

The classification of organisations into Economic Sectors, Industry Groups, and Industries is done using The Refinitiv Business Classification. Estimates of the numbers of enterprise software developers in Economic Sectors, Industry Groups, and Industries is done by measuring various proxies of software developers in a firm (e.g. annual revenue, profit, assets, and headcount of each organisation) on a per industry basis and optimising estimation of this against the known developer population in a subset of the those organisations that are known to BlueOptima. Once this industry level estimate is arrived at, constituents of the Global 2000 are evaluated and their developer populations estimated. The relative proportions of developers in Economic Sectors are then applied on a pro rata basis to the global software developer population.

This analysis is provided as a source of information in good faith based on sound underlying data. However, BlueOptima accepts no liability for any actions taken in reliance on this analysis.

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