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Understanding the Perception of Visual Analytics Adoption in Software Regression Testing - A Manager's Perspective

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ABSTRACT (MAX. 200 WORDS):

Software regression testing is an important activity performed continuously to assure the quality of software. However, it is an activity that is constrained by limited time and budget in Agile environments. Therefore, this study aims to explore the application of visual analytics by quality assurance managers to generate insights from data produced in software regression testing activities and investigates the perception of adopting visual analytics in software regression testing. The findings of the study reveal that the intention to use visual analytics in software regression testing is influenced by its perceived usefulness, perceived ease of use, perceived benefits, challenges, and barriers and therefore forms the basis for developing an extension to the Technology Acceptance Model 2 for future researchers to consider when adopting visual analytics in software regression testing. The study concludes that the advantages of visual analytics outweigh its barriers and challenges and encourages QA managers to adopt it in software regression testing to alleviate its constraints.

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List of Abbreviations

1. Quality Assurance (QA)
2. Software Testing (ST)
3. Visual Analytics (VA)
4. Extended Technology Acceptance Model (TAM 2)
5. Regression Testing (RT)
6. Information Systems (IS)
7. Information Technology (IT)

Acknowledgements

1 Introduction

Data is revolutionizing many aspects of businesses nowadays fuelled by the increased usage of information systems (IS). The increase in data generation warrants a demand for analysing it rather than merely extracting it (Nestorov, Jukic & Rossi, 2019) and brings with it challenges when making decisions (Köpp, Mettenheim & Breitner, 2014). Visualizing analysed data is an important aspect of data-driven processes as it allows humans, together with analysing the data, to support sensemaking (Cui, 2019), discover insights from them (Kielman, Thomas & May, 2009), and support decision making (Simoff, Böhlen & Mazeika, 2008). The disciplines of software quality assurance (QA) and visual analytics (VA) gave rise to important technologies that involve a certain magnitude of interaction with data (Cui, 2019; O'Regan, 2019; Narciso, Delamaro, & Nunes, 2013).

The importance of SQA has gained momentum with the increase in the size and complexity of software development projects. SQA is a vital process in a software development project needed to ensure that the requirements of a software product are met as mentioned by Crosby (1986 cited in Seah & Yap, 1993) and with confidence (Seah & Yap, 1993). It is also a vital part of IS development (ISD) needed to prevent critical failures (Calikli, Bener, Caglayan & Misirli, 2012). The quality of a software product is one of the most critical decision-making variables needed to determine its time to enter the competitive market (Feng, Jiang & Liu, 2018) requiring high commitment and actions from IS managers to achieve the expected level of confidence in software quality (Seah & Yap, 1993; Ravichandran & Rai, 2000). Failure to meet the quality requirements of a software product can be costly to companies (Ambrose & Chiravuri, 2010; Herrera & Ramírez, 2003) and can lead to loss of customers (Reynoso & Sandoval, 2008). Surprisingly, Paynter (1997) and (Calikli et al. 2012) claim that it is the costliest technical effort included in the software development process and statistically accounts for 30 to 40 percent of the overall project effort.

One of the key actions needed to achieve and assure the quality of a product is software testing (ST) (Whyte & Mulder, 2011; Li, 1988; Memar, Krishna, McMeekin & Tan, 2017; ISO, 2011). ST received significant attention with the surge in software development projects and with the increase in the complexity of software development processes (Baumgartner, Klonk, Pichler, Seidl, Tanczos & Mastnak, 2021) to ensure that requirements are correctly implemented (O'Regan, 2019). It is done systematically through what is known as the execution of test cases serving as a set of actions needed to be performed on software (Dowie, Gellner, Hanssen, Helferich, Herzwurm & Schockert, 2005) to identify defects (Shi, Gillenson & Zhang, 2019). O'Regan (2019) describes ST as the act of verifying that clients' requirements have been correctly implemented and the act of capturing "as many defects as possible" (p.59). Hence it provides means to assure the quality of software according to specifications and requirements (Memar et al. 2017; Maletic, Soliman &Moreno, 1999). Therefore, ST is vital to reduce costs related to software development but achieving higher quality in software products brings with it challenges as it is often coupled with extra development time and delays in product release to the market (Feng, Jiang & Liu, 2018) putting more pressure on QA managers to streamline their testing efforts to overcome the aforementioned challenges. This is significant and challenging in companies adopting agile practices in their software develop-

ment projects, as the agile approach advocates the principle of responding to change and delivering working software in a short time, iteratively, and continuously (Agile Manifesto, 2001) and therefore warrants repetitive testing on software to assure that such continues changes do not cause new software bugs on the unchanged part of the software (Govil & Sharma, 2021; Pressman, 2005). Such type of ST activity is called regression testing (RT) (IBM, n.d.; Sharma & Govil, 2021) and plays an important role in maintaining the quality of software (O'Regan, 2019), especially in Agile development projects (Baumgartner et al. 2021). Despite the importance of ST, several challenges are coupled with this process and are inherited to RT as a result since RT is part of ST (O'Regan, 2019; IBM, n.d.; Sharma & Govil, 2021). Braa and Øgrim (1995) brought to light that ST is not merely a technical aspect, but also a social one that is accompanied by several considerations and challenges. Myers, Sandler and Badgett (2011) extend on the aspects of ST to mention that it also includes psychological factors. These challenges in ST can complicate the software RT process hence warrant managers to take systematic actions to lead the testing efforts (Seah & Yap, 1993) effectively and efficiently. Performing repetitive RT as part of agile practices to achieve the necessary product requirements and expectations means that test results can be stored and subjected to analysis (O'Regan, 2019) paving the way for generating a wealth of data.

However, Narciso et al (2013) acknowledge that the creation of large unnecessary and redundant data from testing activities is a prevalent issue. In response to this issue, technologies like VA have provided visual capabilities for humans to get insights from raw data, analyse, visualize, and generate knowledge from them (Cui, 2019). VA involves processes and techniques applied in analytical reasoning aided by interactive visual capabilities or features (Cook & Thomas, 2005). This entails that data can be extracted, processed, analysed, and visualized but more importantly generate knowledge through perception, as people working in the ST domain need appropriate insights on several aspects of the software to realize the advantage of VA in streamlining RT. Leveraging interactive visualization to fuse human perception in the data analysis process by taking advantage of the strength of graphical presentation (Keim, Mansmann, & Thomas, 2010) and exploiting its human-computer interaction abilities (Cook & Thomas, 2005) can provide an opportunity to improve and overcome the challenges of RT. The application of VA in ST promises efficiency for QA managers to detect software defects within a shorter time and enable reading and generation of enriched insights through dashboards and charts (Chang, Ziemkiewicz, Green & Ribarsky, 2009) and effectiveness through reducing the gross cost of testing (Li, 2018). Furthermore, VA brings a quicker and improved understanding of data for improved decision-making (Williams, Boland & Lyytinen, 2015). Other opportunities for VA include nearly real-time updates (Cook & Thomas, 2005) that can help QA managers expedite RT process.

1.1 Problem

Williams, Boland and Lyytinen (2015) shed light on the gap between the implementation of VA tools and their consumption by different organizational roles like managers who are not data-savvy or tech-savvy (Williams et al. 2015; Calikli et al. 2012). They call for further research to utilize VA capabilities in organizational roles beyond the responsibility of technical professionals and for practitioners to step beyond the inclusion of technical people roles in the adoption of VA in companies' processes (Ambrose & Chiravuri, 2010 ; Williams et al. 2015). This paves the way for the socio-technical roles like QA managers (Myers, Sandler & Badgett, 2011; Ravichandran & Rai, 2000) who perform ST as part of QA activities (Myers,

Sandler & Badgett, 2011; Ravichandran & Rai, 2000) to fill the research gap addressed by Williams et al. (2015) and to develop a framework for understanding the impact and adoption of VA in software RT from the QA manager's perspective. Such a managerial role in the ST domain is responsible for planning actions systematically to achieve confidence in the quality of software (Seah & Yap, 1993; Ravichandran & Rai, 2000). However, on the one hand, testing activities generate a wealth of data that can become problematic (Narciso et al., 2013), and on the other hand achieving the confidence in software quality through RT is often constrained by limited time, costs, and the demand of high technical skills (Whyte & Mulder, 2011). Also, Govil and Sharma (2021) brought to light that there are challenges addressed when adopting RT activities in Agile teams like exhaustive and time-consuming test cases maintenance and amendments, difficulties communicating RT results among team members, and the need to meticulously observe and interact with constant changes in the Agile environment.

Based on the identified gap and the challenges identified with software RT, VA adoption in RT can be used to address these issues. The adoption of VA through its capabilities can bring in opportunities for QA managers to explore raw data, analyse, visualize, and make meaningful insights and knowledge (Cui, 2019; Cybulski, Keller, Nguyen, & Saundage, 2015) from RT results that can enhance their job performance. In the context of management, Williams et al. 2015) showcase that having the managers' insights on the organization's historic data would ultimately serve them in making decisions after getting insights and analysing data, which can be suitable for a QA manager role to utilize VA in RT to streamline it. Other remedial elements of VA include reducing decision-making time, enhancing information processing, and minimizing perceived uncertainty (Perdana, Robb & Rohde, 2018). Such capabilities can pave the way also for measuring software quality which has been considered hard to achieve (Onita & Dhaliwal, 2011). We, therefore, in this research focus on studying the phenomenon to bridge the gap between VA technology and its lack of utilization in RT, mainly by understanding the perception of such adoption by QA managers from an individual perspective to alleviate the constraints of RT. Some researchers highlighted the impact of VA adoption on organizations not specific to QA (Daradkeh, 2018; Williams et al., 2015) but understanding the topic from an individual QA perspective remains to the best of our knowledge, untapped in the IS field. The foregoing statements divulge a gap within the IS discipline with respect to understanding the perception of adopting VA in RT. This warrants the topic to be studied from the IS discipline conforming to Sarker, Chatterjee, Xiao and Elbanna (2019) advocacy to add knowledge to the discipline, which we aim to do in this research.

1.2 Research Question

How do quality assurance managers perceive the adoption of visual analytics in software regression testing?

1.3 Purpose

This thesis, through a qualitative interview study with QA managers, aims to explore the application of VA to generate insights from data produced in agile software RT activities. It focuses on investigating a rather unexplored topic and attempts to fill the identified gaps of this

topic in the IS literature by extending TAM 2 model to gain new insights into this phenomenon (Bhattacherjee, 2012). It also aims to develop a framework for VA adoption in RT that fuses the characteristics of VA by understanding the QA managers' perception of it.

1.4 Motivation

ST and VA are two influential disciplines in IS. Software testing is a mature and well-established discipline (Ravichandran & Rai, 2000) while VA is gaining significant attention (Williams et al., 2015) and has progressed immensely during the previous years (Daradkeh, 2018) due to its capabilities in exploring and understanding data for various business purposes. We believe that this study has implications for research and practice by highlighting the various factors that QA managers should consider when adopting VA in the software RT process.

1.5 Delimitation

This research focuses on interviews with managers, team leads, or anyone who had managerial responsibilities in the domain of software QA. That means by default non-QA roles are excluded from this study. Since the field of ST is divided into several sub-fields, the focus of this paper is on software RT. Moreover, understanding the implementation aspects of VA in the RT process is not the focus of this research. Additionally, we are keen to understand the topic from an individual perspective rather than on an organizational level, hence the study does not take into account understanding the perception of such adoption on the job performance of other software development project stakeholders like software developers, project managers, or business analysts. Furthermore, the thesis does not intend to change anything in the testing process or activities, but rather to understand the perceived adoption of VA on it and how it can impact RT.

2 Literature Review

2.1 Software Quality Assurance

2.1.1 Software Testing

Throughout the thesis, several words will be used interchangeably to refer to QA personnel such as QA tester, tester, and QA engineer.

Definition of software quality and testing
According to Reynoso and Sandoval (2008), software quality measures the aspects that are essential for users to have in the software, that is plausibly defect-free, and can be measured concretely or abstractly. One activity that is used to measure and achieve quality in a software product is testing (Whyte & Mulder, 2011; Li, 1988). Several definitions of ST though have been described and interpreted. Onita and Dhaliwal (2017) define it as the process of ensuring that the users' business systems are met and are free of errors. Memar et al. (2017) extend on that to mention that ST provides means to assure the quality of software according to the extent they meet user requirements. Zhang, Windsor & Pavur (2001) add to the definition of ST as the ability to find failures in the software when it does not meet the requirements set by the clients. Shi et al. (2019) say it's important to assure that the functionality of software works fine through the execution of test cases whereby a test case is a set of input values, preconditions, and expected outcomes (Dowie et al. 2005).

Types of software testing
ST has different approaches and types. The most popular approaches are known as black box and white box testing (O'Regan, 2019; Li, 1988). The former deals with testing the application from the code level while the latter focuses on testing the application from a software interface level (O'Regan, 2019; Paynter, 1997). In other words, the black box testing environment assumes that the QA engineers cannot see the internal source code of an application while testing it but rather the external functionalities that are visible to the user (Myers, Sandler & Badgett, 2011). The type of software tests can be either business-oriented dealing with testing the functional requirements of software or technical-oriented dealing with testing the technical specifications of a software (Baumgartner et al. 2021). The former is thought to be more important than the latter as Shi et al. (2019) claim.

Roles in software testing
Testing roles can be divided within a department of an organization similar to many traditional job roles. A test manager usually plans the test cases, monitors, and approves the test results while a tester usually executes the test cases, evaluates them, and reports the results (Baumgartner et al. 2021). However, the authors also acknowledge that a test manager can perform the duties of both tester and manager as shown in figure 1.
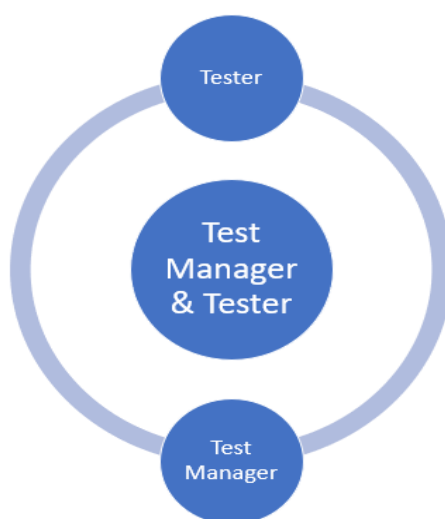
Figure 1. Tester as Manager (adapted from Baumgartner et al. 2021)

Aspects of software testing

ST is a broad domain and includes different aspects. Business success is largely dependent on the success of its systems which relies heavily on testing to achieve that (ISO, 2011). ST is a multidisciplinary field including both social and technical aspects (Braa & Øgrim, 1995; Ravichandran & Rai, 2000; Ambrose & Chiravuri, 2010). Myers, Sandler and Badgett (2011) extend on this and include the psychological factor that plays a vital role in ST.

From a **social perspective**, supported by Avgerou (1987), ISD includes not merely technical aspects but also social ones related to the technology being embedded in its social context, Braa and Øgrim (1995) extend this to explain that the user's experience is an important determining factor for evaluating the quality of software from a subjective perspective and argue that an objective evaluation of the software is not enough to guarantee the quality of a product. Instead, the subjective aspect of ST should be ideally measured by how much it fulfils users' requirements (Ravichandran & Rai, 2000; Dowie et al. 2005). This entails the importance of software quality in an organizational context. ISO (2011) further extends the significance of human-computer interaction in ST and identifies a set of characteristics that are used to measure the quality of software when users interact with it in a specific context. These properties measure the "degree to which a product or system can be used by specific users to meet their needs to achieve specific goals with effectiveness, efficiency, freedom from risk, and satisfaction in specific contexts of use" (ISO, 2011, n.p.).

From a **technical perspective**, it is composed of test cases that represent a set of inputs, execution requirements, and expected outputs employed to verify that the software complies with the users' requirements (Dowie et al. 2005; Wang, Zhu, Yang, Guo & Yu, 2018). ST is considered vital in measuring and ensuring the quality of an application (Khatibsyarbini, Isa, Jawawi & Tumeng, 2018), which is typically determined by the effectiveness and efficiency of the tests being conducted (Srivastva, Kumar & Raghurama, 2008; Rafael Lenz, Pozo & Vergilio, 2013; Tang, 2010). To accomplish this, the required domain expertise needs to determine whether the software under test is free of errors or not (Ashima, Shaheamlung & Rote, 2020), so that the defects can be reported and fixed during the life cycle of ST. This process

eventually acknowledges to the project stakeholders that the specifications and requirements in the software were met according to the customers' requirements (Khan & Sadiq, 2011). IEEE (2008) further extends the objectives of ST in providing the necessary proof that the product under test is resolving the right problem.

From a **psychological perspective**, Myers, Sandler and Badgett (2011) argue that human psychology plays the most important role in conducting ST. Wishing to test an application for the purpose of finding errors yields a higher chance and confidence of catching errors than assuming the software works properly and choosing test cases that generate successful results (Myers, Sandler & Badgett, 2011). Hence, the author suggests the best way to achieve confidence in ST is by exploring errors rather than assuming it works fine for a set of input test data (Myers, Sandler & Badgett, 2011). To achieve this level of confidence in ST, managers are required to set up systematic actions (Seah & Yap, 1993). Trust is another important outcome that can be achieved through ST (Paynter, 1997) that can have a direct impact on QA (Pressman, 2005). More recently, Calikli et al. (2012) stress the importance of human cognition in determining the quality of a product. One kind of social impact on ST is the notion of cognitive bias that involves people making subjective perceptions from the input they receive and is coined by Tversky and Kahneman (1982 cited in Calikli et al. 2012). It enables people to make judgments and decisions based on the limited time and the information they have (Hilbert, 2012) especially when the time to perform a decision is considered valuable as per Tversky and Kahneman (1982 cited in Calikli et al. 2012).

Challenges in Software Testing

ST is a domain that is not free of challenges. It includes several challenges like social, technical, and psychological (Calikli et al. 2012; Paynter, 1997; Nelson, Nelson & Wierwille, 2012).

From a **social-psychological perspective**, and given the importance of respecting short deadlines in agile testing (Agile Manifesto, 2001; Baumgartner et al. 2021), Çalıklı et al. (2012) think that cognitive bias is problematic in ST as it does not always guarantee quality assurance due to the need to follow a logical process when testing a software rather than a shortcut. This is aggravated by the inclination to perform testing on parts of software that may yield a probability of a successful result than not. Humans are prone to cognitive biases when experiencing things subjectively which can have a negative effect on ST (Çalıklı & Bener, 2013). The authors argue that software testers' tendency to test a software assuming it is working fine can lead to an increase in software defects as opposed to systematically testing it with an assumption that it has defects. This is also in line with Myers, Sandler and Badgett (2011) who argue that when testers constructively test a software assuming it works successfully, more errors will be found in the software as opposed to destructively testing it under the assumption that it contains defects.

From a **technical perspective**, achieving a body of evidence showcasing whether the right problem of a software product is achieved and whether the user requirements are met is often bound to limitations and considerations. For instance, due to the complexity of software projects and the increasing demand of users, there is a consensus among researchers that in order to achieve a body of evidence entailing the effectiveness and efficiency of the testing process, a trade-off is needed between the required time needed for testing and the scope of it (IEEE, 2008; Baumgartner et al. 2021; Garousi & Zhi, 2013; Wong, Horgan, London, Agrawal, 1997). This is more significant in agile testing whereby limited time is given for conducting

test activities taking into consideration targeting to meet high-quality standards of software (Baumgartner et al. 2021; Nelson, Nelson & Wierwille, 2012). Paynter (1997) touched on inefficiency issues caused by testing all programs in large systems and the need to find a selective way of choosing the test approaches to improve the quality of the program. Yet, the main scope of the paper was about suggesting a combination of test approaches to uncover errors related to internal and external functionalities of an application rather than focusing on the methodologies and implications of selecting specific test cases (Paynter, 1997).

2.1.2 Agile Testing

With the increase in the use of agile methodologies in software development, ST is by no means an outlier to this paradigm shift. According to the Agile manifesto (2001), motivated individuals are expected to be productive when they are given the support they need in their job. Interestingly, it is one of the most important phases in agile software development as Berłowski, Chrusciel, Kasprzyk, Konaniec, and Jureczko (2016) claim. However, the authors also point out that it is accompanied by several challenges in the testing process which are also in line with Baumgartner et al. (2021), Herrera and Ramírez (2003), and (Whyte & Mulder, 2011) who reflect on this by mentioning that ST is bounded by time and budget-related constraints. In agile testing, QA engineers are expected to commence their work as soon as the development is done so that the test plan and execution of several features are done in parallel and concurrently (Baumgartner et al., 2021). This is where test automation is useful in expediting the testing process by eliminating manual testing whenever possible and diminishing errors that are prone to human errors (Whyte & Mulder, 2011). This is further backed up by Tang (2010) and Kasprzyk et al. (2016) stating that the aim of test automation is to shift the focus of manual testing to an automated fashion, ultimately streamlining agile testing. Furthermore, Kasprzyk et al. (2016) specifically link the importance of performing test automation in agile software development in the RT phase given the unexpected software releases and the availability of limited resources to account for the testing activities needed before a new feature or system specification is shipped to the production environment. On the other hand, it is also of vital importance to note that although software test automation is widely adopted in industries involving software development, manual testing still plays an important role in the ST industry (Myers, Sandler & Badgett, 2011). Advocates of using manual testing in combination with automated tested argue that the former type of testing cannot be completely replaced by the latter due to several factors, one of them is the high costs accompanied by creating and maintaining automated test scripts (Taipale, Kasurinen, Karhu & Smolander, 2011; Kasprzyk et al. 2016) hence why the researchers suggest their complementarity. Other researchers extend the problems of test automation shedding light on the high complexity involved in it (Wiklund, Eldh, Sundmark & Lundqvist, 2017; Van Der Burg & Dolstra, 2010), hence achieving a trade-off between the manual and automated testing is warranted. Furthermore, the iterative nature of agile software development emphasizes and aims to produce higher quality software in less time and budget (Nelson, Nelson & Wierwille, 2012; Zhang, Hu, Dai & Li, 2010). However, the tendency of agile practice to push products to the market as soon as possible has jeopardized software quality (Hutcheson, 2003) creating challenges in agile testing hence necessitating RT as part of the testing process in assuring the delivered software meets the required quality standards (Baumgartner et al. 2021).

2.1.3 Regression Testing

RT is an activity performed in agile testing to make sure that the main modules or functionalities of a software product did not get affected by new modifications on it (Govil & Sharma, 2021). O'Regan (2019) echoed this stating that with RT, the software's core functionality is verified for correctness after it has been subjected to modifications, hence the software integrity is maintained. Considered a subset of ST (O'Regan, 2019) and part of the agile practice (Baumgartner et al. 2021), RT plays an important part in the software development life cycle. RT is the process of verifying that the core functionalities of the software are intact following defects fixing and amendments to the software by executing test cases (Mouelhi, El Kateb & Le Traon, 2015) and locating defects in a program (O'Regan, 2019; Leung & White, 1989). There is a consensus between researchers that RT is necessary to ensure that a modification to the software, whether it's a new feature or a bug fix, does not affect the status of the existing unchanged software features (Vincent, Badri & Badri, 2012; Pressman, 2005; Elbaum, Rothermel & Malishevsky, 2000). Arguably, it is also the most important testing activity in the software development life cycle according to Ashima, Shaheamlung, and Rote (2020), and has thus become a de facto practice in assuring the quality standard of a product (Kung, Gao & Hsia, 1996).

RT can be performed either manually by executing predefined test cases or automatically using software tools to ensure new modifications to the code did not cause new defects (Pressman, 2005). In manual testing, executing all test cases for RT purposes is a tedious and laborious task that can be deemed a less efficient testing method in agile practices (O'Regan, 2019). Baumgartner et al. (2021) highlight that automation testing has a significant effect on RT given its capability to catch errors in a more efficient way, paving the way for the testing process to be more agile. However, RT can become inefficient if all test cases are executed for a single modification (Pressman, 2005) hence the testing activity should be selectively approached (Paynter, 1997). Moreover, Govil & Sharma, 2021 highlighted problems in RT related to technical and human resources as highlighted in figure 2 and can be summarized as follows. The authors mention that automation testing is constrained by time, required subject-matter experts, and high budgeting needed for the maintenance of regression test cases that is also impacted by the nature of agile practices demanding frequent changes of requirements. Moreover, they mention that communication between team members is essential in streamlining RT, therefore lack of communication impedes RT effectiveness and efficiency.
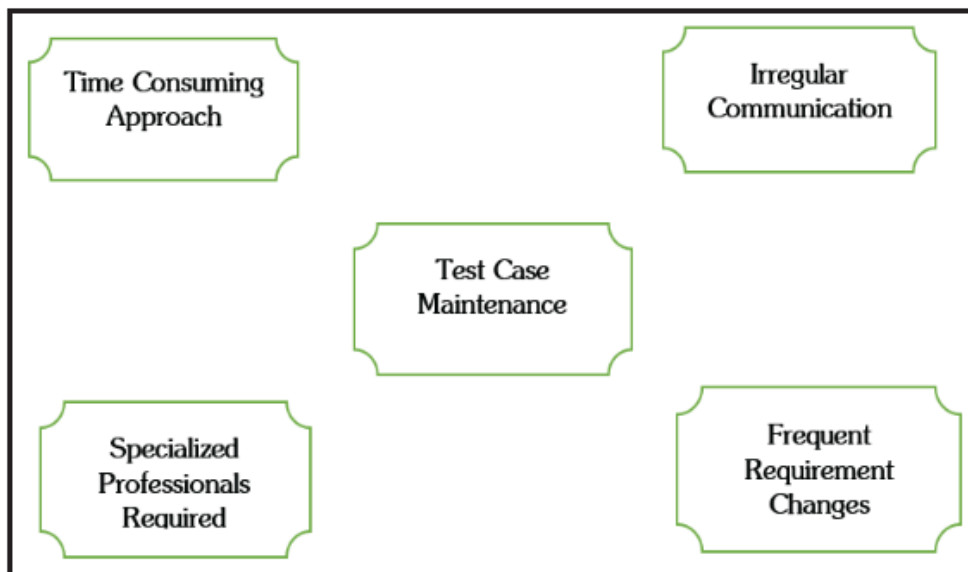
Figure 2. Regression Testing Issues Addresses by Agile Teams (Govil & Sharma, 2021, P.2)

2.2 Visual Analytics

International Data Corporation (IDC) estimates that data will have an annual volume growth rate of 23 % between 2020 to 2025 (IDC, 2022). The development entails great opportunities for information revolution and how it should be consumed. This demands new techniques and methods to enable optimal consumption of the data through improved knowledge generation and discovery insights from the huge and complex dataset, which brings in the capabilities of VA (Kielman et al. 2009).

However, VA is often misused and related to other terminologies or concepts which include visualization, information visualization, scientific visualization, interaction visualization, human-computer interaction, data analysis, and visual data mining (Cui, 2019). To drill through these techniques, visualization refers to a set of theories and concepts used to create a visual representation of data, which can either be informational or scientific in nature (Ferreira de Oliveira & Levkowitz, 2003). Whereas information visualization focuses on the display of computing and representation of data in a bid to help in explaining the human perception of information (Sears & Jacko, 2009), scientific visualization focuses on gaining information from data objects or locations associated with scientific processes (Kerren, Stasko, Fekete & North, 2008). Interaction visualization concentrates on the display and transformation of data taking into account image attributes such as colour and shape (Cui, 2019), and human-computer interaction regarding how computers influence human activities. Data analysis is about analysing data with the intent to discover and generate insights through the application of statistical techniques (Azzalini & Scarpa, 2012). Visual data mining is the process and analytical reasoning using visualization tools to present results in terms of patterns in the data from the experience and ideas in order to make informed decisions making (Simoff et al. 2008). It's clear that these concepts are not the same despite being related.

For the purpose of this research, VA is defined by considering the previous terminologies. VA is the process of analytical reasoning made possible with interactive visual capabilities or interfaces by utilizing visualization and interaction features to enable human judgment in the data analysis system (Cook & Thomas, 2005). Figure 3 shows an overall illustration of a VA environment and layers involved namely data access, analysis and visualization, and decision making (Cui, 2019).

According to Tory and Moller (2004), human interactions influence the understanding and interpretation of visually presented data, and as such, considering that aspect in the design process should be foundational for VA. Though they don't suggest that interaction is the only option for effective data presentation but rather useful in having insights into the data. Because of this position, they align to the model or practice of 'Human in the loop' which suggests human involvement and interaction in the process. Nonetheless, Endert, Hossain, Ramakrishnan, North, Fiaux and Andrews (2014) argue to transition from what is termed as 'Human in the loop' practices with regard to VA to a 'Human in the loop' perspective with consideration for the well-mainstreamed analytics in the interactive processes. That argument means highlighting the importance of interaction among elements namely analytics, visualization, and humans (Endert et al. 2014). Hence, the motivation for this shift was to stimulate an understanding of cognitive reasoning processes. Figure 3 showcases human perception and reasoning in the VA ecosystem. The emphasis in the said figure is to demonstrate that human reasoning together with data analysis offers improved value and insights from the data (Cui, 2019). To drill down in figure 3, VA acts as a link between the machinery of data analysis and visualization, and human analytical reasoning. This entails well analysed and visualized data presented through dashboards and other intuitive visual means that offer insights, as the human cognitive power interacts. This is a looped process until meaningful and invaluable insights are obtained.
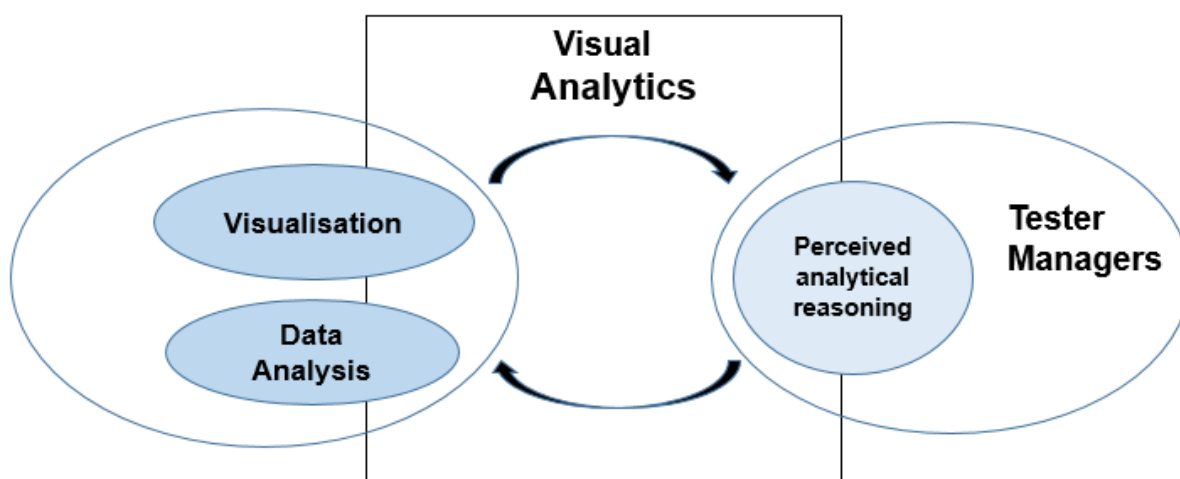
Figure 3. Interaction of Visualization, Data Analysis and Perceived analytical reasoning in VA Ecosystem (Adapted from Cui, 2019)

As indicated earlier, visual analytics is an extension of the disciplines of scientific and infor-mation visualization, and as shown in figure 4, Cui (2019) attempts to highlight the standard steps involved in the visual-analytics process suggesting that VA is process is often consid-ered an iterative sense-making.
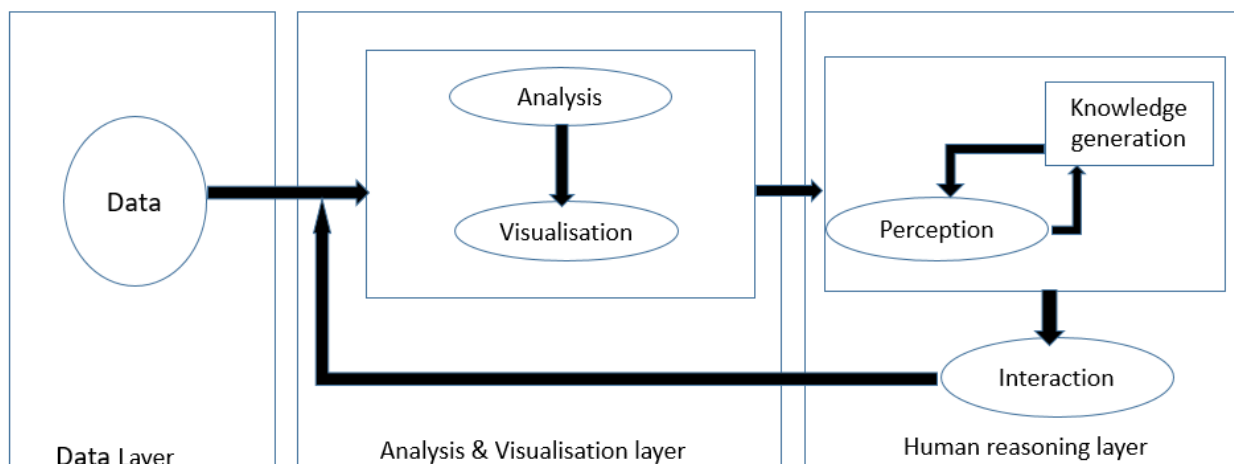
Figure 4. Visual Analytics process with layers (Adapted from Cui, 2019)

To begin, the data extracted from different source is prepared to conduct pre-processing pro-cedures. The procedures include cleaning, transforming, and aggregating among others so that it's eventually in the same schema. Following this, data analysis and visualization are applied with the motivation to extract patterns and trends in the process. Nonetheless, Cui (2019) ar-gues that obtained results at this stage are not adequate for elaborate problem-solving and in-formed decision-making. For this reason, human perception and cognitive power are intro-duced into the process to add value to insights. In the subsequent stage, the data analysis and visualization are updated into account the user interactions. This iterative process can con-tinue until more insights are obtained for the purposes of problem-solving and decision-mak-ing (Williams et al., 2015).

2.2.1 Perceived Benefits with visual analytics

According to Li (2018), there are several benefits associated with the adoption and utilization of VA in organizations that have an impact on both the decision process and outcomes. To start with, Li (2018) highlights that the problem-solving and decision-making processes influ-ence the discovery of knowledge. This is because interactive data visualization tools and tech-niques can improve efficiency more than those without Perdana et al. (2018). It is achieved by the visualized data enabled by the richness and interactive interfaces provided to the manag-ers. Further, VA is said to enhance learning and comprehensive understanding of even sophis-ticated elements in the huge dataset (Wang & Santhanam, 2015) as it makes engagement with users so easily which is vital, especially for the intention to change user behaviour as they can perceive it as useful and easy to use (Wang & Santhanam 2015).

Furthermore, according to Li (2018), one of VA's main aims is to improve and enrich decision outcomes in organizations. This is achieved by defining and generating insights. In fact, Card, Mackinlay and Shneiderman (1999) and Cook & Thomas (2005) argue that the purpose of VA is to ensure knowledge discovery and insights generation. We can deduce that despite disagreement in the definition and scoping of the insights subject, it is of paramount importance that it eventually enhances decision outcomes. Another important element in supporting decision outcomes is accuracy. According to Perdana et al. (2018), VA tools and techniques are useful in helping even non-technical staff in the organizations to read data, analyse and make decisions appropriately. Moreover, they add that VA increases confidence in making assessments on the data among staff. In this case, by utilizing VA tools non-technical staff can quickly make decisions with improved accuracy (Perdana et al., 2018).

2.2.2 Perceived Challenges with Visual Analytics

Despite the perceived benefits that come along with VA, there are minimal or unwanted levels of adoption of the technology by managers in organizations (Lennerholt et al. 2018; Li, 2018). Gorko et al. (2018) claim that some VA tools and techniques have become sophisticated enough for use by non-tech staff in organizations. They argue that the ability to use the system should be prioritized and improved on. System usability in this context means efficiency and user satisfaction in mind (Gorko et al. 2018). This is in line with Cook & Thomas (2005) who argue that VA should serve the discovery of patterns, trends, and correlations in the dataset to have insights. In other ways, it is suggested that there should be a balance between perceived usefulness and ease of use, as they are critical to the overall adoption of VA. To add to this point, convenience and user-friendliness in VA tools are both critical to being accepted and later adopted in organizations (Li, 2018).

2.3 Software Testing and Visual Analytics

VA tools have the capability of providing the non-technical staff the possibility to read, analyse and make proper decisions (Perdana et al., 2018) as mentioned earlier. This entails that QA managers' perception of adopting VA in software RT encloses the standard steps of VA involvement demonstrated in figure 4 that including the data layer, the analysis, and visualization layer, and the human reasoning layer as highlighted by Cui (2019).

Data layer
The increase in software product complexity and requirements have caused ambiguity in making the suitable decision needed to achieve the required product quality (Caglayan et al. 2012). Software quality measurement is often abstract in its nature (Reynoso & Sandoval, 2008) warranting approaches to reduce it. Myers, Sandler and Badgett (2011) argue that it is not possible to establish a complete insight into the combination of all inputs and outputs needed to test software. Shi et al. (2019) resonate that with the lack of resources needed to fully test a software. The continuous advancement of ST practices and the abundance of data being generated from executing test cases during RT cycles in software development projects leads to the creation of a large amount of unnecessary and redundant data (Narciso et al,

2013). With such a volume of data generated from these technologies, graphical representations enclosing historical data can be reviewed and subsequently, utilized in supporting decision making (Williams et al, 2015; Daradkeh, 2018).

Analysis & visualization layer
The nature of software RT revolves around the execution of predefined test cases continuously whenever a new modification is made to a software (Pressman, 2005; O'Regan, 2019) generates a large amount of data that can be extracted and analysed (O'Regan, 2019) and measured (Baumgartner et al. 2021). With visualization capabilities provided by VA, QAs managers can efficiently execute their work by merging and transforming the processed test cases and drawing appropriate insight from them (Cui, 2019). However, selecting what test cases to execute is challenging and constrained by limited testing resources like human and technical resources, prompting decision-makers to consider ways to prioritize test cases (Shi et al., 2019). This issue can be anchored and resolved by VA capabilities as it provides the means to make decisions (Li, 2018; Cook & Thomas, 2005) therefore QA managers can select and decide what test cases to execute based on outcomes provided by VA. According to Baumgartner et al. (2021), test results can provide useful information for QA managers to make decisions on what further test areas should be focused on. The former includes maps, dashboards, charts, and images, and the latter includes enhanced computer graphics representation of objects (Cui, 2019). This entails that it can have multifaceted data presented in a clear and explainable way. According to Kielman et al. (2009), it is these capabilities and features of VA that compels and drive the need to take its implementation in several sectors. Further, based on the underlying processes and techniques, the timely generation and knowledge discovered can be communicated for informed decision-making and recommended for action (Cui, 2019).

Human reasoning layer
Analytical problem-solving skills is an important aspect of ST (Calikli et al. 2012). Analysing software from a subjective and objective perspective brings to light a dilemma that is worth inspecting. (Çalıklı & Bener, 2013) states that cognitive bias in ST is a prevalent part of human psychology and is inevitably involved in sense-making (Cui, 2019) hence it cannot be eliminated from the testing process. Conversely, Reynoso and Sandoval (2008) argue that software quality should be subjected to measurements to determine its level of quality. This dilemma provides the ground for visual analytics to be utilized in providing insights that can pave the way for QA managers to apply their analytical reasoning in determining which approach is most suitable (Cui, 2019).

2.4 Theoretical Background

2.4.1 Extended Technology Acceptance Model

The inspiration for the Technology Acceptance Model was developed based on the Theory of Reasoned Action (Davis, 1989). According to Davis (1989), this theory states that individuals' intentions always determine their behaviour in an environment. He further argues that the behavioural intention is driven by the individual's attitude towards how he or she behaves as well as subjective norms with respect to the performance of this behaviour (Davis, 1989). Ad-

ditionally, the theory takes into consideration the assumptions that people are logical and reasoned in nature and as such, make decisions and evaluate the system to make up attitudes to a particular behaviour (Venkatesh and Davis, 2000).

In information systems research, the theory of the Technology Acceptance Model (TAM) and its extension are used to explain the adoption of technology (Lai, 2017), and it is applied in isolating key factors that can cause users to either accept or reject a particular information technology (IT) (Venkatesh and Davis, 2000; Venkatesh et al. 2000; Lai, 2017).

Furthermore, Venkatesh et al. (2000) suggest that perceived usefulness and perceived ease of use are two important individual beliefs about utilizing technology in a particular environment. They argue, however, that perceived usefulness is a more reliable determinant of technology use (Venkatesh et al. 2000).

From an individual perspective, the TAM theory has been extended and widely used to understand the acceptance of an IS adoption (Wixom & Todd, 2005; Lee, Kozar & Larsen, 2003). Due to its flexibility and applicability, several other constructs have been added. These include subjective norms, perceived behavioural control, and self-efficacy (Mathieson et al. 2001; Taylor & Todd, 1995), and result demonstrability (Karahanna et al. 1999; Plouffe et al. 2001). Venkatesh and Davis (2000) have gone as far as introducing personal characteristics to the model that influences the adoption of new technology as determinants of the perceived usefulness and intention to use the technology. Despite the extensions to the model, the key two constructs, namely, usefulness and perceived ease of use, remain intact (Venkatesh and Davis, 2000), hence the fundamental underlying structure and assumptions have not diverged from the original TAM (Li, 2010).

In this research study, we settled for the TAM 2 model. This is because we attempted to establish the QA managers' intention to adopt VA in the software RT ecosystem. The notion is that TAM is a well-tested theory and has been proved to be reliable and vigorous as far as predicting user acceptance in several different settings (Adams, Nelson & Todd, 1992). Nonetheless, TAM 2 offers advantages as it takes care of social influences such as subjective norms, voluntariness, and image, which were the weaknesses identified and criticized in the original TAM (Venkatesh & Bala, 2008). According to Venkatesh and Davis (2000), TAM 2 also takes into consideration technical perspective and cognitive factors such as job relevance, output quality, result demonstrability, and perceived ease of use as constructs. These factors are critical in influencing the perceived usefulness of particular information technologies. In our study, we think that both social influences and technical perspectives are important in establishing the QA managers' experiences and perceptions regarding adopting visual analytics in software RT. Figure 5 illustrates the TAM 2 constructs, and table 1 demonstrates the definition of these constructs.
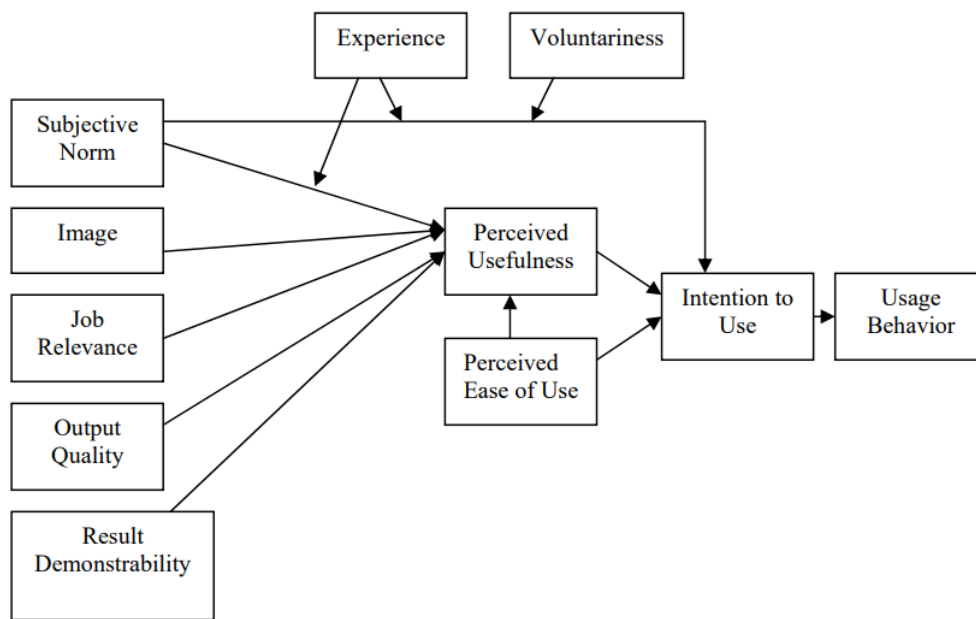
Figure 5. The Extended Technology Acceptance Model (TAM 2) (Adopted from Venkatesh and Davis, 2000)

Table 1 Definition of TAM 2 Constructs

Constructs	Definition
Perceived Usefulness	Refers to the extent to which people believe that utilizing a technology or system results in enhancing job performance (Davis, 1989).
Perceived Ease of Use	Refers to the extent to which people have a belief that utilizing a technology or system would be free or minimal effort (Davis, 1989).
Subjective Norm	Refers to people's perceptions, a great number of people who are important to them think that they would or would not perform the questionable behaviour (Fishbein & Ajzen, 1977; Venkatesh & Davis, 2000).
Voluntariness	Utilizing technology is considered or perceived as an exercise of free will (Venkatesh & Davis, 2000).

Image	Refers to the extent to which utilizing technology is viewed to improve one's status in society (Moore & Benbasat, 1991).
Job Relevance	People's views regarding which system is supportable or suitable to the job performance or role (Venkatesh & Davis, 2000).
Output Quality	Refers to the extent the assignments match the job purpose, that people would consider for their performance (Venkatesh & Davis, 2000).
Result Demonstrability	Refers to the results of utilizing the technology or the innovation and how easy is it to explain to others (Moore & Benbasat 1991).

2.4.2 Application of the Extended Technology Acceptance Model (TAM 2)

In applying this model (TAM 2) for this research study and making it applicable, some constructs were removed, namely "usage behaviour" "voluntariness" and "experience". The usage behaviour as a construct was removed because the scope of the study that was ended on the intention to use the VA and not the actual adoption or usage of the technology. In the case of the "voluntariness" construct, the view is based on the fact that the utilization of VA is not looked at as being mandatory or imposed on the quality assurance specialists. In a similar way, we removed "experience" because we are not necessarily testing a particular VA tool or technology but rather focusing on the perception of adoption of the technology. Further, according to Venkatesh and Davis (2000), the "experience" construct is usually considered in circumstances when the focus is on those that have worked with the system before. In the same line, Venkatesh and Davis (2000) argue that TAM 2 reduces in strength with respect to social influence factors that have an influence on perceived usefulness and intention to use with increasing experience with technology over a period of time.

Intention to Use

In the TAM 2 model, behaviour is determined by the intention to perform such a behaviour, and various research has shown that the intention to use technology and individual actual behaviour have been discovered to have a relationship as Davis, Bagozzi and Warshaw (1989) mention. The depth and extent of an individual's desire to engage in a specific behaviour is reflected in them to utilize technology, which is characterized by their commitment to innovation (Davis et al.,1989).

Perceived usefulness

Perceived usefulness is a very important construct for inclusion in our model because it's the strongest factor influencing the intention to use the technology (Venkatesh & Davis, 2000). It is seen to highlight the stance that people's willingness to use technology is very reliant on how they think it would assist in executing a job appropriately (Venkatesh & Davis, 2000). This entails other factors that would influence the intention to use technology. In this case, if QA managers have a belief that a VA application is useful, they would be willing to take the initiative to have it adopted. In a similar way, perceived ease of use was critical in investigating the extent QAs perceive VA application in testing as being free of effort (Venkatesh & Davis, 2000).

We also considered other constructs in our study, namely: image, subjective norm, job relevance, output quality, and result demonstrability (Venkatesh & Davis, 2000). We believe these have an influence on the perceived usefulness and are hence applicable to our research study area. To be specific, the image construct is applicable in the sense that we seek to determine how quality assurance managers' use of VA in testing could be perceived to enhance their status in the work environment. The notion is that if the image is well considered, it would influence the perceived usefulness of the VA application. The next construct is the subjective norm. This construct was included in the model because QA perception of the team who are important and think they should or should not use VA in executing their work can influence the perceived usefulness (Venkatesh & Davis, 2000). Another construct of interest is job relevance. We think that if QA managers perceive VA application as relevant, for instance, overseeing the selection of test cases systematically when conducting RT, again that would influence perceived usefulness. Furthermore, output quality is included to capture if QAs perceive VA as how well it helps with the testing task. Moreover, result demonstrability was an important construct. The idea was to capture QAs perception of VA would produce tangible results worth counting on (Wixom & Todd 2005).

Perceived Ease of Use

Perceived ease of use as a construct is used in the model to capture the extent to which an individual applies mental or physical effort when using technology (Venkatesh and Davis, 2000). In this study, the interest was focused on capturing QA managers' perceptions of this factor to help determine if VA is viewed the same way. The motivation was based on the fact that previous research studies have shown that people are more likely to utilize any technology, in this case, if it is perceived as easy to use (Adams, Nelson & Todd, 1992; Lee, Park & Ahn, 2001).

2.4.3 Theoretical Framework Literature

Kvale and Brinkmann (2009) emphasize the importance of thematizing referenced literature in the study. The notion is to provide an overview of relevant themes and form a basis for how the interview guide should be structured for our interview guide. Refer to table 2 for details.

Table 2 Theoretical Framework Literature

Theme	Sub-theme	Supporting Literature
Software Testing and Visual Analytics		Taylor (2013); William, Boland & Lyytinen (2015); Pressman, (2015); O'Regan (2019); (Baumgartner, Klonk, Pichler, Seidl, Tanczos & Mastnak, 2021)
Software Quality Assurance	Software Testing	Reynoso and Sandoval (2008); Whyte & Mulder, (2011); Li, (1988; Dowie et al. 2005); Zhang, Windsor and Pavur (2001), Memar et al (2017); Onita and Dhaliwal (2017); Zhang, Windso, Pavur (2001); Ashima, Shaheamlung & Rote, (2020); Wang, Zhu, Yang, Guo & Yu, (2018); Khatibsyarbini, Isa, Jawawi & Tumeng, (2018); Ashima, Shaheamlung & Rote, (2020); Khan & Sadiq, (2011); Myers, Sandler, and Badgett (2011); Seah & Yap, (1993).
	Types of Testing, Agile Testing	O'Regan, (2019); Li, (1988) ; Myers, Sandler & Badgett, (2011); Baumgartner et al. (2021) ; Tang (2010); (Myers, Sandler & Badgett, 2011); Shi, Gillenson, and Zhang (2019)
	Regression Testing	Govil & Sharma, (2021); O'Regan, (2019); Mouelhi, El Kateb & Le Traon, (2015); O'Regan, (2019); Leung & White, 1989); Wong et al. (1997); Engström & Runeson, (2010); Khatibsyarbini et al., (2018); Pressman, (2015); Paynter, (1997); Elbaum, Rothermel & Malishevsky, (2004); Wong et al. (1997)
Overview Visual Analytics	Visual Analytics	Kielman et al. (2009); Cui (2019); Oliveira & Levkowitz, (2003); Sears & Jacko, (2009); Manovich (2011); Zudilova-Seinstra et al., (2009); Azzalini & Scarpa, (2012); Cook & Thomas, (2005); Tory &

		Moller, (2004); Endert. et al. (2014),
	Benefits with Visual Analytics	Li, (2018); Perdana, Robb, & Rohde ,(2018); Wang & Santhanam ,(2015); Cook & Thomas, (2005)
	Challenges with Visual Analytics	Lennerholt et al. (2018); Li, (2018); Cook &Thomas, (2005)

3 Research method

3.1 Choice of method

Recker (2013) argues that qualitative research fits well for a topic that has not been well researched or understood. The novelty of the topic is one of the reasons we chose the qualitative method in conducting our research. Another reason for choosing this research method is its suitability to acquire rich data from a small number of people (Patton, 2015) given the limited time we have to conduct the thesis. Furthermore, Patton (2015) states that a qualitative research design offers a level of flexibility allowing a researcher to adjust the focus of the research inquiry during the interviewing, and because of the scarcity of information related to our study, it encourages us to proceed with this research approach and provide a buffer against unexpected observations or trends that could be encountered during the research process (Recker, 2013). In fact, our research question was changed several times before we settled on the existing one. Having said that, the quantitative research method, which puts focus on collecting numeric data as part of the research process (Recker, 2013), is irrelevant to our study due to its inability to capture the perception of QA managers behind adopting VA in QA context.

The aim of this study is to understand the perception, reaction, and experience of software QA managers in adopting VAs in the software RT process. Therefore, the interpretive research paradigm suits this type of study to understand a phenomenon by the subjective meaning that people put to it (Recker, 2013; Bhattacherjee, 2012) and by the meanings that are understood through words and stories (Patton, 2015). Also, interpretivism echoes well with the subjectivity presented in our research inquiry since the perception of assuring the quality of software can differ between a person and another and they can react differently to testing activities (Goericke, 2020). This also hinges with Saunders's, Lewis's and Thornhill's (2009), Walsham's (2006), and Patton's (2015) argumentation that interpretivism provides a contextualized understanding of the social context being studied. Conversely, we were reluctant to implement any actions or changes as observers in practical settings due to time constraints hence we excluded pragmatism as a research paradigm option (Goldkuhl, 2012). Instead, we are studying the phenomenon of adopting new technology within the software QA process to capture the experiences, essence, and reflections of QA managers to judge and draw upon inference from various social contexts, which we believe has the potential to provide interesting knowledge for practitioners and researchers and is supported by Goldkuhl (2012) statement that interpretivism is a great fit for qualitative investigations trying to generate an understanding of an interesting phenomenon.

The philosophical base of the chosen interpretive research is phenomenology. It is stated by Boland (1985 cited in Goldkuhl, 2012) to be one of the favoured approaches to studying an information system, and in our research, is exemplified in studying people's perception and intention to use the proposed VA in the software RT process. According to Patton (2015), the core inquiry of phenomenology is to explore the lived experience of a phenomenon by an individual and to determine the behaviour associated with such experience. This aligns with our goal to understand the adoption of VA in software RT from the QA manager's point of view as an individual.

3.2 Conducting Literature Review

According to Randolph (2009), setting the boundaries of the research topic should be well defined through the literature review. The notion is that not only does it help the researcher(s) focus on narrowing the relevant concepts of the study but also acts as proof of knowledge. It is through the literature review that the establishment of related studies on the topic of interest can be shown. Further, Bhattacherjee (2012) suggests that a literature review should show results on trends and theories on the topic of investigation and aid in discovering problems and gaps based on previous studies.

As per the guidelines provided by Randolph (2009), as researchers, we defined the criteria of the literature review by ensuring that keywords in the research topic are considered. We learned that optimized search queries helped in filtering and narrowing down high-impact score journals and publishers. Also considering the novelty of the topic, we had to include conference papers to ensure that appropriate and required reference material is well harvested. The academic search engines used included mainly AIS eLibrary but also included Google Scholar, LUBsearch, IEEE Xplore, and Science Direct. The following shows the queries used:

- test* OR title:(Quality assurance) NOT (Machine learning)
- title:(quality assurance) NOT (Machine learning)
- (Software test*) AND (agile testing) NOT (regression analysis) OR (quality assurance) OR (quality control)
- (software testing) AND (data visual*)
- abstract:(software testing) AND abstract:insights
- abstract:(software testing) AND abstract:analysis
- abstract:(software testing) AND abstract:redund*
- abstract:(software testing) AND abstract:analytics
- abstract:(software testing) AND abstract:visual*
- abstract:(software testing) AND abstract:visualisation
- abstract:(software testing) AND abstract:visualization
- abstract:(software testing) AND abstract:(data insights)
- abstract:(quality assurance) AND abstract:(data analysis)
- abstract:(software quality assurance) AND abstract:(data analysis)
- abstract:(software testing) AND abstract:(data analysis)
- (software testing) AND (data analysis)
- title:(software testing) AND title:(data analysis)
- title:(software testing) OR title:(software quality assurance)
- (software testing) AND (test cases) AND redundant
- (software testing) AND title:(test cases)
- (visual analysis*) OR (quality assurance) OR (quality control)
- (visualisations*)
- visual* OR title:(Quality assurance)

The search method was iterative and repetitive considering that this topic was the intersection of two broad and important concepts namely visual analytics and software RT. We needed to

navigate and drill down further to primary sources whenever we harvested any linking papers, as reaching saturation was our target as suggested by Randolph (2009).

3.3 Data Collection Methods

Interviews are widely used in qualitative research due to their credibility and impact in collecting rich data (Schultze & Avital, 2011; Klein's & Myers's, 2001). Bhattacherjee (2012) extends on that to mention that it is the most commonly used technique to collect data in interpretive research. Recker (2013) also mentions that interviews could be descriptive, exploratory, or explanatory in nature. In our case, we have settled on a combination of descriptive and exploratory interviews. This is because, according to Recker (2013), descriptive interviews provide insights into rich descriptions from the interviewees by understanding their perceptions of the phenomenon under study. Exploratory interviews allow interviewers to create new theoretical concepts based on the interpretations generated from the interviews (Recker 2013). In our case, we are interested in creating a new theoretical framework by gaining a rich description of individual subjective understandings of the phenomena while being guided by an existing theory and supported by the literature. Therefore, we conducted interviews to capture the subjective understanding of QA managers and their reflections on the application of VA in the software RT process. We believe the choice was justified and aligned well with the desire to collect rich data for the topic in a bid to capture everything that we saw and heard during the interviews.

Informants for the research were first identified from one of the researcher's professional networks in the software industry and then contacted via LinkedIn, Whatsapp, or Skype. They were chosen to be contacted based on their current or previous managerial or team leading capacity within the software quality assurance department and all of them work in IT companies. This is because the aim of the study is to understand the perception of adopting a new information system within an existing ST process, hence key informants can provide valuable information due to the experience and merits they have within their specialization (Recker 2013; Patton, 2015). In total, 7 informants were approached but only 5 of them accepted to be interviewed within the time we preferably requested for the interviews to happen. All the interviewees have various levels of automation testing knowledge and two of them have several years of work experience in that.

Complying with Myer's and Newman's (2007) interview best practices, invitation letters were sent to all participants via Microsoft Outlook, explaining to them the subject and scope of the study. Due to the capability of video recording in capturing people's thoughts, facial expressions, and personal experiences with the phenomenon under investigation (Recker, 2013). Given the fact that the respondents were from different geographical locations, namely, Lebanon and Ukraine (4 reside in Lebanon and 1 in Ukraine), we found that video conferencing the respondents is a proper way to perform the interviews to enable us to record the natural setting of respondents (Patton, 2015) as a substitute to a face-to-face meeting.

Further, the interviews were conducted through video conferencing tools such as Google Meet, Microsoft Teams, and Skype. As a matter of fact, it was the respondents who chose a communication channel of choice after providing them with several options. The motivation for this flexibility was to make the respondents comfortable expressing themselves using the tools they prefer or have. To achieve more with interviews, we used a semi-structured interview approach to ensure optimal extraction of views from the QA managers in understanding their perception of the proposed technology adoption (Recker, 2013). The questions were

asked in an open-ended way to ensure participants' perceptions, feelings, and knowledge was captured (Patton, 2015) and follow-up questions were asked of the interviewees if their response triggered that (Recker, 2013) or if further clarifications were needed for the participants. During the interview sessions, we did both video and audio recordings with the consent of the interviewees and equally took notes to ensure key messages are collected. With video and audio recordings, we could authentically and visually capture the interviewee's gestures feelings, body language, and non-verbal reactions which are hard to be captured otherwise but are crucial for studying the experience of the interviewee (Walsham, 2006) needed for the qualitative research (Patton, 2015).

The interview was controlled by a guide to safeguard the respondents' limited time availability, relevancy, consistency, and flexibility of the research (Patton, 2015) and is seen in Appendix 1. Four of the interviewees were conducted in English while one of them felt more comfortable mixing Arabic and English. This did not stop us from conducting the interview in Arabic and English because Walsham (2006) argues that researchers should not discourage interviewees from speaking their own language. The interviews lasted between 21 minutes to 52 minutes. One of the interviews (R4) was translated to English by one of the researchers who is a native Arabic speaker. The rest were done in English.

Nevertheless, Recker (2013) has identified some challenges with interviews, one of which is related to biases arising from the researcher's personal expectations of the phenomenon under study. To avoid this due to one of the researcher's acquaintances and connections with the respondents, the other researcher led the interview, asked probing questions, and facilitated the interview conversation. In the English-based interviews, the co-researcher was involved in the interview when clarifications were asked by the interviewees or when the subject was deviating from its objectives. However, both researchers were involved to an equal extent in the interview conducted in Arabic to avoid the language barrier-related impacts.

Table 3 List of respondents

Respondent	Organization	Position	Date of Interview	Length	Appendix
R1	Comin	QA Team Lead	10-05-2022	46:00	Appendix 4
R2	BLU Loyalty	QA Team Lead	10-05-2022	51:42	Appendix 5
R3	CME	QA Team Lead	11-05-2022	21:18	Appendix 6
R4	BLU Loyalty	QA Team Lead	11-05-2022	30:24	Appendix 7

R5	Intellias	Head of QA	12-05-2022	41:21	Appendix 8

3.4 Data Analysis Methods

According to Oates (2006), qualitative research analysis offers flexibility to multiple techniques to choose from. The decision to arrive at the appropriate data analysis methods is driven by a number of considerations which may include the type of research design and the overall research goal, among others (Bell, Bryman & Harley, 2019). In this study, we employed coding and transcription.

The first step in the analysis process was a transcription of every interview (Kvale & Brinkmann, 2009). Thanks to the advantages of audio recordings, the data collected was transcribed more accurately (Walsham, 2006). However, the author states that transcription is a time-consuming process, so automated tools were used for transcribing the interviews. Microsoft Word and Google Docs speech recognition software were used to transcribe all the reports. We, however, learned that manual intervention was also helpful and necessary in ensuring that words, body language, and facial expressions were captured and verified for authenticity. In line with Walsham (2006), this optimized approach to transcription was necessary to help collect alternative data. The transcription process took a couple of days. Once all online interviews were transcribed, a second round of check was performed on the content of the transcriptions by running the video recordings again to ensure the authenticity of the data and to ensure important verbal and non-verbal details were not missed out. Using video recordings as a tool to capture words in our qualitative research (Recker, 2013) has allowed us to transcribe facial expressions, reactions, and emotions. Soon after transcription, we started the coding process, which involved going over the data and adding a response codes list. The idea was to familiarize ourselves more with the data to be synthesized. In line with Kvale and Brinkmann (2009), coding helps in synthesizing the transcribed text to be meaningful and manageable. This entails being able to aggregate transcribed text to consolidate meaning by identifying themes, patterns, and categories. Kvale & Brinkmann (2009) further state that coding would either be data-driven or theory-driven. Data-driven inductively generates codes from the material, whereas theory-driven is a technique that utilizes predefined codes based on existing literature. In this study, we settled for theory-driven coding based on the extended Technology Acceptance Model 2 (TAM 2) and literature, meaning that the analysis approach was deductive and then inductively added two new constructs to the model. The idea was to develop a framework that would be useful in determining whether or not to adopt the VA in QA ecosystem. Further, TAM 2 was deemed a good fit for the study because we were interested in understanding the factors that would influence QA managers' perception of adopting VA in software RT. However, we selected some constructs from the TAM 2 model and others from the literature. See table 4 for the abbreviations of the factors that were used during the coding phase. It was then followed by thematic analysis, in which we were interested in identifying and uncovering themes related to intent to use, perceived usefulness, perceived ease of use, and benefits. The method provided a possibility for data to be organized in meaningful ways, resulting in a deep understanding of the VA as a phenomenon under investigation that

could be used to create a comprehensive perspective. According to Walsham (2006) and Patton (2015), qualitative data analysis could be subjective to the researcher's way of interpreting and viewpoints, hence bringing in biases to the work if not well handled. In this research work, we attempted to address any potential biases by conducting triangulation and checking over and over to ensure that results were well captured (Patton, 2015).

Table 4: List of codes

Factors	CODE
Intent to Use	IU
Perceived Usefulness	PU
Perceived Ease of Use	PEU
Perceived Benefits	PB

3.5 Research Quality

Given our choice of conducting qualitative research, we chose reliability and validity as two important scientific qualities needed to ensure our research meets quality standards. Reliability and validity requirements are two important determinants in achieving scientific quality (Recker 2013) in qualitative research (Patton, 2015). To achieve reliability, it means our study should be replicated in another context and yield the same results given the same conditions of the study are met (Bhattacherjee, 2012). Yet Patton (2015) mentions that no specific validity and reliability measures exist for qualitative research. Moreover, Bhattacherjee (2012) mentions that reliability can be jeopardized in qualitative research due to the subjectivity of the researcher. To avoid this in our research, we structured and prepared our interview based on the theoretical framework (TAM 2) and based on the comprehensive literature review. These questions were compiled in the form of a guide to target and lead the data collection process. The same guide was used during the interview with all participants to obtain relevant and clear information across all subjects.

To achieve validity in qualitative research, the focus, according to Patton (2015) should be on the ability to get rich data and the ability of the researcher(s) to analyse them and understand the phenomenon studied. The means to measure validity is subjected to different interpretations as Patton (2015) mentions that there is no necessary one way to measure validity, while Recker (2013) and Bhattacherjee (2012) state that the researcher should look into whether the data collected through the research actually measures the constructs. Therefore, first of all, the researchers contacted subject-matter experts within current or previous QA capacity to collect high-quality data, which is further supported by Patton (2015) as a way in making valuable insights about the phenomena studied as mentioned earlier. One of the researchers took lead

in conducting the interviews and analysing the data to avoid biases in the findings as also mentioned earlier, but both followed up on the work after the interviews were done by having joint discussions to review and check the findings' accuracy. This is in line with Recker's (2013) statement that accuracy should be identified as part of research validity. Due to the semi-structured interview approach taken by asking follow-up and probing questions, the researchers were both involved to varying extents in the conversations with the participants to not steer away from the focus of the thesis and to maintain the flow of getting as much information as possible. Subsequently, some deviations from the main questions occurred but they were within the context of the questions. Additionally, the collected and analysed data was documented in the thesis transparently.

3.6 Ethics

Patton (2015) acknowledges that qualitative interviewing faces ethical concerns. Because qualitative research involves greater engagement, in-depth interviewing, and intervention with people, certain ethical aspects were taken into consideration to align with Patton's (2015) ethical guidelines throughout the research process. Conforming to Bhattacherjee's (2012) ethical principles of scientific research, the following principles were abided to. The first principle is reaching out to participants to be involved in the research in a voluntary and harmless way, by explicitly asking first if the subjects wished to participate in the study via social media channels, followed by sending them formal emails asking for participation in the study after getting their acceptance to participate. The subjects were informed that they could withdraw from the interview at any time, and they could decline to answer any question if they wished to (Fleming and Zegwaard, 2018).

An informed consent document was sent to all participants informing them about the intention of gathering information from them, who the information from the interview was intended for, how will be utilized, the type of questions asked, how the answers are handled, and the risk risks and/or benefits associated with the person being interviewed in accordance with Patton's (2015) consent protocol. The forms were sent back to the researchers with their signature and confirmation and will be kept with them during and after the research process (Bhattacherjee, 2012). With such consent, researchers disclosed information to interviewees that can aid them in deciding whether they are suitable for the study or not (Bhattacherjee, 2012). This consent has been attached in appendix 3.
The option to remain anonymous was included in the informed consent before the interview started, and confidentiality was maintained by assuring the subjects that the data collected during the interviews would be solely used for academic purposes (Patton, 2015; Bhattacherjee, 2012). When analysing and reporting the data collected from the interviews, we made sure to keep unwanted or unanticipated findings in the transcription transparent (Bhattacherjee, 2012; Recker, 2013). Finally, and in accordance with Patton (2015) consent protocols, the elements of the consent were highlighted again to the interviewees before the questions were asked in the interview and they were asked if they had any questions before we started the interviews.

3.7 Limitations - 28 -

A limitation we faced is the inability to consult a translator to translate one of the transcriptions from Arabic to English due to time and financial constraints hence it was translated by one of the researchers. Although the utmost precision was considered while translating words from the Arabic transcription, minor linguistic differences might have slipped through.

4 Findings

4.1 Intention to Use

In this study, QA managers expressed a strong desire to adopt VA in software RT. As we conducted the interviews, it was discovered that there were many reasons for possible adoption, but the most critical one was that it would support decision-making among QA managers. According to Respondent 1 (R1) and Respondent 2 (R2), VA adoption is required in the QA ecosystem considering its capabilities and features. R1 used this analogy of VA in QA:

> *'I think that VA is like a doctor's diagnostic and monitoring tool on a patient' (R1.57).*

In a similar way to R2, we consider VA utilization as a smart way to resolve issues in software RT (*R2.34).* In other words, both R1 and R2 believed that VA could be used with appropriate tools and features similar to those in the data warehousing area to clean and transform it into a data warehouse (R1.65, R2.49). Also, linking it to data warehousing and business intelligence popularity, importance, and usefulness in the business industry (R1.72), could give successful results because it would enhance understanding of historical data, which is useful for software RT for the purpose of pattern recognition. If VA can have AI capabilities, that's an additional feature whereby it would learn how to recognize patterns in test cases (R1.72). However, R1 says business drives the need to adopt any technology in this era (R1.86). However, Respondent 2 (R2) added that the intention to use VA is dependent on how it is deemed useful, especially if it would help determine the affected scope in software RT (R2.69). Due to the challenges associated with software RT, R2 states that adopting it is inevitable and is always ready to take the lead to its full implementation (R2.83). Furthermore, Respondent 3 (R3) states the intention to use VA is dependent on it being tested to successfully support RT and deemed functional:

> *'I would immediately convince the management, considering the challenges with software regression testing'*

This was also supported by R4, who stated that management awaited and was supportive of adopting new tools to help enhance levels of quality assurance (R4.55), although R5 thought leading the VA adoption was his responsibility, and management would always adopt technologies to help with decision making (R5.12). However, the decision to adopt any technology is a mutual effort between the project management (PM) and the QA manager (R3.27). This is because PMs, like product managers, product owners, or technical product managers, fall under the management umbrella along with the QA managers and have mutual decision making (R3.27). Moreover, PMs and managers always like to see reports and visual data instead of raw data. In a similar way, respondent 4 (R4) would like to adopt VA in software RT and stated that it was more beneficial with manual testing than with automatic testing (R4.19). Respondent 5 (R5) stated that it's extremely important to adopt VA as a QA manager due to the greatly reduced time associated with creating visuals or dashboards (R5.12). R5 further adds that VA provides the ability to focus on problematic areas to raise a flag, hence aiding in decision-making.

4.2 Perceived Usefulness

The factor of perceived usefulness was meant to investigate the extent to which the QA managers thought that adopting VA would enhance decision-making and performance in software RT. This was important to be determined since all the respondents expressed in the affirmative the intention to use VA. They indicated that VA could enable RT to be easily executed, and user-friendly, reduce the time to do test cases, enhance quality tests, and easily explain case results. To drill down to individual responses, R1 said VA would create hype for the team because its relevance is enormous in the subsector (R1.188).

According to R1, visual-driven tools are preferred, and it's no wonder code-based tools are losing market share and are no longer teaching students at university (R1.207). R1 further indicated that VA is perceived as useful if the needs of the clients are met and linked it to Microsoft and Apple's strategies of putting clients as a priority (R1.86). R2 talked about the perceived usefulness of big data and some AI capabilities and features in the VA (R2.60). Also, R2 talked about reducing the percentage of manual work during RT since it has some repetitive tasks, hence helping to focus only on delivering results. (R2.55) stated:

"Visual features would be determined from the code on the impacted areas of test cases."

This is in line with R3 and R1, who indicated that VA is about historical test cases (R3.8) and indicated generating graphical presentation from the massive test cases dataset (R1.80) respectively. Moreover, R3 gave an example of how he has been using visualization tools for a client managing about 30,000 employees globally and thought of VA in QA (R3.24) and emphasized the speed of test releases (R3.48). R4 talked about speed as a factor in a similar way to R3 did and added output quality. R5 added self-explainability was critical to enable empowerment of those with less technical staff (R5.18) but overall shared the views of R1, R2, R3, and R4 and said:

'To me its important to understand not just the result of some processes but also quality of the process and creating specific metrics and then visualizing this metrics.. I want to work at efficiently.'

4.3 Perceived Maturity

The factor of perceived maturity is meant to capture the capacity to make decisions and the level of professional experience in software RT. It was important to capture this information because it was meant to validate the selection that the respondents were QA managers who had the position of influence in making decisions, albeit they understood the technicalities of the industry. Further, the supposition made was that it would help to determine the likelihood of adopting VA in software RT. The majority of the respondents were QA team leaders, having worked in both manual and automatic software RT, and one respondent had similar experience but is currently a project manager. It was found that all the respondents had been working in an agile environment. R1 & R2 indicated that they set test cases that were already predefined to be executed in each release to help amend the requirements of RT, which meant conducting RT based on their experience within the system (R1.15, R2.26). R1 and R5 agreed with what R2 stated:

"Regression testing can be ambiguous and blurry from a QA perspective to determine some-times the scope of each ticket to identify to perform regression on." (R2.28).

Which is a similar assertion to R3 stating that on a monthly basis rather than on a sprint basis (scheduled basis), they conducted RT and had a similar process and documentation. R4 and R5 revealed that determining the scope was based on modifications made in the update in order to merge new code into an environment (R4.5, R5.2). Overall, the respondents expressed how difficult and time-consuming it is to scope test cases in their current practices.

4.4 Level of VA knowledge

This factor was for the purpose of assessing how much QA managers knew about VA capabilities and features. The rationale behind establishing this was based on the premise that they would easily adopt VA if they had knowledge of it. A strong majority expressed having worked with visuals but not necessarily related to software RT. R1 talked about VA and related it to other concepts.

"It amazed me when you coupled the visual analytics from one side with QA regression testing from the other side, because I know about visual analytics in the field of data mining and data warehousing, whereby you go to the business intelligence side, decision making, management decisions, so this is what visual analytics is used for in the real world" (R1.19).

In a similar way, while R2 related VA to dashboards and charts (R2.49), R3 revealed that he knew TestRail as a test management tool and indicated how beneficial it would be to QA. R4 and R5 revealed how previously they worked with visualizations to come up with more metrics to identify what was a need and provided more information for management request information (R4.13, R5.22).

4.5 Perceived Barriers

With this theme, we aimed at establishing challenges and barriers that QA managers perceived they would face in adopting VA in software RT. R1 stated that the QA sphere is persistently challenged with keeping experts in the field and claimed the attrition levels were high, which would potentially affect the introduction of new technologies to the teams, which normally required a learning curve. R2 discussed that the learning curve with new technologies sometimes slows productivity.

"We'll have to run a manual regression afterward just to make sure that that it's kind of working fine like comparing that after the merge to production and making sure that we didn't have any issues".

Just like R1 and R2, R3 claimed to find it difficult to easily trust the results generated without coding because QAs wanted to read and understand what was happening during test execution in as much as visuals were seen as resourceful, but equally thought it was beneficial in the long term and short term (R1.210, R1.205, R3.55). R3 talked about the challenges related to interpreting the metrics and linked them to the TestRail Management system, which they had previously used. R3, R4, and R5 further claimed that scrum teams or development teams have the mentality of thinking in a technical way, and that's exciting for them. R4 talked about a high workload in QA and hence having limited time to add new tools (R4.57). While R5

shared similar challenges and barriers earlier mentioned, R5 added the complexity of visualizing metrics, which may again slow the adoption of VA (R5.22).

4.6 Perceived Benefits

The factor captured perceived benefits associated with adopting VA in software RT. It would help in determining how QA managers consider them as a critical factor in either adopting it or not. Firstly, all QA managers upfront indicated that there were several perceived benefits. Secondly, they indicated that VA capabilities can add value to QA execution and implementation and the company as a whole. Thirdly, they talked about VA making it easy for management and decision-making, especially in helping in determining the code of the impacted areas. Not only did they think that teams would be efficient in QA but also better understand the code quality and delivery of results. They also linked it to employees' motivation at work if they are using the right tools to execute the work efficiently. Although R4 discussed that it was more beneficial for manual testing than automatic testing, QA managers indicated that all types of testing would benefit from VA (R4.22). R3 stated:

"I'm sure it's much faster than again analyzing raw data and going over hundreds of related tickets and remembering what happened last month and what's happening currently, so QA gives me that data fast" (R3.44).

R4 shared a similar sentiment that VA would increase the software RT cases, hence giving confidence in the product modification (R4.22). R3 and R4 also indicated it would enable the QA managers' team to start shifting their minds, not just by looking into code (R3.53, R4.22). Overall, it can be deduced that QA managers' perceived VA benefits outweighed challenges and barriers in software RT.

5 Discussion

5.1 The application and use of VA in Software Regression Testing

The results suggest that QA managers expressed a strong desire to adopt VA in software RT, and the main reason was to support the decision-making process. It was discovered that the intention to adopt VA as technology in QA was influenced by several factors, as supported by Venkatesh et al. (2000), who suggested that in extended TAM 2, the intention to use technology was influenced by three broad factors: perceived usefulness, perceived ease of use, and subjective norm. In line with the study results, there is a correlation between these factors. And in line with Venkatesh et al. (2000), the results show that the perceived usefulness of VA in RT was the most influential factor in the intention to use the technology. Further, the results were somewhat contradictory on the contribution of perceived ease of use to the intention to use the technology, as respondents discussed that perceived ease of use had little influence on the intention to use the technology and that it contributed largely to perceived usefulness as a construct. We do, however, believe that perceived ease of use can influence both usefulness and intent to use, and this belief aligns well with Venkatesh et al. (2008), who extended the model to TAM 3 to ensure the inclusion of external factors affecting it.

Furthermore, the subjective norm was another factor with variant views. While most respondents found it less significant, we argue that this difference in views might have been brought up because we didn't consider "voluntariness" and "experience" factors in the study design. And according to Venkatesh et al. (2000), the subjective norm is partly influenced by "voluntariness" and "experience". Nonetheless, the exclusion of these factors in the design was premised on the fact that it was not a requirement to impose the QA managers and that there was no tangible VA technology to have experience with, respectively.

To discuss specifically the perceived usefulness and ease of use, the results suggest that VA capabilities and features would facilitate the execution of software RT, is user-friendly, reduces the time to do test cases, enhances quality tests, and is easy to explain results to others. These results address the identified ST aspects and challenges in the literature, namely social, technical, and psychological. According to Braa and Øgrim, (1995), users' experience is critical to evaluating the quality of software whose assertion aligns well with the user-friendliness and enhanced result explainability that VA provides. All the respondents indicated that VA can potentially address identified aspects despite having challenges. The technical perceptive challenge was related to the efficiency in the execution of tests (Srivastva, Kumar & Raghurama, 2008; Lenz, Pozo & Vergilio, 2013; Tang, 2010). It can be shown from the results that VA would greatly minimize the execution duration. This is based on the respondents' argument that in the case of the huge dataset and the pace at which clients could want to be attended to, and spent in test cases, execution remains significant. Furthermore, from the psychological challenge perspective and according to Myers, Sandler, and Badgett (2011), having a higher chance and confidence to catch errors, and more trust (Paynter, 1997), positively affects the outcomes of testing. In line with the results obtained, VA improves quality testing. Respondents emphasized an increase in the detection of errors and the output quality with the use of VA.

Concerning perceived maturity, the results demonstrated that VA application was required more in manual testing than with automation testing which is in line with Whyte & Mulder, (2011) assertion that manual testing was prone to human errors. However, all respondents agreed that VA capabilities were required in both cases for decision-making purposes, even though a combination of the two types of testing was preferred. It is also understandable due to the cost implications for the maintenance of test scripts (Taipale et al. 2011; Kasprzyk et al. 2016). Further, considering that respondents expressed displeasure at how difficult and time-consuming it is to scope test cases during RT, we believe that, to some extent, QA managers can be easily motivated to adopt VA in ST to enable timely decision-making and efficiency in the QA environment, among other reasons. Furthermore, the findings show that the respondents were not completely new to VA. They had some varying VA knowledge, but the common element was experience and understanding related to practice in warehousing, business, decision-making, and general management considering that all respondents interviewed were occupying previous or current team leading roles. This level of VA knowledge among QA managers and their well-understood importance in identifying needs and generating insights from the test cases was convincing enough to believe that it would influence whether they adopt VA or not in software RT.

Perceived Barriers

Having established barriers from the QA managers' perspective, it's important to relook at how they relate to the intention to use them as a construct on extended TAM 2. Earlier in the literature, it was stated that there was a challenge to VA adoption. The findings have shown several perceived challenges and barriers that would potentially impede VA adoption in the QA ecosystem. If a new technology is introduced to new staff, QA managers believe that would always affect whether to adopt it or not. Furthermore, QA managers believed that, like every other technology, VA would have a learning curve when introduced in a particular setting, which sometimes takes a long time. This was referred to a degree in VA training to help the team have the appropriate skills. On the contrary, we argue VA applications have self-reliant features and capabilities (Lennerholt et al. 2018), and therefore, even less experienced staff would kick off with ease and, henceforth, reduce their supposed learning curve, affecting productivity in the QA environment. The findings also indicated that QA managers viewed their team as very technical-driven. They further claimed that QA specialists would always want to understand the execution details. On the contrary, we believe VA utilization in QA should be seen as complementary and not as a replacement for QA processes. If this shift in mindset is achieved, QA specialists are likely to deliver the desired results effectively and efficiently.

Another barrier was related to difficulties encountered with the previous applications. For instance, from the findings, respondents talked about the challenges related to interpreting the metrics and linking them to a test management tool, which they had previously used. However, according to Gorko et al. (2018), VA capabilities have become advanced and well enabled to meet the current requirements in many fields, including QA. We, therefore, argue that, in line with Li, (2018), VA applications are more convenient and user-friendly for enhanced performance. Concerning the barriers, all respondents acknowledged the aforementioned barriers to VA adoption and equally indicated that they would influence whether they adopt the technology in QA. They also indicated that the learning curve would slow down the speed at which staff executes the test cases; however, in the long term, it is highly beneficial. We,

therefore, argue that barriers should always be looked at with keen interest because they have the potential to affect the intent to use VA in QA.

Perceived Benefits

The decision to either adopt VA or not in QA is based on perceived benefits or advantages associated with it. In this study, QA managers viewed VA as adding efficiency to the ST cycle by making it easy for management and decision-making, especially in helping in determining the code of the impacted areas. In line with Perdana et al. (2018), who indicated that interactive data visualization tools and techniques improve efficiency and make it more explainable due to the richness and interactive interfaces provided to the QA managers. This is supported by the findings that VA in QA enhances the understanding of code quality and delivery of test results during the QA resulting in an increased interpretation of the visualized test results. Furthermore, the findings suggest a link between having employees motivated at the workplace and the usage of the right tools in executing the QA activities. Li et al. (2018) further highlight that VA increases knowledge as a result of huge dataset exploration and analysis. This was found to be useful for QA managers who are exposed to huge datasets of historic testing results to drive knowledge from the raw data (Card, Mackinlay & Shneiderman, 1999; Thomas & Cook, 2005). It also increases the engagement of a QA manager with the system, causing a change in the behaviour of the QA manager toward performing RT as they perceive it as useful and easy to use (Wang & Santhanam, 2015). Moreover, there is an increased willingness for QA to become result-oriented, which shows a level of high dependability once the adopted technology is mature.

Based on the foregoing, we would argue that perceived benefits go beyond the perceived ease of use and perceived usefulness as the factors of influence on the intention to use. We believe that perceived benefits tend to focus on the advantages associated with using the technology.

5.2 Implications

Based on the findings, we can deduce that the intent to use VA in the software RT ecosystem would be impacted by four (4) factors, namely: perceived usefulness, perceived ease of use, perceived benefits, and perceived challenges and barriers. See proposed figure 6 for details. Perceived usefulness is influenced by job relevance, i.e., how VA supports the core business of software RT. The second external variable influencing perceived usefulness is the quality of test results, which has the resultant effect of reducing errors. In this way, the QA manager's focus is to ensure the test case results are of high quality. The third is result demonstrability, to capture and ensure that test results can be communicated and explained easily to others, in line with the definition stated earlier in the literature by Plouffe et al. (2001). Other QA managers' interests and the contribution to one's status when using the VA technology and by perceived ease of use. This perceived usefulness view is not different from the Venkatesh et al. (2000) extended TAM 2. However, we also believe that, based on the results obtained from this research study, perceived benefits and perceived challenges and barriers should be keenly considered because they could potentially have an impact on the desired outcome of adopting a new IS. QA managers highlighted the perceived benefits of VA in the software RT environment, their assertion is that intention to use VA should largely be based on the utmost advantages it brings to the entire system, and we, therefore, argue these benefits have the im-

portance and contribution to the intention to use the system. It is worth noting that the intention to use VA in the software RT processes is a strategic decision that should be attached to the benefits attached to it. Similarly, perceived challenges and barriers are of concern also. According to Lennerholt et al. (2018) and Li (2018), VA adoption is still low. We believe that barriers and challenges to VA adoption should be of interest to QA managers to properly either adopt or not adopt VA in software RT.
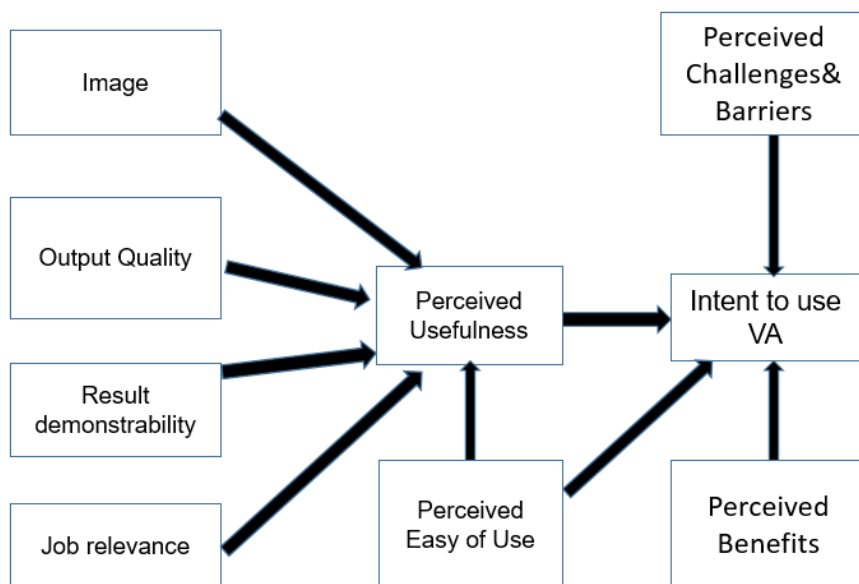
Figure 6 Adapted Extended TAM2 (by the authors)

5.3 Software Regression Testing with VA adoption in Information Systems

The fusion of two concepts, ST and visual analytics, has mostly been conducted, for example, from a software engineering and computer sciences lens (Entström, Mantylä, Runeson & Borg, 2014). And yet, according to Weiss (2012), ST remains a perpetual and long-standing challenge for corporate institutions willing to minimize errors in software quickly. He further adds that individuals who used appropriate testing approaches would catch errors early in the development cycle (Weiss, 2012). We believe that Weiss's (2012) assertion holds true for VA considering the perceived benefits highlighted earlier. With the experiences we have had during the writing process, we found limited literature on this unique and novel topic. In this way, the topic of ST with VA in IS opens opportunities to contribute to the literature. Furthermore, the developed and extended TAM 2 framework takes into account the dynamics surrounding VA utilization in IS.

Overall, we believe the results of this research study would stimulate further research on the topic in IS as the discipline becomes established and relevant going forward.

6 Conclusion

This research study set out to understand the perception of VA adoption in software regression testing, with particular focus on the QA managers' perspective, with the aim of answering the "How do quality assurance managers perceive the adoption of VA in software regression testing?"

The aim of the study was to explore, via qualitative interviews with QA managers, the application of VA to generate insights from data produced in agile software regression testing activities. We focused on investigating a rather unexplored topic and attempted to fill the identified gaps on this topic in the information systems literature by extending the TAM 2 model to gain new insights into this phenomenon. Furthermore, we aimed to develop a framework for visual analytics adoption in software regression testing that fuses the characteristics of VA with the QA managers' perception of it.

The results of our study indicate the intention to use VA in the QA ecosystem is influenced by perceived usefulness and ease of use, in line with the original developers of TAM 2. However, we also found that from the QA managers' perspective, perceived benefits and barriers are very important to be considered and therefore formed the basis for developing a new framework for studies related to VA in QA. We learned from the respondents' discussion that even if the VA would be useful and easy to use, barriers and benefits were very influential. Regarding the perceived usefulness, we found that it was the most influential factor in intention to use. The respondents have shown that VA should primarily focus on contributing to solving core issues in QA processes. This includes responding to factors such as relevance, result demonstrability, and quality of output. While others argued about the extent to which the perceived ease of use of VA affected the intention to use it, it was still established that it was an extremely influential factor.

Based on the results obtained, it is pertinent to understand that Intent to Use VA in the software regression testing environment is complex as it involves several factors to be considered. Additionally, the results show that VA can add value to QA ecosystem. However, to successfully adopt VA or not in the QA ecosystem, QA managers should keenly and with flexibility consider the four factors: perceived usefulness, perceived ease of use, perceived barriers and challenges, and benefits.

6.1 Future Research

Visual analytics will keep evolving as a phenomenon, and its potential is to some extent untapped. As such, more research work to be conducted regarding the topic would be recommended. In this study, we have developed and extended TAM 2 to consider the barriers and benefits with regards to having the intention of using VA in a QA environment. It is recommended to perform future quantitative research to test the theoretical model developed in this study. The outcome of such a type of research can lay the groundwork for the theory to be supported or falsified in the form of measurements (Recker, 2013) by reaching a larger audience.

Understanding the perspective of QA managers is critical as their role is critical in whether to adopt VA or not. While our study revealed barriers and benefits to be of paramount importance to the intention to use VA, we recommend further detailed research investigations that would largely focus on those two factors because of their potential to contribute to the QA domain by adding value to mainstreaming efficiency in the QA activities, and to the academic body of knowledge in IS.

Appendices

Appendix 1. Interview Guide

Background Check

1. Do you mind recording this interview?
2. Do you wish to be anonymous?
3. In what capacity were you or are you involved in the software quality assurance domain?

Generic Questions

4. What kind of software regression testing do you or did you perform?

   Is it a "test-all" approach to executing test cases or a selective one?

5. How do you determine the scope of regression testing during a release cycle?

   Is it based on a systematic approach, ad-hoc perspective, or based on a personal experience with the system?

6. How much do you know about visual analytics capabilities?

Questions - Part 1

Intention to Use

7. What is the impact of VA in software regression testing with regards to decision-making? why?

   Would that aid you in scoping/selecting regression test cases in a systematic manner based on the historical test result extracted from different applications or test management tools using VA?

8. Assuming that significant challenges to the implementation of VA were overcome, would you intend to use such technology during software regression testing? Why?

Perceived Usefulness

9. What is your perception of utilizing visualizations interfaces/dashboard to view histor-ical regression testing results?

What impact does it have on job performance?

What is your perception of using visualizations interfaces/dashboards with manual testing?

What is your perception of using visualizations interfaces/dashboards with au-tomation testing?

10. What is your perception of using VA during regression testing in agile practices?
Perceived Ease of Use

11. What is your view on the ease of interacting with visualization dashboard/interfaces during regression testing?

Subjective Norm

12. Who do you think would influence you to use VA during regression testing to view historical test results? Why?

Image

13. How do you think the view of others toward your department will be affected after the adoption of VA in your current regression testing activity?

Job Relevance

14. How relevant is it for you to use VA during software regression testing in your job role as a QA manager? Why?

Output Quality

15. Do you think the output quality of regression testing results could be affected by the use of VA? why?

Result Demonstrability

16. How explainable do you think the dashboard showing historic regression test results would be?

17. How easy do you think it will be to convey to top management the quality of software after introducing visual analytics in regression testing? Why?

Questions - Part 2

18. What challenges do you think would impede the adoption of VA use in Software regression testing? Why?

19. What benefits do you think are associated with the use of VA adoption in software regression testing? Why?

- What is your view on the impact of visual analytics adoption on regression costs and time-related matters?

Closing question

20. Do you have any additional perspectives/information that you think has not been discussed but would be relevant to the study?

Appendix 2. Interview Invitations

Title: Interview Invitation For a Master Thesis

Dear X,

Fredrick and I are postgraduate students at Lund University pursuing MSc in Information Systems. We are sending this email to kindly request your participation in conducting a Master thesis research study titled: Understanding the Perception of Visual Analytics Adoption in Software Regression Testing - A Manager's Perspective**.** The intention of the research is to examine and understand the Quality Assurance manager's (or anyone who has held managerial responsibilities within the QA department of a company) experience and confidence in the idea of adopting Visual Analytics capabilities during software regression testing. Specifically, we aim to understand QA managers' perception in applying Visual Analytics capabilities to visualize historical regression testing results extracted from different applications or test management tools and examine their perception to see whether it makes regression testing more efficient and effective in catching software anomalies. Hence the focus of the research is related to studying the perception of QAs toward such adoption from a socio-technical point of view. The various

constraints and challenges related to regression testing have prompted and motivated us to conduct this research in order to understand the opportunities that can be brought on by adopting Visual Analytics in regression testing and most importantly to examine the perception of QAs behind such adoption.

We believe that your experience and knowledge in the domain of software quality assurance would greatly contribute to this research topic and provide rich and important empirical data to our thesis.

Kindly note that your participation is voluntary in this study and you can withdraw at any time from it. We do not ask you to provide your identification information unless you agree on that hence it can be performed in an anonymous mode. Moreover, the empirical data collected will be solely used for research purposes.

We look forward to your valuable contribution to the research and we are open to conducting the interview via Zoom, Meet, or Skype call at your convenience.

Thank you for your time and consideration,

Sincerely,

Fredrick Chomba

Hicham Itaoui

MSc Students in Information Systems, Lund University, Sweden

Appendix 3. Consent Form

CONSENT FORM

What is the intention of gathering the information?

We are sending the research protocol to kindly request your participation in conducting Master thesis research titled: Toward the adoption of Visual Analytics in Software Testing-Understanding Software Quality Assurance Manager's Perception of utilizing Visual Analytics application during Regression Testing. The purpose of the research is to examine and understand the Quality Assurance Manager's experience and confidence in the idea of adopting Visual Analytics capabilities during software regression testing.

Who is the information from the interview intended for? How will it be utilized?

It is for students (Hicham Itaoui and Fredrick Chomba) conducting their master thesis in Information Systems at Lund University.

What questions will be asked in the interview?

Mainly, our questions will revolve around two main themes:

Perceived usefulness of visual analytics adoption in software testing, specifically in regression testing.

Perceived ease of use of visual analytics adoption in regression testing process.

How will your answers including confidentially be handled?

The responses will be handled anonymously if requested. They will be also reflected transparently in the report without changing their meaning.

What are the risks and/or benefits associated to the person being interviewed?

Interviewing participants for about 45 minutes might bring discomfort. Otherwise, the benefits outweigh the risks in that your participation in this study provides an opportunity to contribute your experience and knowledge in the domain of software quality assurance to the research topic.

Name:

Signature:

Appendix 4. Respondent 1 (R1)

Speaker	Code	Content
1.HI		[Re-explaining the goal of the interview, the concept of visual analytics and regression testing, and reassuring ethical issues before we start the interview]
2.VD		[nodding his head], okay, yes sir [smiling], yeah let's go ahead
3.HI		Okay, good. So umm, for the sake of you know keeping things ah ah transparent, Fredrick will be leading the questions and I will be supporting the the arguments or I'll be complementing any things that is not clear or you know needs more clarification and stuff like that ok?
4.VD		OK
5.FC		Yeah sounds good, uh thank you very much for the opportunity to meet you finally yeah um the first question could be related to what kind of software regression testing have you done or do you perform, umm is it a test all approach or some selective cases? We just wanted to have an overall understanding of those yeah that you yeah and I know Hicham may have some ideas but I think we just want to put things into context yeah sure
6.VD		Yeah again so you want to know what kind of software ah I use?
7.FC		The kind of software testing, ah the kind of regression testing that you have done or you use
8.VD		[Nodding his head] Ok Ok
9.FC		Yes
10.VD		Alright
11.VD		So, the kind of regression testing, so basically uhh in the company where I worked with Hicham in the capacity of a team leader umm we were expected to do manual testing
12.FC		Alright…

13.VD		Alright so yeah manual testing is there and is not soon to be gone you know no matter how much we move to automation because automation has its well its limitations alright
14.FC		[inaudible]
15.VD		Alright so at the end of the stay with the company umm, we were moving to automation slowly and I so I left the company so during that period uhh my experience with Hicham in the team in those projects were solely based on manual testing, including the regular functional non functional testing plus the regression testing was done in a manual way what I mean by manual way ehh is that umm there is no script umm there is only test cases and test scenarios ehh written by the team okay based on the experience so the most senior person would provide experience about the application to the more junior or newer people inside the team and then together they will write uhh the test cases alright so it's a verification loop the senior will tell what are the areas that need to be covered the junior person will write the script the senior will approve the script and then that is set, once that is set umm you can repeat this checklist all over again every time you're gonna do tour functional or non functional or regression testing [Nods his head]
16.FC		Awesome, oh Okay
17.HI		That is awesome insights, Vicken has covered the first two questions actually and now we can move to the third one.
18.FC		Sure, yeah, umm the next one is related to visual analytics, what's your how much do you know about visual analytics capabilities?
19.VD		[Smiles] Well uhh, it amazed me when you coupled the visual analytics from one side with QA regression testing from the other side because I know about visual analytics in the field of data mining data warehousing whereby you go to the business intelligence side, decision making, management decisions, so this is what visual analytics is used for in the real world, and from the other side, uhh you have the QA area whereby regression is the most maybe uhh difficult or most tricky area in the QA career in a QAs career because you really don't know exactly uhh what to test or what to cover unless you are given clear guidance by the development team where to look for regression uhh regression.
20.FC		Okay

21.VD		[Inaudible] Yep
22.FC		Yeah
23.VD		So the moment I read this title that you have chosen I was really glad [smiles] for you two because I'm pretty sure and I really hope that you're gonna make a very good thesis about this in your masters with this subject and I'm I understand where Hicham is coming from and from the pain we had underground in terms of regression and the way he is looking ahead and looking for solution for this problem.[H1]
24.FC		[Ehm] awesome
25.HI		Thank you very much
26.FC		So um I think…
27.VD		So that was answering your question? Or was I off subject?
28.HI		No no
29.FC		I I think first of all there is not correct or wrong answer
30.HI		Yeah this is a …
31.FC		[Inaudible…] the good part is that you have answered I think I think most how you appreciate the fact that you already have a good impression of what it is all about which is a good thing for us, yeah, umm, and so I think in our context visual analytics I think it it could we can of course try to narrow it maybe talk about dashboard being like Hicham explained, yeah so those are the aspects that we are trying to see the possibility of being infused mainstreamed in the testing process so umm and this now takes us to some other questions umm one of the questions is how do you, how could you perceive the application of VA in regression testing to make in making decisions?
32.VD		[thinking and rolling his eyes up] umm again, the application of visual regression in making decisions?

33.FC		Yes how could you how do you see it being used in decision making for instance?
34.VD		Okay okay in decision making in terms of quality assurance this is the focus
35.FC		[Inaudible]
36.VD		Not in terms of business
37.FC		Yeah
38.VD		So well ahh, umm ok let me put it this way ah okay let me let me go to the core of the subject …
39.HI		Yeah
40.VD		that you are trying to reach
41.HI		Yeah
42.FC		Yeah
43.VD	PU	so, the moment you sent me the consent form ah by email I was like mm the informed consent form is typically used in the healthcare industry Hicham would know better because his father is a doctor
44.FC		[ehemm]
45.VD	PU	I don't know if you have any doctos fred in your in your family but you can aks around and see that docitre usually ahh makle the patient sighn such informed consent
46.FC		[ehemm]
47.VD		I will let you I will tell you why i'm bringing this topic I will make the link

48.FC		Yeah sure sure
49.VD		So ah because they want uhh the patient to be aware of the treatment he is being given by the doctor with the pros and cons and all the risks involved okay? In an ethical way
50.FC		Yes
51.VD		Okay let's take this think further and take the QA domain okay and compare it to the doctors or the healthcares okay so if you think about it we've been doing regression or doctors have been doing regress regression testing ah from the beginning of humankind
52.FC		Yeah
53.VD		But without knowing or calling it regression testing, let me put it in easy way so the code that you have that you have written is like the body of the of a person
54.FC		[Ehemm] oh awesome
55.VD		Okay so any intervention you do on the body of the person surgical or esthetic or whatever it will definitely have an impact on other parts of the body right so what do doctors do let think together the doctors put the patient in a monitoring phase for a certain time okay and they monitor uh the health metrics of the patient they put them on a machine they monitor his heart him maybe his brain his blood pressure etcetera etcetera so there is a whole list of things that a doctor monitor okay after well before and during and after the intervention right ?
56.FC		Yeah
57.VD	IU	So okay this is the doctor's case so um let's take another case maybe it's a very different domain but it also its very highly paid in civilized country plumbing so plumbing.'I think that VA is like doctor diagnostic and monitoring tool on a patient' and also for a plumber is so they will do the intervention on the pipes of the house alright and then before during and after doing the intervention they have way to monitor if there are any hidden leaks inside the pipes or the house in other aead o the house maybe with the neight or any other place right so healthcare and plumbing are two real life example where regression testing happening but without maybe calling it regression …

58.FC		[Ehmm] awesome
59.VD		ok so moving to the to the and right to the answer to this question is that umm if you're looking to umm [rolling his eyes up] to build a visual analytics I don't know if you want to move to that question to build a visual analytics you wanna ask me that or should I I
60.FC		Yeah sure sure
61.VD		Someone is looking to build the visual analytics ahh it might consider how doctors and plumber work okay in terms of checklist and health metrics probably you understand so probably you would have visual metric of the code ahh similarly design as health metric of a doctor monitor screen for example okay with all the not the emoticon symbol sign metrics you understand so ahh that would be a cool dashboard to ha vasa visual analytic tool.
62.HI		[Hehmm]
63.VD		So far I will stop here ah maybe you have different questions for me
64.HI		Yeah maybe I would wanna complement this and ask for example if for example this dashboard provide you the capability to view the historical test results you have test results from lets say applications like Jira or locally or even excel file that are saved somewhere in the company or u know shared document or google and so forth and you have the capability of VA or visual analytics to showcase t you those metrics using a dashboard so that q a managers can look at them and see what its previous defect history and see some patterns for example if this feature or this functional is facing a lot of problem through many release cycle it raises alarm for example certain functionality took more time than other this also raises alarm and so on its like you are providing the QA manager a dashboard or lets say a visual tool to view historical test result and based on that they can make decisions whether such ah dashboard can actually accelerate or slow down the job by knowing how were to focus testing exactly where, so where ahh we where trying to see how could you perceive that as a QA manager if you have such capability in front of you

65.VD		Yes excellent excellent, so umm you're moving things further (smiles) and very fast and you guys are nearly on time because we are moving pretty fast that is great so umm the thing is that umm again you're taking me back to the data warehousing area whereby you do this cleaning of data and transformation and moving it into a data warehouse
66.HI		Yeah..
67.VD		Whereby you source data from different source right
68.HI		Yeah exactly..
69.VD		So the process is the same but the purpose is different different usage
70.HI		Yeah exactly..
71.FC		Exactly yeah
72.VD	PU	Ok [thinking] umm ahh so definitely since ok let's do a parallel since the data warehousing and business intelligence are has taken so much fame and importance and usefulness in the business are in the business industry so umm I truly believe that using the same process and applying to the QA eh will give also successfully results okay because ahh well you understand historical data is again very useful for any domain okay so ahh it's all about pattern recognition okay so your tool will definitely have a part if it would have a part of AI that would be also an additional touch whereby it will learn how to recognize patterns now that is something maybe more advanced but let's stick to the basic stick to the basic of retrieving data without analyzing just retrieve and displaying them maybe allow the person to find similarities you know okay, while I'm talking ah something came to my mind [rolling his eyes up] is that you know the relational database
73.FC		Yes
74.VD		How is it build?
75.VD		So how do you Fredrick? How do you visualize a relational database when we learn the relational database the most basic form of tables it's

		one to many relation like you have one table with a foreign key going to multiple tables right?
76.FC		Yeah
77.VD		So I'm thinking about the regression the core of it is like one change
78.FC		Yeah
79.VD	PEU	Has multiple areas impacting so visualization of one bug or one new functionality let's call it functionality A okay will need to see on the screen something like the relational database A linked to different areas inside the code
80.FC		Okay
81.VD		Okay so this is something that I am expecting or perceiving to be cool because to see something very close because these people are from the IT industry and if they see something similar to relational database,with capacity to handle big data, that would be cool you know because it's something very familiar easy adoption OK ahh you're talking their language instead of building instead of building something very complex
82.FC		Yeah
83.VD		You're touching the minds and hearts of the users who are IT professionals
84.FC		Sure, so I want to guess that it is very easy to adopt such type of technology, right?
85.VD		It it it goes back to the way giving so after all this is a product if we take company A B C producing ok let's say you submit your master thesis to three companies and these companies will work independently on building a product software tool OK on what you gave them in theory so you give them the theory and they will apply it by building a tool but every team we'll build it in a different way
86.FC		Okay

87.VD		So so you you know in the reality of things how Microsoft and apple and these evolved and they became success stories because they know how to reach the customer and I understand umm what is needed or what are their needs exactly
88.FC		Okay awesome awesome
89.HI		Amazing
90.FC		Hicham you wanted to comment something?
91.HI		No No
92.FC		Umm yeah maybe we move a step further to talk about the usefulness of these type of technology visualization with regards to software testing I think in a way you have explained it but maybe in the context of do you see it being able to accelerate the work or slow down your job performance as the QA engineers are doing their work or the quality assurance engineers?
93.VD		[Hmm] (thinking) interesting accelerator work so... It's the same story repeating itself
94.FC		Yeah
95.VD		When you're introducing a new tool to the team OK, there will be a learning curve
96.VD		[Ehemm] OK and people come and go from the team so if you have one expert who took maybe six months or one year to be expert in this tool visual analytics for regression testing and if you lose that guy OK so you're losing capability inside the team so think about resource think about processes so, sometimes i mean, not every time technology will solve your problems
97.FC		[Ehmm]
98.VD		It's the process that will solve your problems

99.HI		[Inaudible]
100.VD		OK, so if you reach a point so you might be doing the same thing with-out at a tool
101.FC		Yeah
102.VD		So I don't know if in your title you are using the tool word or you're just saying the concept because we might be able to do this in simple excel sheets and a different kind of sources in a manual way okay
103.FC		Yeah
104.VD		Moving things into a tool okay so there is definitely an adoption and there might be rejection also if the tool is not very user friendly or adap-tive enough
105.HI		[ehmm]
106.FC		Awesome
107.HI		He's... [Inaudible]
108.FC		In fact we're going a step further
109.HI		Yeah
110.FC		We will be asking about the easy, imagine this is friendly how easily could it be ah how is it a big factor in adopting it?
111.VD		OK let's say things are very, very good and it's an excellent tool easy to adopt ahh like ahh a child of seven years old or 10 years old can easily understand and go with it
112.FC		[ehmm]
113.VD		Alright so umm so but again, the tool the tool might be great but the user might [inaudible] use 5 percent of this tool

114.FC		Okay?
115.VD		Did you think about that because ah they might be interested only with that's much of the tool capac.. capability and again this something that we see in most of the softwares people go into the software believe me if I say they only use maybe 5% just like the humans they only use they say how many percent is Hicham? Of the brain capacity
116.HI		[I am not sure]... I forgot the estimate but...
117.VD		Let it be say 10 %
118.FC		Yeah
119.VD		Yeah 10% of all capacity I think it goes back to the same logic
120.FC		Okay
121.FC		But [Inaudible] in principle could you agree that perceived usefulness of visual analytics could be umm could be could be appreciated say to deal with manual testing automatic testing
122.VD	PU	It would be appreciated in hands in the hands of people ahh who this tool is intended for and in the hands of the people who appreciate such tool umm at their work
123.HI		nice
124.VD		It's always there are always conditions for the adoption
125.FC		Yes awesome awesome
126.FC		What about how could you view or whom whom do you think could influence the the use of this VA capabilities
127.VD		[Hmm]
128.FC		During testing aa

129.VD		Oh
130.FC		[inaudible] yes
131.VD		Who who will be impacted you mean?
132.FC		Yeah, how do you, yes, you as a lead, whom do you think could be influence the use of VA within regression software testing?
133.VD		Hmm [Thinking] okay..okay..so basically umm [pauses for some seconds] look umm im not gonna give you a cliche answer I'm gonna try to be as as as as straightforward as possible so the application of information technology nowadays OK is moving to the business world mostly OK
134.FC		yeah
135.VD		So the students of computer science are rarely going to the research realm there are mostly heading to the business world, okay
136.FC		[Ehemm]
137.VD		I don't know why maybe because of the remuneration or maybe because it's more exciting to go to the big you know big names and work in the corporate world rather than going and becoming a researcher or a professor in a university
138.FC		[Ehemm]
139.VD		so this is this just a trend that I am I can observe and tell you about okay so if we take this trend then we will simply i mean reach to the conclusion that this tool will be used mostly most probably in a business setup
140.FC		[Ehmm]
141.VD		Okay so the ones who are the beneficiaries of this tool will be the business team

142.FC		Sure
143.VD		And the management, ultimately the management
144.HI		[Ehm]
145.VD		Because because if if we go bottom up in the organization if we say QAs are at the bottom and making sure that the base is the base is very solid okay the beneficiary ultimately will be the business team and the management, I'm not talking about the customer because they definitely all share one goal to satisfy the customer need given OK but in terms of stakeholders inside the organization it's the business team who will benefit from this immensely, okay
146.FC		Awesome awesome, what about the the influence of VA adoption on managers who are using it as opposed to those who are not using it?
147.VD		Oh
148.FC		What could be your comment on that?
149.VD		Okay so if we have two teams
150.FC		Yeah
151.VD		A and B
152.FC		Yes
153.VD		A adopts the tool and maybe after one year we ask the other team that didn't adopt we ask them some questions and we see how they perform maybe?
154.FC		Yeah but in terms of reputation, who do you think, what could be your comment with regard to reputation this is this is your team you adopt ah with your team as manager ah Hicham teams team do not adopt, ah how could that be...

155.VD		Okay okay so [thinking] umm let me give you another real world example group of students kids in a school and another who are smart who are known that their grades are good OK and the other group of students who are known that their grades are not good
156.FC		[Ehmm]
157.VD		So we take those two groups it's not me who have done the study its out there, so we tell the the smart guys that they're not good and the ones that are not good we tell them they are smart
158.FC		[Ehmmm]
159.VD		Okay, and then lets see how they will perform ahh after a while and see their grades
160.FC		Yeah
161.VD		So you will you will see that the perception that they have of themselves that they are not good will give bad results the ones that are actually not doing well but they are convinced that they are smart are doing very well now [smiles]
162.FC		[Ehmm]
163.VD		Okay alright so these are two different groups
164.FC		Yeah
165.VD		So back to our reality back to our question okay did you make the link?
166.HI		Yes
167.VD		From the example I gave you
168.FC		Yes i did i did maybe we just want to elaborate more

169.VD		Ok so let me tell you why ok do you wanna explain to me or i will explain right to it so basically the ones who are given the tool okay are like they're like telling them this tool will give you great results and the other guys you're telling them that you don't have the the tool so you will like probably not do well ok so between these two lets i mean its just a comparative its a study you know so you have two group its a human behavior study that you are trying to do
170.FC		OK
171.VD		I can not give you conclusions because the ones that have the tool okay might not give results or better results than the other ones
172.FC		[ehmm]
173.VD		I'm questioning you assumptions ok I'm not giving you clear cut answers and I'm questioning the basic assumption that you're putting because I don't want you to fall into the ah ahh confirmation bias
174.FC		yeah yeah
175.VD		I don't want..
176.FC		I completely hear you I completely hear
177.VD		You understand
178.HI		[Ehem]
179.FC		Yeah
180.VD		So there is no clear cut answer to this. It all goes down to the person making use of the tool. If you have a hammer and you don't know how to use you may harm your finger, correct? In experts hands the hammer will do its job correctly the way it's meant to do
181.HI		[Ehmm]
182.FC		Awesome

183.VD		Basically this is my point of view [smiles]
184.FC		Okay uhmm let me ask this direct one about the suitability, how could you view it the suitability of VA in software regression testing ?
185.VD		Suitability...[Thinking]
186.FC		Yeah suitability
187.VD		As a
188.FC		as a QA manager as a QA manager do you really think if this tool do you really think this tool is suitable for consideration in software testing
189.VD		Suitable..relevance [thinking] look umm it definite would like we propose this to a team of QAs… VA will definitely create a new hype in conducting QA processes [smile]
190.FC		[Inaudible]
191.VD		It will and it will create an excitement and I'm sure some of the guys or girls or ladies or whoever is there inside the team will be excited some of the will be excited to adopt those people needs to be worked on and encouraged so that they become champions of that tool so later on they become trained trainer kind of approach ok so they learn it and pass the knowledge to the others
192.FC		okay
193.VD		Yeah definitely it would create a hype because its its common pain the regression, regression is a , it's a tricky business, regression
194.FC		Yeah what about in terms of quality? Did you see visualization and visualization is embedded in software testing do you see the quality the result they quality of result being improve or you'll see what would be your thoughts on that?
195.VD		Okay so [thinking] look umm in coding you have different approach at the beginning it was pretty sequential coding okay

196.FC		Ehm yeah
197.VD		And then it moved to be more encapsulated
198.FC		Ehmm
199.VD		Object oriented they call it so one procedure or one routine cause the other and the other one cause the other it's not anymore sequential like if you type if then like tons of line together no its no more sequential but you have two schools and both the two schools of writing code exist in the market still okay so is the tool gonna work well in these two types of coding, so if its purely oriented object oriented then you are losing a big market after all it's a product so you wanna sell it to companies so if you miss on sequential coding you're missing umm like maybe large banks who use like Cobol okay umm still for now maybe I don't know how much the percentage much the percentage 60 or 70% off the banks in the world they still use the very old language which is like 40, 40, 50 years old Cobol you have heard about it maybe or searched for it
200.HI		Yes
201.VD		Or you can Search for it, they're teaching it anymore in university but it's out there
202.HI		Uhmm
203.VD		But it's out there is scarcity in Cobol developers in the world
204.FC		uhmm
205.VD		By the way they are very well paid if you wanna look into it
206.VD		So if the tool doesn't cover this so you you are missing the very very opportunity you understand?
207.HI		Yeah
208.VD		I'm more concerned because the regression will hit the base OK testing will hit the code right?

209.FC		[Uhmm]
210.VD		So it needs to be compatible ahh this at least two kind of scripting ah methods yup
211.FC	IU	So how easy it is easy do you think umm this can be the adoption process or this message of visual analytics would be perceived with the top management to be able to consider adopting it in the linear regression
212.VD		Okay okay i understand you
213.FC		[corrects himself] in the regression testing
214.HI		Yeah
215.VD		Yes Yes okay I will I will answer this question Hicham will smile now [smiles] because in of the okay by background I'm more into project management I will bring into this discussion the project management side of it, so you're management is your sponsor
216.FC		[Ehmm]
217.VD		So if you wanna say the idea as an IT manager to your higher manager that you want to adopt this tool okay so this is a project the implementation of this tool by itself is a project inside the organization OK so it will have a budget it will have a timeline it will have milestones you know just like any other project it might take three months six month it might be in house no in this case you're bringing it from outside so it might be outsourced to the consultants and come implement it for you
218.FC		Yeah
219.VD		Okay we're not tackling that this tool is in house because I don't know how many companies have the capability to build their own visual analytics tool for the regression they might do it
220.HI		Okay

221.VD		I'm not aware of this many companies do their own tools. They become preoperatory okay they become their own but the big the big guys I don't know if the other ones so if this is something not yet it doesn't exist, I want to ask you guys does this tool exist?
222.FC		Okay okay maybe before I answer that one I've just taken note let me ask you two just questions then I will come and conclude with the question you have asked, from your challenges do you think could impede or could stop or could slow the adoption of VA of visual analytics in software regression testing?
223.VD		[Thinking] hmmm ahh challenges ahh again I'll take you back to the project okay, the number one threats to any project and the number one reason of failure of project is communication problems
224.FC		[Ehmm]
225.HI		[Ehmm]
226.VD		Okay, okay, communication inside the corporation with the stakeholders ahh outside organizations if you have not very well organized your communication how you're gonna do it Where you gonna discuss it what kind of messages are sent what's the frequency of communication what's the method of communication are we gonna use telephone emails WhatsApp whatever so Zoom skype so if you don't put a certain like you prepared the consent form at least you've prepared you've respected the other party in that case myself you respect me by providing me even though it's a small document but it proves that you are like thinking ahead
227.FC		Yeah
228.VD		With that piece of document you are protecting both parties [smiles]
229.FC		Exactly
230.VD		So i think again back to the subject having a small communication plan okay you will find many templates online about this having a small communication plan at the beginning of the project will save you hassle later one okay this is the number one challenge that you will face

231.FC		[Ehmm]
232.VD		The 10 percent 10 percent i will leave the challenge to the technical challenges okay
233.FC		Awesome
234.VD		That you might face
235.FC		Awesome
236.VD		Quality integration call it I don't know last minute compatibility issues with the servers etcetera etcetera
237.FC		Awesome awesome yeah but maybe to condense what you have said, ahh what could you say could be the benefits of adopting this software regression I I think you have talked about it but i want your condensed with the way you answered the challenges part
238.VD		You want to you want me to focus on the benefits?
239.FC		Yeah the benefits
240.VD		Okay so we move [inaudible] from challenges we're now moving to the benefits
241.FC		Exactly
242.VD		To the benefits to the organizational
243.FC		[Ehmm]
244.HI		What I would say more I would if if you mind me just to ahh clarify this its its from an individual perspective more than an organization
245.VD		Yes

246.HI		Yeah so basically were trying to see the benefits and the challenges from an individual perspective rather than organization
247.HD		Oh thank you for clarifying thanks Hicham for this i was i was moving ahead to tell you about the organization
248.HI		[Ehmm]
249.FC		[Inaudible]
250.VD		So umm [inaudible] individual level again how can you be an in individual level separate from the organization? [wondering] okay let me put it this way maybe you will okay as an employee If we put it that way as an employee they are not motivated [smiles]
251.FC		awesome
252.VD		Right Fredrick? Because you are happy to have something that actually works okay and it works for you
253.FC		[Ehemm]
254.VD		it's making your life as an employee easier right because before you used to do things here and there with mainly spreadsheets and I don't know how you used to do things and it took you maybe like a week to complete the regression I know things are like ahh in the click of a mouse you can do things in a couple of hours your you are now a motivated employee [smiles]
255.FC		Awesome
256.VD		Yes
257.FC		Awesome
258.FC		Okay , ahh, back to the question that you have asked because I think yeah we want to give you also an opportunity there's that important question that you asked concerning whether it exists or not I think yeah umm , Hicham could you want to comment on that?

259.HI		Ahh, if you mind Frederick just if you can clarify a bit on what you are trying to convey
260.VD		I'll repeat the question I'll repeat the question So I was just wondering ahh and then ahh It's okay we can take this after the recording
261.FC		Yes
262.VD		Okay there are any because I don't want to names to be mentioned in-side this interview
263.HI		okay
264.VD		if that are actually any actual tools out there ahh tackling this matter so it's okay let's skip this question its okay
265.FC		Ah okay okay anyway so are there any anything ahh any reflections ahh that you have just that you think maybe we would have missed but you think could be important to this topic that you could want to add on
266.VD		[Thinking] umm yeah yeah definitely there is
267.FC		Okay great
268.VD		So ahh how many reflection would you like to have [smiles]
269.FC		Ahh
270.VD		Laughs
271.FC		Even a million [laughs]
272.VD		Yeah [laughs]
273.HI		As much as time allows you because we don't wanna take so much time of from you
274.VD		Yes I'm gonna to be very straightforward again

275.FC		sure
276.VD		So umm so basically umm…lets put it this way…I I keep on getting this in mind like umm you know The outliers in statistics
277.FC		yes
278.VD		Okay Fredrick you said yes?
279.FC		yes
280.VD		Yes so it's the numbers like like you said one million
281.FC		[Ehemm]
282.VD		yes
283.VD		So umm… in a way it's cool to have a tool that will catch the outliers okay which are like anomalies in your numbers very big numbers like you're not supposed to have [inaudible] like lets say very small object you're not supposed to have the price of it very high right or very little like 1 dollar thats an outlier in statistics
284.FC		yeah…
285.VD		So in regression testing umm [thinking] are you gonna tune the tool [thinking] To catch the outliers are you gonna have this capability?
286.HI		[inaudible]
287.VD		You might be asked this your users your end users or management will ask you the tricky questions
289.HI		[inaudible]
290.FC		[Ehmm]
291.VD		They will go to the extreme with you

292.HI		[Ehmm]
293.VD		The test your patience and to test your ahh knowledge about the subject because in real life okay sometimes wrong data entry happens okay your bug might be a caused by a number which is an outlier like somebody entered because the developer didn't put a correct limitation so he was able to enter like 1 million or 100 million okay and then the system is crashing why? because it's a data entry it's an outlier
294.HI		aha
295.VD		right?
296.FC		aha
297.VD		and your tests are failing and you are staying late at night okay banging your heads on the laptop
298.HI		[going with the conversion flow and saying "what's happening"]
299.VD		To understand what's happening
300.HI		aha
301.VD		And in the early morning time You discovered that oh this guy one user has entered an outliers number and it's crashing the system for us
302.HI		aha
303.VD		Okay so…so… is this tool gonna…ah be able to tune we're gonna be able to tune it to be sensitive enough to understand outliers?
304.HI		ehmm
305.VD		That's my reflection. I don't think we have an answer right now. If you have an answer or you guys have thought about it that would be great I love to…
306.HI		No i think this is would this

Speaker	Code	Content
307.VD		[inaudible]
308.HI		This this might open us some insights or are some challenges in our
309.FC		Yeah exactly
310.HI		Yeah which we need to think of exactly
311.FC		Ah otherwise these are the questions that we had I think Hicham could want if you have got any additions
312.HI		No no actually actually these are the questions and I would want to thank you very much Vicken for this opportunity it it really means a lot for us and those insights are really important for for all thesis and hopefully when I come back to Lebanon for a visit we'll have a cup of coffee or tea or something
313.VD		I'll be waiting [smiles]

Appendix 5. Respondent 2 (R2)

Speaker	Code	Content
1.FC		What kind of software regression testing are you involved in is it test it all or what kind of approach ah ah have you been are you involved in maybe as a break as a way of just breaking our discussion?

2.NO		it's lagging a bit cannot hear you are very well
3.HI		Ahh
4.FC		Okay maybe
5.NO		maybe it's my connection
6.HI		Ahh we…
7.NO		Let
8.HI		If if
9.NO		Let me try to rejoin
10.HI		Ok alright alright. So we gonna have to wait for Nadim until he is back [waiting]...can you hear us now Nadim?
11.NO		I can hear you very well Hicham but I couldn't hear Frederick for some reason
12.FC		Are are you able to get me now?
13.NO		Yeah its lagging a bit but I think lets try
14.HI		Okay we can try that

15.FC		We maybe we can try I think if it's not so clear I think Hicham can always comment [Inaudible]
16.HI		Yeah sure Yeah
17.FC		Yes
18.FC		Umm what kind of software regression testing do you do or do you perform?
19.NO		What do you mean by kind?
20.HI		Yeah, umm
21.FC		Test-it-all or is it a test-all approach or executing test cases or a selective one?
22.NO		Ah, usually we have a set personally where we work we have a set of test cases that is already predefined that we kind of execute in each release but these set of test cases like is kind of generic but is subject to be amended somehow ah like to meet the needs of the regression like it's not like a 100 percent like it's not a set that's cannot change it's always changes and varies depending on The task that we have in the release
23.FC		Awesome Awesome so umm how do you determine the scope of software regression testing ahh during a release cycle?
24.HI		is it based on a systematic approach ad hoc ahh personal experience
25.FC		[Ehemm]

26.NO		it's basically it at least from my point of view it it relies on my own experience within the system
27.FC		[Ehemm]
28.NO		Ahh that is related to the task that we plan during the beginning of each Sprint so basically during the beginning of each Sprint we get like like a 200 tickets
29.FC		Ehemm
30.NO		based on these 200 tickets that we have end to sprint and based on the experience that I have and which ticket might affect which ticket might affect other parts in the system we can determine the scope
31.FC		Awesome
32.NO		moreover moreover [smiles]
33.FC		Yeah
34.NO		as well yeah because not everything is clear from QA perspective so devs as well Provides sometimes the scope or for the affected scope in each ticket, so that will help us determine and enhance like the areas that, where need where we need to perform regression on. It's a requirement in this era to do things smartly.
35.FC		Awesome Awesome yeah we move to the topic of visual Analytics ah how much do you know about visual Analytics?
36.NO		okay how much I know like I know a bit

37.FC		Oh ok awesome
38.NO		Not that I don't know anything
39.NO		I hope that I will be able to help you [smiles and giggles]
40.FC		Ah okay no [inaudible] I think for the purpose of our discussion I think yeah visual Analytics we we cannot narrow it even us down us up to the dashboards just I I think it's just the issue of trying to mainstream the visuals within the software regression testing so we'll be talking in that talk context yeah but of course we know that by definition it could be broad and bigger yeah but I think for the purpose of our discussion it's about dashboards [inaudible]
41.NO		Yeah fair enough that is the part that I know actually
42.FC		Awesome awesome you really know a lot
43.NO		maybe I think that I know [giggles]
44.FC		Yeah umm how do you, how do you, how do you intend, how could you see visual Analytics being applied in Regression software testing to be transformed ahelpful in decision-making? how do you perceive visual analytics dashboard being used in being used in software regression testing ah to help make decisions… I don't know if I'm clear?
45.NO	IU	Yeah that this clear actually but that will actually depend on the data that is presented in the dashboard
46.FC		Yeah

47.NO		like we cannot like actually if if if you can give me an example of the data that is available I will be able to answer your questions and give you a detailed answer on how it will help us in decision-making
48.HI		[Ehmm] yeah perhaps I can jump in here and maybe elaborate on this more for example umm given that you Have a let's say historical test data results from previous release Cycles all the previous testing that you have performed ahh you with your team let say you have conducted several test cases and you have now a ahh bunch of data about how those test cases turned out to be are they failing are they not failing why they are failing lets say the patterns that they are they failing much more are they constantly failing or not so it's basically like it's basically if you are provided with her dashboard that shows historical test results extracted from different applications let's say you talkin from I don't know some tools like like Excel or like test management tools and so on but even if you have access to the code and you are doing unit testing for example for the people who are if you are familiar with this or if you know people who do this if you are able to extract extract all all of this questions all of these data in a single dashboard that shows to you to test historical test results and show you in a dashboard way or a visual way so that you can I mean would that help you in deciding where how you can take it further with the regression testing?
49.NO		Yeah that will that will of course help a lot actually basically because we have fined data from dashboards we will be able to observe patterns so let's say the the dashboard shows as a simple example shows that in each release we have we have a test case that Failed related to user registration somehow so that will help us to include it automatically in the our regression testing but ahh and once it's not failing anymore we can we can exclude it like it's not failing anymore during each Sprint so of course it will help but again it depends on that depends on the data accuracy because we might have some errors importing such data end to a dashboard we might like it is helpful at some point but I don't think that a dashboard will only solve the problem
50.FC		[ehmm] yeah

51.HI		Okay
52.HI		but would it for example help you in decision-making like for example in the next ah would you perceive it to be important in the decision making?
53.NO	PU	Yeah yeah it will help us in decision making a lot
54.FC		Awesome, for me I just wanted to Make a follow-up when you said It's not only the dashboards what else could you think could be able to help you or what can we coupled with dashboards to make sure that there is a successful execution stop software regression testing?
55.NO	PU	yeah maybe that does directly related to data analytics or visual Analytics but with visuals features it would be easy to detect to determine from the code on the impacted areas.
56.FC		Ah okay
57.NO		It is not directly related but it's very important to have that in an application
58.HI		Yes
59.NO	PB	the dashboard will of course help but like if we have a big data set we like something related to AI can help a lot
60.FC		Okay So with this understanding of visual Analytics how how easily do you think it's going to be for it to be adopted in the workplace for instance or are you as an individual or to introduce it to do your team?
61.NO		[thinking]

62.FC		Assuming the limitations that we ah of course you have talked about there could be some limitations that it may have but assuming that those limitations are taken care of, how easily could it be for you to adopt visual analytics in software regression?
63.HI		Or more like I think now Fred you are tackling the perceived usefulness right of this adoption or are you talking about the perceived ease of use?
64.FC		no I am talking about the intention to use
65.HI		The intention…
66.FC		How yeah ah assuming it's very [inaudible] assuming that limitations I I think you have talked about ah visual analytics not being the only thing that can solve the problems so now we are trying to establish assuming that any other these other challenges or barriers is that you may talk about that we may know yeah but maybe we'll talk about them later how easy or could it be very easy to have dashboards integrated or well adopted in software regression testing?
67.NO		okay so basically [thinking] again it's it's without without having these limitations It's very easy to adopt it
68.FC		[Ehmm]
69.NO	PU	and it will be kind of interesting to adopt a new thing that would help us enhance basically processes do a process end especially that it helps us determine the affected scope like like it is interesting somehow to have that
70.HI		[Ehem]

71.FC		Okay
72.NO		I don't know if that answers you
73.FC		It it [inaudible]
74.NO	PU	It does because yeah we are interested here to get the perception We are trying to see the experience or the confidence come from the QAs rather than understanding the implementation itself you see?
75.FC		Yeah okay… what's your perception after using the same VA all the same dashboards all the visuals to view historical regression software testing do you think it's good help accelerate or slow down your job performance
76.NO		Okay, just (between bracket: these questions are Hicham's questions I am pretty sure [laughs])
77.FC		[Inaudible]
78.NO		The way he asks questions [laughs]
79.FC		Yeah
80.NO		Okay so basically Oh sorry can you repeat the question the last part of the question
81.FC		do you think it's could slow or accelerate

82.NO		okay at first it will it will slow the process to be honest because we're no one is actually familiar with such tools at least let say we implemented that in our company no one is actually familiar with that tool so it will take us time to figure out how it works and it will like it's not like if we try it it's not that we adopt it 100% so let's be clear on that point like you try it and have trials and errors just to make sure that the regression scope coming from the dashboard is self-sufficient so we will it's like a trial failure face and then we try to adopt it like between the try face I'm trying to adopt it's like this will take us sometime and afterwards depending on accuracy percentages of the dashboard or that report that we currently have
83.FC		[Ehemm]
84.NO	PB	Uhh, it like depending on the accuracy That will speed our process let's say it has some errors like we cannot just just rely on it so we have to think on our own and take the tools data into consideration otherwise it's fine
85.FC		Awesome yeah we absolutely agree with you, adoption is obviously in stages but ahh so we understand that there is issues of automatic software testing and manual ahh do you think that the application of this visuals could be helpful in both and if so what do you think so?
86.NO		We are talking about Automation and manual testing here?
87.FC		Yeah exactly either side maybe you could want to comment on both
88.NO		Okay
89.FC		do you imagine having visuals implemented or mainstreamed do you really think that could help in either or you can talk about it in the context of also maybe agile environment also?

90.NO		Okay so so basically ahh in my opinion like the regression it's kind of an automated thing that's we do it should be actually automated just because it's kind of we're wasting our time
91.FC		[Ehemm]
92.NO		Ahh so basically before like just answering the question so basically it would be automated so I comment from automation perspective first
93.FC		[EHemm]
94.NO		So ahh from automation perspective ahh the [thinking] like if That tool show some repetitive from the historical data that we have if that dashboard shows some repetitive let's say ahh tests to be done
95.FC		[Ehemm]
96.NO		Ahh that and those tasks are not automated these should be automated as soon as possible because we'll be wasting our time during the manual regression that we actually do
97.FC		[Inaudible]
98.NO		So like…okay..i think that point was clear yeah?
99.FC		Yeah
100.NO		I don't have to give an example or anything
101.HI		Yes it was [Inaudible]

102.FC		I I think its OK yea
103.NO		Okay so
104.FC		[Ehemm]
105.NO		Ahh so Depending on the dashboard details and the details ahh will be able to understand what to automate like that will be really helpful to us
106.FC		[Ehmm]
107.NO		and will be as well be able to reduce the percentage of manual work ahh during regression as well because as I said it's some repetitive tasks that we do so it's going to be very helpful to us as QAs ahh to be able to the manager part-time mode efficiently
108.FC		Okay awesome but I think you have talked more about the useful-ness but what about the ease-of-use do you see visual analytics and dashboard being able to make or being able to to easy you work or being easy to be integrated in the software regression …process?
109.NO		[Thinking] if it… in my opinion if it's useful regardless whether it's easy or not
110.FC		Yeah?
111.NO		If it's useful for us
112.FC		[Ehemm]?

113.NO		even if it's difficult at some point to start with that like let's say you're doing a task 100 times on the first time it will take you 2 hours on the 2nd it will take you 1 hour and a half and afterwards it will start taking you last time end last time so regardless if it's easy to use or not
114.FC		[Ehemm]?
115.NO		If its if it makes the QA life easier like we try to reduce the … percentage of men would work that we do in the regression
116.FC		[Ehemm]
117.NO		Like as to a lead I'm ready to have that implemented because it will be hard at some point to start with that but afterwards it will get easier
118.HI		Hmm
119.NO		I hope that answers your question as well
120.HI		Yeah it
121.FC		Yeah

122.HI		It answers pretty well the test automation part but also for example that say for or resources related reasons the company cannot afford ahh like having test automation Specialist or experts how would you perceive this tool if it's to be utilized within the hands of manual testers for them to have this dashboard so that it can show them ahh historic results so that they can maybe figure out patterns where to focus and try to to you know to put more efforts on those parts of the software and not focus on all of the software and not focus on things that are less important so that it can eventually efficiently and effectively increase the impact of regression testing, would you perceive that the important for the manual testers also at this stage given the constraints?
123.NO		Yeah it is very important for manual testers but again if it's easy or difficult, if it's easy to use this tool
124.FC		[Ehemm]
125.NO		In the team within the QA team
126.HI		Okay
127.NO		But if it's difficult to use I'd rather not waste the QA team members efforts or time on figuring out that so this activity if it's difficult to use this activity should be done actually by let's say the lead to be able to understand the impacted areas and he will distribute tasks to the team like here it depends whether it's easy to use or not
128.HI		Okay
129.FC		Awesome. how relevant do you think this visual Analytics would be with your work with the all done executing software regression testing

130.NO		[Thinking] ah
131.FC		In terms of relevance…
132.NO		Can you elaborate more on the relevance meaning because I can talk here a lot
133.FC		Ahh you can talk you can talk the way you understand it because I think you talked about ah if you see area how if its useful you have talked about if it's easy to use But then what's the relevance related do the work for instance you as a lead as a lead being able to use or adopt the this visual Analytics within aah within your team for the team to be able to use it yeah how relevant would you see that to your job as a lead for instance?
134.NO		Like it's [Thinking] okay let me try to summarize [giggles] what I'm thinking just ahh [Thinking] okay so basically it's interesting like in a nutshell because it will here all jump back to the usefulness of that tool so I need to talk more about the relevance
135.HI		Yeah it's fine because this is the main this is the main theme let's say the construct in our theory which is the usefulness so you can go back to it
136.NO		Yeah i can…it's pretty useful [smiles] I let relevant task its useful [giggles]
137.FC		Yeah yeah
138.NO		So…I I trying to find some lets say arguments here
139.FC		[Ehemm]

140.NO		Related to the relevance but
141.HI		Yeah, maybe I can make it easier on you and I could for example exemplify like would you find it to be highly relevant medium relevant low relevant and why each one for example? like how would you proceed relevancy would you perceive it to be high high low ahh medium or maybe conditionally it depends on the circumstances of the or complexity of the testing ah ah needed ? or? You can
142.NO		You are talking about the relevance of the results order elements of the tool?
143.HI		We are talking about the relevance of the results shown by the dashboards do you from the previous ahh data
144.NO	PU	Okay [Thinking] So…[Thinking] ahh basically I think it's like I can I can not say it will be 100 percent relevant because like lets say that would depend on the accuracy of the data that is displayed by the tool so…if the data is accurate that it would be pretty relevant then we can just start like just start like not, like try to avoid manual regression and automate everything via the data that is presented by the tool [ehemm] But let's see if the data presented by the tool or let's say we tried that we tried doing a redemption based on the data provided by that dashboard and we went to production and had like several issues on production
145.FC		[Ehemm]
146.NO		like the data is not relevant thus… that's we cannot rely on it like 100% like we'll need manual intervention in that case
147.FC		Sure
148.HI		Okay

149.FC		I think its fully understandable but what just a follow up umm how how do you view it yourself imagine how how would you view it as a manager or as a lead person being able to use this tool compared to the one who's not using it?
150.HI		Like what privilege maybe ahh he is trying to convey what privileges does this tool provide to you as opposed to the managers in the same capacity who don't use this?
151.NO	PEU	I see I see okay. So ahh basically this tool will have its or this dashboard will have its ups and downs basically, so again first when we rely on that dashboard like when we try it we are not 100 sure percent like We're not hundred percent sure of the results
152.FC		[Inaudible]
153.NO		So We"ll have to run manual regression afterwards just to make sure that that that it's kind of working fine orl like comparing that after the merge to production and making sure that we didn't have any issues so here we are like first of all it will be like a waste of time for us kind it's not kind of it's not waste of time but mainly we have to do double the work just to make sure that all try to avoid potential issues on production
154.HI		[Ehemm]
155.NO		So Lets so other managers who Don't use that tool or that dashboard
156.FC		[Ehemm]
157.NO		Will have more time for the none will testers that say to work on something else

158.FC		Awesome
159.NO		like first of all like us if we're using at a tool its kind of its waste of time kind of but once we're sure and we can rely on that dashboard data or dashboard details it will it will be it will save us much time because it will just tell us the impacted areas we won't have to… run the full regression list of test cases that we have it will be mostly selective
160.HI		[Ehemm]
161.FC		[Ehemm]
162.NO		And we run the automation in general just to make sure [inaudible]
163.HI		I think Nadim
164.NO		So
165.HI		Yeah go ahead, sorry
166.NO		No sorry
167.HI		I think Nadim also covered the challenges part of our questions
168.NO		Yeah I swear I didn 't have the questions [smiles and giggles]
169.HI		He covered he covered one of the Important questions which is about the challenges so we can compile from what he has said so far some challenges that can be used in this research yes

170.FC		Awesome Awesome ahhh because you talked about, what would be the challenges so you guys talked about the challenges that's good be within this the challenges that could be resolved all that could be faced right yeah but what about the challenges in terms of adopting this visual analytics Within software regression testing what could you comment on that how easy could are there challenges that you think could impede this not to or could slow this not to be adopted in software regression testing?
171.NO		Ahh here like it will…like one challenge to adopt that as QA lead okay I personally have the experience to read and understand dashboards but we have another parts of QA leads or like another sample of leads that cannot read and understand dashboards like to be able to extract useful data that should be implemented in the regression so that can be another challenge like it depends on the lead knowledge on the QA knowledge to be able to determine the scope just by reading the data
172.HI		[Ehemm]
173.FC		Yeah
174.HI		[Ehemm] so here you are suggesting that There should be some sort of also some some some abstract reasoning or or some human intervention along with the dashboards is that what you're trying to convey?
175.NO		Basically yes okay the dashboards will present the results he might resent the list of test cases but you should as you as a lead or as a QA in general I cannot trust the results that are presented by the system
176.HI		[Ehemm]
177.FC		[Ehemm]

178.NO		like I can go through historical data to make sure that all is okay first
179.HI		[Ehemm]
180.NO		and to make sure that the areas really that those are the areas so manual intervention along with the tool is at least for me required
181.HI		Okay
182.FC		Awesome ah its ah I think it's understandable but then what what how how do you view in terms of results that are gotten imagine you doing software regression testing or you are executing it and this enablement of this empowerment visual Analytics to be able to produce the results how or what could you Be your comment or how explainable do you see the results ahh being displayed or dashboard what how do you easily see the dashboards
183.NO		Can you give me 1 sec? [Takes a pause for about 1 min and 20 seconds to fix something personal]
184.FC		…Anyway I think the question I was trying to convey is How explainable do you think it is this dashboards ah could be and showing the they historical testing results
185.NO		How explainable?
186.FC		Yes
187.NO		Like

188.HI		And do they make sense for you do they make sense for you for example would you would you see that if you see numbers from a dashboard or or some some metrics or variables or things like that would you would you perceive that as explainable enough for you to proceed with your regression testing would that would you perceive that as to be explainable for you?
189.NO		Ah, OK so basically from what you said Hicham that's actually more than enough for
190.FC		[Ehemm]
191.NO		me to be able to know and understand what should be done in during the regression
192.FC		Okay
193.NO		but again here we can go to a part where that can be a limitation to some people like that won't be able to get and understand the the needed during the regression
194.HI		So you would suggest that some some training is warranted before that is in place for those who don't or who have who don't have experience in this technology?
195.NO		yeah maybe some training or showing kind of some ahh, table that explains the meaning of each number that is displayed why this thing the report that in my opinion the dashboard that I keep on saying report but it's a dashboard like basically like a number that a table that explains what 10 means and what one means what 5 means like it's just what I'm thinking right now would be pretty interesting for for any user to be able to know and understand the regression scope

196.FC		awesome and whats you perception with regard to quality of the outputs do you see the visual analytics or this visuals that I am referring to being able to to improve the quality of the results that are produced as executing software regression testing?
197.NO		Yeah actually yeah it will be pretty helpful Yeah this is the question answers itself
198.FC		[Ehemm]
199.NO		I don't have any comments, the question answers itself [smiles]
200.FC		yeah Yeah I mean the beauty is that there's no yeah the only issues that we could want to hear more of you you know because you have vast experience vas fast knowledge in the area so I think we tend to benefit more from
201.NO		Ok so you want me to talk in other words
202.HI		As you wish, it's it's based on your comfort
203.FC		Yeah sure but how easy could it be for top management of for top management to be able to have this adoption of VA within ahh, software testing

204.NO		Ah, basically if the company is capable in adopting such such tool then it would be pretty interesting of having it as like at will be beneficial on the long term as I explained previously on the short term it might not be cost efficient in my opinion but on the long term it will make everyone's life easier like the management will be able ahh to understand what's happening and that tool although it's helpful like from management perspective although it's helpful for QA's but that tool can be helpful as well to understand the quality of code delivered by devs to QAs before reaching before starting the regression so OK if that tool will inform us of kind of to do regression on part ABC and part ABC had mistakes then we had mistakes during the execution actually and then we have a poor quality of code uh that is delivered to QAs so basically the topic is for regression only but top management will benefit from that tool many other areas
205.FC		Yeah
206.HI		I think I think Nadim also has touched on some benefits benefits of of such of such adoption
207.FC		Yeah in fact I wanted to comment the same but probably to ask him to add if there are anymore other benefits that he thinks VA could bring within in software regression testing
208.HI		but I would also add before that maybe if if if what's his input on the perception or what's his perception on or what's the impact of such adoption on the costs and the and the time related issues with regression testing for example

209.NO		As I stated previously it will like it will be time consuming from QAs side to start with it so the so the company has when let's say the company bought that tool it has the company has to take into consideration let's say the regression takes one day for five QAs to perform it, it should take into consideration that it will be kind of uh the regression will take us more time in the beginning to be able to know and understand the accuracy of the results provided by that tool so but it will be highly a kind of uh like if we can't depend on it it will be very reliable and it will on the long term it is very beneficial for the company but its not on the short term
210.FC		Awesome awesome uhm yeah I know you've talked quite a lot and we have already captured quite a number of things but then are there wit I think we've got an overall understanding of the way we are asking the questions I don't know if they're some addition or some reflections some perspectives that you think maybe you haven't talked about that could be important for us?
211.NO		Uh…just give me a second to think of that
212.FC		Yeah sure sure
213.HI		Yeah take your time
214NO		[Thinking] I personally think that we've covered everything related to regression but that tool can uh can actually become pretty handy when it does not only focus on regression although its purpose is for regression but as I stated previously it can help in help know and understand if we have issues on dev side so if it if we're not covering their regression area like it can help us it can help the company in many other ways

215.FC		Awesome
216.HI		[Ehemm]
217.NO		but for regression I think it Hicham's questions where more than enough
218.FC		Awesome yeah I think that's all from my end I don't know from Hicham?
219.HI		No I think that's it from my end…[thanking the interviewee and proposing a tea break as a token of appreciation for the interview time given]

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Appendix 6. Respondent 3 (R3)

1.FC		As a way of just breaking the general questions, what type of software regression testing have you performed or have you been involved in what I mean by this is it the is it could we say maybe following the category of test-it-all approach or maybe it has been a selective kind of software regression testing?
2.BD		I'm sorry, what do you mean by selected?
3.HI		yeah I will yeah perhaps I can I can expand on this
4.FC		[Inaudible]
5.HI		Its for example do you test everything when you're doing regression testing or do you select certain test cases based on the circumstances or based on the complexity of the and what is your what is your procedure or let's say your your methodology or strategy or let's say yeah you you strategy

| 6.BD | IU | yeah yeah I understand I understand well as you said mainly it depends on the complexity of the new feature that's being added but this is the ideal case but unfortunately this is not the practical case out of our experience ahh lots of our testing or lots of our like testing strategies failed when we do this because you know code is very fluctuate is vey hush somehow if we can say especially when your system is getting bigger and bigger so we ended up to always test everything whenever I want to release so for example we decided now to do releases ahh on monthly basis rather than on Sprint basis and I told the guys and ahh all this from team that every time we need to release we need to test everything of course we have everything documented and most of them automated and so on we have many means to test everything but I always ensure ah to test everything because you can never you can never ever know what might break if you included just a semicolon in your code so This is why the sprint that we want to release in we make sure that it's like 10 days sprint we make sure that we as QA we have everything ready everything all the tickets are ready and the first three days and I will test everything the new tickets in the first week and I need five full days of testing everything else which is the regression and by that way we manage to umm have high ratings for our apps and reduce the bugs on production I know this is not the ideal way but trust me sometimes you need it depends on the culture of you by the way this might help you it depends on the experience your team your developers have if they are all seniors this might not might not be the case but if they are mixed between juniors and seniors you have to do this |
| 7.FC | | Awesome yeah OK awesome and that's comprehensive, umm, OK we're slightly move away from software regression. What we want to establish what is your level of understanding the level, how much do you know about visual analytics? |

8.BD	PU	umm honestly not much let me tell you mainly as Hisham said I have around 13 years of experience in quality assurance but this year I moved into TPM technical project manager manager so we're meeting with PM's and yes we're starting to abide by visual analytics stuff and graphs you know but it's somehow new but as for quality assurance in all my life to be frank I once used it and I can tell you it's beneficial I once use it in TestRail and I discovered they provide some kind of visual reports I'm not sure if you can call it visual analytics because I've read a little bit about the difference but one thing which I really was impressed like few years ago but I used TestRail and the report that was generated by TestRail by the way TestRail is a test management tool OK where you write your test cases and then you execute them now I found out from a report that we have a very risky area in our code so let's say uhh in software, in your app you have a login feature you have a hosting feature you have a community feature and so on now the more I test TestRail grabbed history and combined history and show me analytics text and there was a red area let's say the login area which always always fail in every regression which means so guys come we need to refactor all of this and this is what we did so yeah I assure it can help but I think the drawback and you know better guys the drawback is the amount of data that you need to enter for the visual analytics to be precise
9.FC		Awesome you've really condensed our research you know I I think I'll continue still asking a few questions so that you elaborate further ah I think one of the questions that we could want to establish as you know as a manager ah do you see could you intend to have an adoption of VA of visual analytics in software regression testing?
10.BD		Do I what?
11.FC		Could you be willing to adopt to have it adopted in or have it mainstreamed in software regression testing?
12.BD		Uuh yes of course I would love to

13.FC		OK well maybe then you could want to comment from the context of decision making?
14.BD		Yeah it's exactly because of the example I just gave you when I used a test management system because it once helped me to figure out something which I couldn't see honestly but the report showed it to me, and guys there's we have a weak point here let's go and refactor it and when we re-factored it we stopped having this regression bugs and so on every Sprint or every release

15.FC		OK I could want just to comment on on some some levels of usefulness I I know you talked about it already yeah that's the reason I'm saying you know you answered that first questions like it has condensed everything but I think no just for you to highlight more
16.BD		[Smiles] Sure
17.FC		let me let's ask let's talk about the usefulness how do you see how you perceive this visua analytics or the user dashboard or even the reporting system umm how useful do you see it within the visual within the software regression testing
18.BD		how useful… I'm sorry?
19.FC		how useful yeah
20.HI		yes how useful within your job performance let's say

21.BD	PU	Well actually umm in just one little sentence it's always better and nicer for the eye to see graphs then lots and millions of data records
22.FC		umm awesome awesome, what about easy of use
23.HI		Ease of use
24.BD	PEU	yeah again rather than having you sorting all the data in your mind if you see hundreds of records well rather than trying to sort this all in your mind again this is easier for the eye and it can give you I think results and insights much faster and and by the way just for you to know Hicham currently I'm working with a with a client our job is for data insights so it's a huge client he has 30,000 employees all over the world so I know how much data how much insights and data and visual umm the world the world is asking for yeah
25.HI		Very interesting
26.FC		Yeah quite interesting umm let me ask you whom do you think could influence the adoption or the use of VA within software regression testing?
27.BD		Ah probably it's a mutual effort between the PM and the QA manager that's so PMs like product managers or product owners or technical product managers so these are all these under the umbrella umbrella of management along with the QA manager they both have mutual decision making
28.FC		Ah ok great

29.BD	PEU	Because Remember Remember PM's and managers always like to see ah ah reports and the visual data instead of raw data
30.FC		OK now let's imagine we've got two managers this manager has pushed in for the adoption of VA within software regression testing and the other has not, ahh what could what differences could you see between the two what could be your perspective on that having those and those who not
31.BD	PU	OK well it depends on results everything in life is based on results so if you so in front of me there's Frederick and Hicham so I can see two managers you are pushing for visual analytics he's pushing for away from it OK so I'll tell you and I am lost between the two so I just come and tell you please we have like this amount of tests or so on we need to we need to run using your method do it and I will see the speed versus quality and Hicham will do it and I would see his speed versus quality and accordingly I will decide
32.FC		Great, what about the relevance of QA within software regression testing?
33.BD		uh can you emphasize more about relevance?
34.FC		How relevant do you really think the adoption of VA is to software regression testing?
35.BD		Umm, I haven't used this to answer that [smiles]
36.FC		Maybe your perception how you how you perceive it
37.BD		Again I think I answered this before in my condensed answer and again I would like to see visual stuff which which of course should give me a correct data if that's the case of course I will never would like to see raw data

38.FC		Oh yeah ahh maybe I could want you to comment just on how easily you think could be easy to explain the results that that empowered by visual analytics versus those what could your comment be on that?
39.BD		uh yeah uhm well honestly in my opinion like every time I get a report so for example once I use the TestRail management system which I previously talked about I wasn't aware of how to read the report it's report I wasn't aware so it took me some time to try to understand what these metrics or these following or these graphs mean so I think that the most important point is for the analytics that are visually represented to be a easy to understand and to let the one explaining this data to easy explain it to others
40.FC		Okay okay what about in terms of the quality or outputs of the results do you really think that visual analytics could add value to the quality of results that could come up
41.BD		Well we're taking we're talking about an ideal case so let's suppose all the visual analytics are correct?
42.FC		yes
43.BD		uhmm uhmm, I'm sorry repeat your questions I wanna I wanna rephrase repeat your question please
44.FC		yeah OK sure sure I think if you notice the first question I was talking about the results how easy is it to explain but then I'm talking about the quality of the results when I'm trying to see this is the report or this is work we we are doing visual analytics we are doing software regression and we could want to see the results and want to compare in terms of quality do you see visual analytics being able to add any value with regards to quality of the outputs that we ?
45.BD		Umm, yeah yeah I think speed is a very important factor currently we making we are working in a very fast pace ah the software industry is working is moving in a very very very fast pace and clients keep asking

		and asking and asking so uhmm that if you provide me assistance which will give me quality it graphically I'm sure it's much much faster than again analyzing raw data and going over hundreds of tickets and remembering what happened last month and what's happening currently so if your system give me a that this data that fast then of course everything I I will adopt to give me speed, anything
46.FC		OK and how easy could it could be for you to convince the very top management for the adoption of such a technology within software software regression testing?
47.BD		if I tested out and it worked for me it will take me minutes to convince my management not more
48.FC		Awesome
49.BD		Trust me, when you work in that software industry especially specifically with such a huge clients big clients which I just mentioned we want quality and speed whatever you give me whatever which brings quality and speed I will adopt it instantly and visual analytics if again it works and it's correct of course I will adopt it because it will give me lots of speed it will speed up my releases
50.FC		Okay great maybe now just to comment what could you comment on the challenges that you see with the adoption of visual analytics yeah within the software regression testing?
51.BD		Yeah yeah now I understand why you why you told me I've answered everything in a condensed way [smiles and giggles] I also answered this before yeah the challenge will be the big amount of data that you need to enter in your system so I have a I have a question mark honestly again as I told you if it works I will instantly adopt it because I can see its speed but I am I have a question mark about the amount of data that that that need to be entered so that I can get this graph this uhmm precise graph
52.FC		Uhmm I I know you answered about you answered those about the benefits but maybe you could want us to add some any other benefits that you

		think could come along with the adoption apart from those maybe that you commented on, are there any additional benefits?
53.HI		Or may be something that we didn't or maybe something that we didn't answer or ask something that you could think of yeah that you can maybe elaborate on more maybe
54.BD		yeah yeah I have I have something in mind do I you know when you work in software industry your scrum team or your development team they're all very deep into tech stuff OK they're always having their ideas open and coding and coding all the time they uhm they rarely go into uhmm into this like graphs and analysis and so on they don't love this OK they usually tech people they don't love this but and you know quality is related and regression is related to developers at the end so real quality assurance engineers we test that of course this will be very beneficial to the developers so I think this will be an added value to for the developers to start shifting their minds not just by looking into code and technical stuff but you have a wider image of what's going on because the PM's and the the management role always have difficulties in stopping the the developers from thinking technically and technically and technically you know it's it's it's really hard so for example yesterday just yesterday at night something happened with me I have a I have a I used to have a I have colleague in my team a quality assurance engineer who decided to leave and he went to another company you know I tried I I tried I told him how to write I'm not sure if you're aware of this a behavior driven development (BDDs)
55.HI		BDDs…
56.BD		which are which is yeah away in the writing test cases in an English way so that all the team can understand understand tech and tech people because all this time he used to write the BDDs in an because he is an automation engineer he used to write them in automation way in a technical way so it took me lots of time to make him understand man this should be written in a business way the BDD phenomena was there created to think business wise not technical wise after a few months I managed to make him uh do do it in the business the business way then he decided to leave and yesterday he he joined it was that was his first day in another company but he totally forgot everything so he sent me a scenario seriously sent me a scenario which which should be written in three lines I wrote it for him in three lines but he said to me in 11 lines because he was thinking technically he wasn't able to think business wise so this is a small example just to let you know that yeah this is interesting I think to help the tech

		people get out of their shell and also think as business people and client used to think thank
57.FC		[Ehemm] thank you very much for my I'm done over to Hicham
58.HI		I think we're done also for my end maybe we can close now the recorder before we close this meeting

Appendix 7. Respondent 4 (R4)

1.FC		As a way of just breaking our or starting our interview, what kind of software regression testing do you do to perform your work? Is it the test-all approach or executing test cases or just being a selective one or maybe we could want just to hear about that?
2.SK		umm okay, usually we use test cases to do the regression, but personally I don't mind to use other software or plan to do the regression I mean, anything it would be helpful or speeds up the regression testing I would feel myself open-minded to try it or use it. But now we use the test cases.
3.HI		OK Fredrick we can move to the second question
4.FC		OK how do you determine the scope of software regression testing when you're doing your work?
5.SK		Okay the scope is based on the modification that was made in the update in order to merge this release so it depends on the target of the modification whether there is a corruption in the changes or any thing else we determine the testing scope or the scope that we want

6.HI		So Said how do you determine the scope of the regression testing is it based on personal experience or your knowledge with the system or do you see the most suitable test cases based on historical test results?
7.SK	PU	Okay I personally use the three methods that you have mentioned first of all if I am test if I tested something that is similar to the what I'm testing now I would remove or keep the test cases that are relevant or irrelevant dominant and I would use the experience that I have in the system and basically these are did I miss something from what you mentioned?
8.HI		No, this is perfectly fine
9.HI		Now Frederick we can move to the third question
10.FC		Visual analytics how much do you know about visual analytics or when you here visual analytics what comes what comes to your mind?
11.SK	PEU	Hmm, What comes to my mind is the visual testing. I mean what I see with my eyes, And what I'm capable to differentiate for example things related to design or not only design also things like wrong data showing maybe. This is what came to my mind when he asked me
12.HI		Thank you, we can continue with the questions
13.FC		Okay so imagine, imagine with the capabilities, because yeah I want to assume that of of course I have got an idea of what your response is, But I think for the purpose of this discussion we're looking at visual analytics as consisting of dashboards you know of visuals in our software regression testing so umm what could you what could be your perception in terms of adopting visual analytics in software regression testing to help decision making? What could you be your perception on that?

14.SK	PEU	Okay What I think is that for sure it has an important role and it's fundamentally important for one to visually differentiate if there are errors if it's like for example using historical data like what was mentioned then I would do comparison between the old data and new data And here I can quickly understand that there's an issue because there's an obvious difference will the numbers or we can say that there's a design flaw or I'm thinking about other than if there's no issue with the design but when I look at the software all the page that I'm accessing I would feel that it is not comfortable for the eyesight Even if I didn't scroll or clicked on enter so it's fundamentally important for you to like what you or what your eyes see
15.HI		And now you have jumped to one of key Concepts in our thesis which is the user friendliness us but we will come to this question in abit
16.SK		Okay
17.HI		Yeah umm, Frederick you can continue with the next question
18.FC		Umm okay so yeah umm Obviously there are challenges with the implementation of or especially some of these Technologies so you I know you have talked about how good it is with the with the use of visual Analytics to help decision making but in your view what challenges if challenges for instance or the barriers to the adoption of visual Analytics are dealt with umm do you think this could be a good thing It is a good idea to have an adoption of visual analytics and software regression testing?
19.SK		uhhh, Surely it is a good idea but the problem is where? What do you want to adapt a new thing you will always face the problem there will be people who Will resist this change and say that it is not good, demands extra work, and is difficult and this mentality makes it harder and more time consuming in adopting in the fastest way and making use of this technique. But for sure, I am in accordance with adopting such idea.
20.HI		Sounds…good

21.FC		Awesome. Usefulness? What Is your perception of using visual analytics in software regression testing, do you really think it could slow the process of testing or it could accelerate the process or do you think it could improve or worse than your job performance ahh and why? Yeah if this is mainstreamed in software regression testing
22.SK		Personally I think it would be a short thing that in one of the places that aggression testing will take some considerable time how to slow down the regression but its main target is that it could help in being beneficial remote for the client in the main target is to deliver a product that is perfect for the client with a minimum bugs with a perfect design, I don't know, layout, so even if I lose some time in some places during the regression testing knowing that this testing should be fast okay but on the other side I see that that is something more important which is guaranteeing by increasing the testing and increasing the confidence on the product of the modification that I've done using this idea or this tool or this I don't know, software if you can say it which is the visualization
23.HI		Sounds good
24.FC		But what could be your comment in terms of adoption Within manual testing automatic testing could there be, any differences in the setup or the use is the same or the purpose is the same?
25.SK		uhh If we're adding on the automated testing for sure it won't be I don't know I don't think so that this will be beneficial at all, it will be useless. if we added on the manual testing which is done before the regression header can be very beneficial because it's taking its time to be utilized and a slow pace rather than in the regression testing which is done in a fast pace And it could be beneficiary even before the regression testing is initiated in this case this tool will not be warranted to be used during the regression testing in case we use it in the manual testing and if we don't use this during the manual testing then for sure for sure it would be better to be used during regression testing
26.HI		Ok thank you

27.FC		Next let's talk about the perceived ease-of-use, what do you think VA adoption what do you think could it make software regression testing user-friendly? If we ought to have the adoption of this VA within software regression testing Do you really think it could be friendly? If so, why? If not, why?
28.SK	PEU	Okay, perfect, basically whenever we start working on any software tool that can help us in testing I don't find it's user-friendly and I don't like it and I start asking myself what is this it's not nice but once I get too used to this tool and work with it, I would say wow how much it is helping me! How good it is and the benefits that I am gaining from it So always at the beginning I would not like it and I would say no, but at some point when it's mandatory for me to use it and when I get used to it I would find that I cannot continue testing or I would always want to use this tool all this software, it's like I rely on it.
29.HI		Okay okay, we can move on
30.FC		Whom could you think could influence you to use visual analytics in software regression testing?
31.SK		hmmm, I don't know if it's supposed to be a big company that used it and is an influencer, but, ahmm, honestly I don't rely on the fact that there should be someone influencer using tool or is using this thing to motivate me I can merely read about it on Google to match the way we work will the testing then I would start using it so I'm not of the type to rely on that there should be someone influencing me to use this tool, even though we are in an era where there should be an influencer because there's social media in which you have heard about it through a company is helpful but this depends on the people some of them get influenced by this idea some others don't like my case. I don't really care if there is an influencer or anyone influencing the usage of this tool.
32.HI		Social media…yeah okay okay
33.FC		Okay
34.HI		You can continue now Fredrick

35.FC		Yeah okay, What is your perception on the influence of visual Analytics adoption on managers who who is who wants to speak it all or who are going to use it who could adopt it in software regression testing versus those who don't, How do you see the two of them, umm are there any value between the two or how could you view the two managers one was adopt it and one wasn't within for the purpose of visual analytics for the purpose of software regression testing
36.SK		Hmm, Honestly Hicham I didn't get much the question here?
37.HI		Yeah I can explain it to you. If for example you have two managers okay and one of them is using this VA tool in order to facilitate the regression testing while the other is not using it. So one of the managers is using it and the other isn't, in your opinion what do you think that the managers who is using it he has more value? No I don't mean it that way, what I mean is on the increased work value that it brings on, any effect on that? So what is your perception behind such adoption from this perspective?
38.SK		Okay okay I see it beneficiary for the person utilizing this tool , first For two reasons the person learned on a new software so there's new ideas he has learned is ahead of the manager not using it. On a different side, the person would save time, cost, and work using this tool for the manager using it as opposed to the one not using it. So the manager using it has an advantage as opposed to the one not using it. So for sure, I would recommend its usage even if at some point it becomes useless but at least the manager used the tool and benefited from it at certain point which is good
39.HI		Okay okay
40.FC		let's talk about relevance, how relevant do you think VA could be in software regression testing could be to help QA managers like you?

41.SK	IU	The way I see it is that this depends on each person and how much is this person willing to above this tool and a new technology in the testing process but for this to be making the work easier and faster we'd be going back to the previous question which is that that requires a strong marketing if such tools are promoted on social media it might increased its adoption but on social media this promotion might not be helpful for the users and clients who do not get influence by such tools adoption promoted on social media, so if I see this tool on Facebook it might mean nothing for me but if I see it on an ad like on YouTube or through somewhere that I use at work, for sure I will be getting to read more about this tool. And at this stage you feel like all the companies and all the managers they are run to do I new technology developed for two reasons…
42.HI		[Lost the internet connection]
43.FC		Okay hopefully it has not interrupted your…
44.HI		No it has not interrupted my my thinking, I still wanted to go back to this question of relevancy, ahh so Said do you feel that such adoption is relevant to your work? How much and why?
45.SK		Yes yes it is, for sure, how much? High. Because the testing output would be easier and nicer and I would have adopt it because I want something to speed up my work and to generate a more successful output and a nicer output.
46.HI		Okay
47.FC		Okay
48.HI		We can move on
49.FC		I think You started to talk about something on output quality, yeah sure. Maybe you could want to finish that or comment something we're talking about the quality of output

50.SK		[Fredrick asked me if this tool affects the output quality of the work I was telling him that it should affect the output and for the better for sure because for me to work and adopt such tool I would need two reasons either it should speed up my work making it easier or it should increase the quality and the output that I'm giving so if none of those are met I will not be using this tool at least as a responsible team member I would want to see the advantages and at least I'm expecting for it to give me one advantage that its worthwhile or that I care about and based on that I'll be working and using this tool so it should for sure increase the output quality of my work
51.HI		Thank you
52.FC		OK, awesome, umm, how do you think, how easy do you think the results or outputs that are generated by the visual analytics could be or during software regression testing? How easy it is how explainable it is do use the dashboards could be for let's say showing test historical results I don't know if that question is clear for you
53.SK	PU	uhm yes yes. In my opinion it is easy to learn and use this tool and it is easy for someone to to understand or read the dashboard compare the historical test data because this is not just easy it's the easiest way in testing, I mean okay, There's no need to go search, hassle, do calculation and to check rules and read them, no, visually you can quickly have a look to see, read, and compare on a screen the outcomes. It would make your work easier than searching for rules in a certain way to do the testing. So I personally find it easier because I like to use my eyesight, I like to rely on what I see. And based on that, I judge.
54.FC		How easy do you think it could be to introduce, to convince or to convey or to bring on top management of the possibility of adopting VA in software regression testing?

55.SK		Okay, In Lebanon I think it is easy because the management waits to bring on new tools, adopting new tools and to integrate new tools that would help interesting if you are talking at the level of quality assurance or in the development if it's at the level of developers so we have and based on my personal experience they wait and wish the manager to bring new tool to integrate it use it and even if this tool is not practical or if it didn't succeed they don't have a problem as long as they have as long as they're trying something new because always there's a high percentage of a software adoption to succeed and there's also a low percentage of a software adoption to fail within the work. But usually they don't have a problem with that. It will be very easy to convince them.
56.FC		Umm, next question is, let's talk about the challenge, so from an individual perspective, what challenges do you think could impede, could slow adoption of visual analytics in software regression testing?
57.SK		The challenges that could rise I think that could be found in any company When there is a high workload so we don't have time to add up new tools uhh and in some places, no one yet knows how to work on this tool so someone has to learn it and then the rest of the team has to learn it or to teach one member in the team and this all goes back to the time factor it needs time as every company has high workload so in my opinion, this is the only challenge that I could not adopt such technology or and make it harder for me to use this tool other than that it's the situation is calm and there's no high workload and the team can learn such tool, there is not supposed to be challenges what is a necessity is for one person to learn this tool, knows the advantages, and based on that it should be implemented
58.HI		Ok thank you
59.FC		So in the same way, what do you think from the individual perspective, what benefits do you think are associated with the adoption of VA in software regression testing?

60.SK	PB	uhm, Personally I see that the benefits are in several places, it could be speeding up the work but could be making it easier for me, it is necessary for what is displayed in the software or application, does it attract the user? Whether it's a game or [not clear] to make a reservation? Does this excite the user? If the user finds it simple, fast, pleasant then yeah he would proceed with using the tool otherwise no and this is essential and no one can know it or can tell you yeah people like it or no. If you have a tool that helps You simplify the website or let's the application bee-friendly user more from an eyesight perspective this is very very important
61.FC		Frederick's I discovered the impact of visual analytics on on regression on regression time related matters yeah but my question what are you Said what impact would be on costs related constraints of regression testing on the costs?
62.SK	IU	Yeah umm, Honestly here that would depend if you want first of all how many how much time is it taking from you how much are you paying for the software this modification that you are submitting to the client is it worth while having the visualization testing on it I can have a simple modification which is prevalent so there's no need for me to use this tool for me to do this testing because due to financial constraints I might not be generating a lot of profits for me to use this tool or the modification does not warrant using Search tool so here it depends on the managerial aspect or on the quality assurance manager Who sits with another manager to make decisions on whether such modifications warrant the adoption of such tools or not but for sure the less the cost of such tool is the more it will be utilized
63.HI		OK thank you
64.FC		OK ummm, yeah I think you have talked about a quite number of issues and this have been helpful, do you think there is something that we may have not talked about that you think could add value to the questions we have asked?
65.SK		Most probably your questions have covered everything related to to visualization, no i mean most probably your questions covered all the concepts all the idea currently trying to figure out something that can come up in my mind, but no almost everything was covered
66.HI		Perfect

67.FC		I am done from my end I think Hicham…
68.HI		I am also I am also done from my end and we want to thank you very much for your time, this has been very valuable.

Appendix 8. Respondent 5 (R5)

1.FC		[recording was off but the interviewer asked the participant what approach to software regression testing he used….] it and approach of testing test cases where it has been a selective one what is how has it been with you which ones have you been in
2.BG		I think I've been involved in different types right right now and most important one is a hybrid mode between regression composed of manual and automated ones and that means that most important metric for us was what part of our test cases are automated so from visualization perspective it was extremely important to see how many tests we need to plan execute by hands and how many tests will be automated by robots
3.HI		OK
4.FC		OK
5.FC		I like this discussion, so you determine the scope of regression testing?

6.BG	IU	uh usually it's just a matter of priorities for example you could say I have regression just four hours and that means you are able to just some [inaudible] pass for example and some negative cases but sometimes well and in that case you just need to prioritize them accordingly like this one and needs to be executed every time and so on in some cases you need to select different environments configuration different browsers or different platforms or whatever because sometimes you're not able to execute all of them but in different cases you need to execute regression on different environments and that means you can combine Different configurations different browsers different platforms whatever and different cases because in some environment you might not have some integrations on some environment you might not have some data for example if you are testing on QA most probably you don't have integration with production like certified services but you're able to prepare this data to cover specific cases then on the stage environment you are able to include tests with data amount very similar to production on the huge amount of very close date and with specific configuration so you can execute different types of tests during different regression cycles between one deployment cycle depending on the environment what we're doing right now we are preparing suits based on environment if we're executing progression on dev it's usually extremely fast and it API only be adjustment validating kind of contracts are working then if regression is passed on dev we are promoting builds to clean environment the environment we have lots of checks and regression is kind of start point let's say coverage for regression test on QA environment is much bigger most of regression performed specifically on QA environment because we're able to generate as much data [inaudible], next is the issue of staging environment or further release whatever you should call it this where you have similar data to production or similar configuration production and in this case your regression will be focused on testing kind of deployment or configurational changes like if your software is able to deploy ah your stage environment that means most probably to be able to deploy to prod as well because it's the same amount of service same amount of containers whatever so in this case is your regression will be composed mostly of checks that are distinct integrations and specific data usage is
7.FC		that was quite elaborate umm if let's talk about exactly away from software regression testing, how much do you know about visual analytics?

8.BG		Well [thinking and rolling his eyes up] my first attempt to build a visualization for my analytic was when I've been a performance engineer I think eight years ago and most of the previous it was just a heat map to understand do we have degradation or not later during test management career I applied different approaches for presentation and for specific metrics you need to define specific visualization to be most profitable umm every tool you can use whatever it will be I don't know [not understandable] or whatever it will be I will have this possibility or maybe Jira confluence whatever you're using and you just need to select the correct graph to identify what you need and provide more important for management request information
9.FC		Okay
10.BG		So to get back I used a lot of different visualization types they don't really able to say some most important ones because they are resolving specific cases and you are selecting based on your request
11.FC		So do you think it's a good idea to or to have software regression system or the adoption of the...the adoption of visualization of visual analytics in software regression testing or tests?
12.BG	PU	it is extremely important I have a manager, my manager and he has unlimited respect for my side sometimes the feeling that he spent literally days on creating dashboards in Jira [smiles] because visualization provides you ability to focus on problematic area to bring a flag On a very brief look on any analytics on your project no matter if it's amount of bugs or I don't know priority of bugs or amount of test cases not executing for several months or not updated for several months or whatever so you are creating some actual points based on flags and best way and fastest way to get this flags is visualization test data of this result data
13.FC		OK awesome I know like adoption of it, we could have the intention but there could be barriers to it but let's assume that the barriers to the adoption of visual analytics are overcome do you really think ahh... it's it's a consideration for you to be able to adopt it?
14.BG		I'm not sure I've understood like question could you please rephrase it?

15.FC		OK I want to assume, I like the way you answered the previous question and I want to assume that the significant challenges to the implementation of VA. Let's assume that there are overcame, could you could you intend to use visual analytics during software regression testing?
16.BG		[Thinking] well, obviously we have lots of challenges during resolving specific task because sometimes for example here using Jira as a test manager with some plugins in it most probably you will not have solution for your specific case in that case it would be extremely challenging however you can create scripts on Python or Java whatever you need and also you might be interested in using our language because it's most focused on analytics and when we previously created a proof of concept for analytics we used this it was Python or R because they are most suitable for resolving this case so combining for example Jira API to get specific information of your execution time or whatever and analytics created in your code R or Python or whatever other language creates whatever you need
17.FC		OK I I see I I like that you yes very very technical yeah and yeah but of course some of the perspectives that would be of interest is from the social side considering that as a manager and and how is easily we can easily push for the adoption of these so just bear in mind as we go alone it's an issue of system thinking as a manager so that we don't go technically so much. Yeah umm maybe we talk about the usefulness, what is your perception what is your perception with regard to adopting visual analytics in software regression's or how useful do you think it could for you to have the adoption of software regression? be OK yeah so how useful?

18.BG		to me now it is important to understand not just the result of some processes but also quality of the process and creating specific metrics and then visualizing this metrics.. I want to work at some efficiently. I want you to understand this two types of information for example you can select just test cases that were failing and test cases that were passed it means nothing if you feel that this specific test case was failing for all the lifecycle I mean several years so there is no sensitive information however if you are making a two dimensional statistics like this this test case is new or created two years ago or two sprints ago you are able to understand that we have regression issues so we are finding something during regression or you can see for example statistic related to this particular test cases where failing for several releases and it wasn't fixed that means that this particular area of your product is not important because it's failing and no one take care about his failing that means that it's out of priority let's keep it from regression it's not needed so you are excluding it and the speeding up your regression so it's just the two examples of two dimensions one is just pass fail and completely another as history of this pass fail that leads you to different analytics ahh of this results it's not just a status no more it's more information regarding quality of the status
19.FC		OK do you see do you see visual analytics being friendly or what's the ease of use to adopting visual analytics to be able to do the test cases or to do the software regression testing testing?
20.BG		Well ,yes [Thinking]
21.FC		I'm I'm specific I'm referring to the ease of use of this technology with regard to what you have been doing yeah in software regression testing?

22.BG		Most of those tools are providing dashboards out of the box for example in current project we're using Allure TestOps it's extremely powerful tool for analyzing results previously it was just Allure reports but right now it's a test management tool as well and it provides you very clear dashboards out of smokes it's preconfigured you have all the trends whatever you need already you don't need to configure it at all if you're talking about for example [not understandable but he is referring to a tool name] it is much more complex because you need to be familiar with Jira language to create specific filters let's say advanced filters however in Jira you are able to get more information more statistics regarding each of some specific tickets, assignees or whatever because usually in test management tools alone you just getting test related data for example results assignee execution time or whatever but not about the requirements bugs or similar stuff and that means if you're using Jira for example yes it's most common used tool you freeze significant troubles in implementing complex dashboards for example histogram chart that allows you to understand some compound metrics like how long takes to fix particular ticket we require you to create advanced filter and then use advanced chart as at advanced plugin to create a dashboard so it's not easy need to learn it however creating some plot data or some pie charts is extremely easy even in Jira because you're just selecting any feature you have or any board and the [not understandable] create pie chart or whatever you need easy with just a few clicks
23.HI		But if you mind me uh if you mind me Frederick to interrupt to to intervene here rather just to just to clarify for the sake of clarity from the from the from the end of software that let's say quality assurance specialist or or I mean not special manager how would you perceive that this adoption of technology would make the let's say the regression testing easier to perform like do you find it to be easy if we have this visualization tool for the QA?
24.BG	PEU	Easier to track [smiles] not easier to perform but easier to track and then maybe fix some process issue based on that because you based on this analytics you use visualization analytics to speed up analysis process, ah you might find some gaps in your process and fix it but As for regression execution not really I don't think visualization will help actually actual regression execution but extremely useful for analyzing the results
25.HI		So you think that it can help in decision making or not?
26.BG	IU	yes yes obviously yes
27.FC		OK uhmm let's talk about the perception how whom would you think would influence the adoption of the VA in software regression testing?

28.BG		[Thinking] umm who...
29.FC		Whom do think in your setup or you as a manager ah whom do you think could be the one to influence the adoption of of visual analytics in software regression system?
30.BG		Mostly it's QA leads or QA managers but the for engineers it could be useful as well because they are able to understand their value of specific this particular activities based on some results for example I spent three days on regression and I don't feel that I made something important but I'm looking to dashboard and I'm seeing that I filled 20 bugs and all of them are valid no rejects [smiles] and I see that I perform I don't know 100 of test cases from different levels component [not understandable] integration level system level so I'm feeling that I'm doing something valuable that I feel confident that I checked various aspects of my product different models and most of the cases because I can filter which test cases were not performed were not covered by the execution or whatever so organization will be extremely useful for managers and leads to understand the results and for engineers to understand the value of their work... I think that's it yeah
31.FC		Awesome yeah let's talk about the issue of reputation, ahh what is the influence of VA adoption on managers who use it as supposed to the one's not using it? Umm so for you as a manager how do you view it maybe you as a manager the one who is a adopted or you as a manager you have introduced it and you've got a your team someone using it and others are not using it what is your perception over, over that?
32.BG		uh usually I have an idea on what problem I would like to resolve of what transparency I would like to achieve and in my team I have a QA lead that extremely experienced in creating dashboard in Jira [smiles] so I'm bringing the task to him he performs all the job and then I'm sharing this dashboard with complete chapter and right now we have 27 people in QA and we are sharing with information have comparing team to team like in this team we have 70 bugs in this team we have huge amount of bugs guys can you help them to speed up the process or whatever so for me if I'm not able to resolve ahh this question in few clicks and I I need to build some complex dashboard and ask him [QA Lead Name] and we are using this dashboard a lot I'm literally checking filters and the dashboard on the daily basis and the we even using filters in Jira to validate recently created bugs like if I'm creating a new bug the fastest way to get a notice it's not yet filled all ready to go to filter

33.FC		OK we talk about yeah maybe we talk about relevance, how, I know you have talked about the benefits but I want you to talk about the relevance of visual analytics adoption in software regression.
34.BG		[Thinking]
35.FC		How relevant do you really think as a manager for you do you really think it some is it relevant?
36.BG		yeah
37.FC		For managers?
38.BG		Umm, I will not go to each engineer and ask how it goes [smiles]. I need a single point where I can understand all the answers so having such kind of visualization for regression result whatever it will be test reports or dashboards whatever you need will help me to speed up the complete process of analyzing the results so for me as a manager of a small group that are executing regression it's a very valuable to understand the results of this activity and visualization of this activity is fastest way to do this do
39.FC		Do you think do you think the output the output quality could also be enhanced by the adoption or the issue of visual analytics?
40.BG		yes I'm pretty sure in this [showing confident] because visualization helps you to rise [not understandable] or some process issues or some font issues whatever they are will cause and if you are aware of this issue might be interested in fixing them it helps you to fix the gaps
41.FC		ah talking about let's talk about explainability, how easy is it for you to explain or to explain the results empowered by VA or visual analytics in software regression testing?
42.BG	IU	It depends if you are skilled in this activity you can build metrics and analytics and visualizations analytics that will be self explained if you don't have much experience with this you might need some explanation of what you just done, but if you see that you have to explain that means you need to fix it to make it more self explainable

43.HI		But from a QA current perspective for example you are you as a QA manager are viewing those visualizations would you how explainable can you find those visualizations?
44.BG		[Thinking] absolutely clear [smiles and laughs], again it depends on what the problem you trying to resolve with this visualization and how how succeed you in this activity if you build a correct dashboard if you feel that this correct graphs it will be very informative and clear if not there might be a questions
45.FC		ok but having talked about all these usefulness I think we have talked about a lot of factors or constructs but then now how easy could it be for you to convince top management for the adoption of visual analytics within software regression system?
46.BG		Uhmm, just show manager some infographics and then show the table and ask them to make a decision based on this two inputs [smiles and laughs]
47.FC		I love that, so from the, now what about from your perspective as a manager what do you think would be the challenges with the implementation or with the adoption of VA in software regression testing?
48.BG		Uhmm most of challenges will be related to type of or I'd rather say the way how data you're looking for is stored for example if you would like to understand how many bugs are created for model that was implemented by specific developer if you don't have linkage between bugs and specific developer most probably you have to create very complex query if you already have linkage between bugs and for example user story it will be easier because you can filter which user storing are implemented by specific developer however if you know that few developers were working on the same user story and links are links from back to the same user story there might be issues again so all the challenges that I'm seeing regarding implementation of visualization are more related to implementation of metrics so it's not a question of complexity of visualization it's a matter of complexity of metrics that you will try to gather and then visualize
49.HI		And from a QA perspective for example from out let's say from a person who sees those visualizations who is adopting this technology as part of the processes or as part of the job lets say a role or activity on an individual level do you see uh what challenges do you see?

50.BG		uhmm, maybe access to data because if you would like to gather some specific information you might [not clear] role based access in your in your system and you're sharing some filter or you're sharing some dashboard or some visualization and this user don't have access to some data so graphs will be [not clear] or corrupted or whatever so you have to create your visualization in that [not clear] so it will be shared across the [not clear] but not exposing personal data per person for example not to blame someone for example
51.HI		But is that also the case with the managers also like they they have access data issues as well
52.BG		uhmm, we have managers on different levels [laughs] for example I'm creating several dashboard of 4 QA chapter internally and my manager don't have access to our internal stuff because they might create some questions why is this particular QAs is not creating any bugs for two weeks well because he used to create this case is because he's doing this better than others so sometimes you are not really want to share explicit metric to your manager you just need to analyze it first and create approximation [smiles] or adopt it somehow so visualization can clear way sometimes could lead to uncomfortable questions
53.FC		Yeah uhmm, I know that you have in a away talked about the challenges but maybe in a condensed way from you again from your individual perspective as a manager, what benefits do you think could be include in the adoption of VA within software regression?
54.BG	PB	I will save my time I will not spend hours on analyzing text data I will not spending time on creating some filters or whatever if I already have the dashboard, visualization uh that that's most important thing and prior created visualization could show us information that you are not really tend to validate like I will not check every single test case to see if it if it wasn't updated or not but visualization will help me to check which test cases are abundant so it's just it will speed up your process and sometimes sometimes speed up is so extreme so you will not be executed this activity manually at all OK [Nodes his head]
55.FC		Okay uhmm maybe I could want you to comment on the impact cost and time, how beneficial is it?
56.BG	PB	It depends on the way you're implemented your metrics if it's a few filters in Jira or any other tool you are using it could be for free lets say but if you are developing complete framework on some language to analyze your data that might take time

57.HI		but from my perspective from a perspective of a QA doing the regression testing on the time and the costs that are that are accompanied with you know the regression testing how do you perceive the the the the impact of the VA on such constraints
58.BG		[Thinking] it's almost free I mean you will spend a few hours to create analytics of information you already have so you don't need to create very complex queries or algorithms to analyze data it's just regression it's just the few sets of data like when how what happened and that it it's not a big deal to analyze regression process and result so if you're talking specifically on regression implementing visualization for it it's not complex and in most of the cases you will be able to build it by tools as that you are already using, Jira, TestRail, I don't know whatever could be [smiles] [not clear], ah if you don't use it and you are for example fan of excel sheets [confidential info of other company] that could be harmful and you have to prepare your data in unified format first otherwise you need to reinvent the bicycle how to analyze it but even in this case you are able to create some scripts to analyze this data again I I would prefer R or Python but you could create on whatever you need
59.FC		OK umm so the yeah I think now you have an impression of what we have just what the topic is about, yeah, I I think in a condensed way you see it's an issue of adoption, VA how is the manager viewing it. Now with that view that you have do you really think we have some yeah I think we are done with the questions but then we're asking for some perspective if there are any if there is anything that you think you may like to comment on that might help with this topic
60.BG		Let me show you a presentation. I will share my screen. Can you see it?
61.FC		Yes
62.BG		[At this stage, he shows to us many slides presented at his company that includes several types of visual analytics tools in the market and their level of easiness to understand and their self explainability level. It turns out from all the 10 tools presented, 7 of them are easy to use and understand their results]
63.FC		I'm done over to you Hicham
64.HI		I just wanna thank you for your time Bron and it's really what you gave us is really insightful…

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