

# Importance of the Use of Analytics in Requirements Engineering

Marina Pincuka

Institute of Applied Computer Systems, Faculty of Computer Science and Information Technology, Riga Technical University, Kalku 1, LV – 1658, Riga, Latvia  
marina.pincuka@rtu.lv

**Abstract.** Requirements Engineering is regarded as one of the most important functions in software development process. Inadequate/ incorrect engineering of requirements may lead to expensive errors in software development or even to project failure. Even though there are a different methods and approaches that are proposed in literatures, many of these approaches have not been used in the industry or have been proved to be ineffective. The main goal of this work is to investigate the Requirements Engineering weak points and see which of these weak points can be strengthened by the use of analytics.

**Keywords:** Requirements Engineering, Analytics, Requirements Engineering Challenges

## 1 Introduction

In project, requirements definition is an important function that affects project processes and results. Dissatisfaction of the requirements may lead to unhappy customers, incorrect system processes or even project failure. The use of analytics allows to process the information that otherwise may be ignored or overlooked.

Based on Dick J., Hull E. & Jackson K. [3], Requirements Engineering (RE) is the subset of systems engineering concerned with discovering, developing, tracing, analysing, qualifying, communicating and managing requirements that define the system at successive levels of abstraction.

Dankov Y. and Birov D. [2] describes analytics as the process of developing actionable insights through problem definition and the application of statistical models and analysis against existing and/ or simulated future data.

The purpose of this paper is to reflect the results of the research in progress concerning the importance of the use of analytics in Requirements Engineering functions. Paper reports on three research questions: (i) “What is the state of art of the use of analytics?” (ii) “What are the Requirements Engineering challenges?” and (iii) “How the use of analytics in specified Requirements Engineering function can improve the weak point of Requirements Engineering?”.

The paper is structured as follows. The survey of the state of art of the use of analytics is presented in Section 2. Challenges in Requirements Engineering are presented in Section 3. Summary of Requirements Engineering challenges and the use of analytics

to reduce the Requirements Engineering weak points are described in Section 4. Brief conclusions and directions of further research are stated in Section 5.

## 2 A Survey of the Use of Analytics

To understand the state of art of the use of analytics, a literature search was conducted using terms “use” and “analytics”. 25 sources were selected and analysed using Springer Link, Science Direct, IEEE resources, 13 of the sources, were identified as overlapping and are not included in a review. Collected sources of types of analytics are new and do not overlap with previous overview published in Pincuka and Kirikova article “Types of Analytics in Requirements Engineering” [16]. New overview was made to expand understanding of use of analytics in different fields.

The gathered articles, were analysed as follows: (i) “What is the industry in which analytics are used?”, (ii) “What kinds of analytics are used?” and (iii) “What the analytics is used for?”. Gathered kinds of analytics and their brief definition is described below:

1. Game analytics – applying analytics and big data in the gaming context [11];
2. Web analytics – the measurement, collection, analysis and reporting on Internet data for the purposes of understanding and optimizing Web usage [1];
3. Visual analytics – information visualization that focuses in analytical reasoning facilitated by interactive visual interfaces [14];
4. Descriptive analytics –describes what is happening or why something happened [19];
5. Predictive analytics – provides foresight and make predictions about the likelihood of a future event [19];
6. Prescriptive analytics – provides support for making decisions, or some cases independent form its own decisions [19];
7. Business analytics- comprised of solutions used to build analysis models and simulations to create scenarios, understand realities and predict future states [13];
8. Big Data analytics – the use of advanced analytic techniques against very large diverse data sets that include structured, semi – structured and unstructured data, from different sources and different sizes [13];
9. Diagnostic analytics – the form of advanced analytics that examines data or content to answer the question, “Why did it happen?”. It is characterized by techniques such as drill-down, data discovery, data mining and correlations [5];
10. Text analytics – a process of converting unstructured text data into meaningful data for analysis, to measure opinions, reviews, feedback, to provide search facility, sentimental analysis and entity modelling to support fact based decision making [18];
11. Learning analytics - the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs [4].

Table 1 summarizes all identified types of analytics, industries in which analytics are applied and usage of analytics in different use cases. These analytics are further used in Section 4 in example to overcome Requirements Engineering challenges using analytics.

**Table 1.** Use of analytics in different industries

Type of analytics	Industry	Usage
Game analytics	Information Technology: Game development [11]	Understand use preferences and behaviour [11]; Improve decision – making [11]; Gather insights [11]; Reduce the risk of failures [11]
Web analytics	Information Technology [1]; Website management [1]; Marketing [1]	Optimizing website functionality and conversion [1]; Analysis of past performance [1]; Optimizing performance of and conversions from marketing campaigns [1]; Determining the best creative executions through testing [1]; Baseline information for site redesign [1]; Predictive metrics for developing future marketing campaigns [1]; Budgeting and planning for upcoming business objectives [1]
Visual analytics	Medicine [14]	Trend monitoring [14]; Anomaly detection [14]; Testable hypothesis detection [14]
Descriptive analytics	Medicine [19]; Marketing [13]	Understand why something happened [19]; Provide information about past behaviour, patterns or trends in the data [13]; Categorize, characterize, consolidate and classify data to valuable information [15]
Predictive analytics	Medicine [19]; Information Technology [13]; Marketing [13]; Insurance companies [13]; Aviation companies [13]	Prediction of the occurrence of future events [19]; Supports decision – making [13]; Understanding of behavioural patterns and trends [13]
Prescriptive analytics	Medicine [19]	Supports decision – making [19]
Business analytics	Marketing [13]	Prediction of the future states [13]; Understand of the reality [13]
Big Data analytics	Marketing [13];	Supports decision – making [13];

Type of analytics	Industry	Usage
	Human Resource management [7]; Construction industry [15]; Information Technology [24]	Understanding of behavioural patterns and trends [13]; Capturing the strategic linkage [7]; Improve performance [7]; Forecast future threats and opportunities [24]; Enhance organizational performance [24]
Diagnostic analytics	Construction industry [15]	Evaluation of the potential causes of a problem [15]
Text analytics	Information Technology: Mobile application development [8]	Risk identification [8]; Benefit identification [8]; Supports – decision making [18]
Learning analytics	Education [4]	Understanding and optimization of patterns [4]

The collection of types of analytics and the industries in which they are used allows to (1) understand the main domains of application of analytics and (2) collect different methods and approaches how analytics can be applied in different fields, to understand how analytics can be applied in Requirements Engineering.

Gathered analytics are described without any classification into groups, because the purpose of this article is to understand use of analytics in different fields and if it is possible to apply this analytics in Requirements Engineering and overcome Requirements Engineering challenges.

### 3 Requirements Engineering Challenges

Requirements Engineering deals with a lot of challenges, for example, authors Kahan et al. [9] mentions, previous identified requirements issues/ challenges like - business process focus, systems transparency, integration focus, distributed requirements, layers of requirements, packaged software, centrality of architecture, independent complexity and fluidity of design. Author Schmid [22] mentions Global Requirements Engineering challenges that are based on location of the stakeholders, in his article he mentions challenges with International Requirements Engineering and Distributed Requirements Engineering.

In this section Requirements Engineering challenges are collected based on Requirements Engineering phase in which challenge appears on.

Requirements Engineering function has a four phases [12]:

- Elicitation is the act to determine or obtain the relevant requirements for the development of a solution. In this phase requirements are identified and discovered;
- Requirements analysis is a phase, where a user's requirements should be clarified, categorized and documented to generate the corresponding specification.

In this phase requirements classification, representation, derivation and negotiation are provided;

- Requirements specification describes the phase, where the requirements are brought into a suitable and unambiguous form. The idea in this phase is to document the requirements, and to make the requirements document readable and understandable to anyone;
- Requirements validation is to review or validation requirements for clarity, consistency and completeness. In this phase requirements faults are identified.

Table 2 presents challenges in Requirements Engineering and phases of Requirements Engineering in which challenges usually emerge.

**Table 2.** Challenges in Requirements Engineering

Requirements Engineering phase	Challenges
Elicitation	Incorrect understanding of the requirements [12][6]; System knowledge may be fragmentary, distributed and tacit [21]; Lack of information [23][20][6]; Problems with client and customer representatives [23]; Problems in communication [23][10]; Conflicting requirements [20][10][6]; Random/ uncertain/ unclear requirements [20][10]; Unrealistic requirements [10];
Analysis	Integrating physical objects with information objects [21]; Change/ volatility of requirements [23][20][10][6]; Requirements quality issues[23]; Neglect of non-functional requirements [23]; Incomplete requirements [20];
Specification	Minimal documentation [23][10]; Complexity of requirements documentation [10];
Validation	Requirements validation[23]; Inadequate requirements verification [23];

Summarizing all of the challenges from different scientific papers (see Table 2.) the conclusion can be made, that often authors emphasizes the same challenges in the same phases of Requirements Engineering function.

#### **4 Use of Analytics to Reduce Requirements Engineering Challenges**

In this Section using summarization of Requirements Engineering challenges are provided the types of analytics, which can be used to improve Requirements Engineering issues. In table 3 are mentioned only those Requirements Engineering challenges, to

whom methods of analytics can be applied to, for example, analytics can not be used with challenges in customer/ client representatives or minimal documentation, in these cases other methods should be provided. Analytics, that can be applied to Requirements Engineering challenges where identified in a literature survey, based on analytics use cases and author master thesis Pincuka M. “Analytics in Requirements Engineering” [17]. Analytics, which are proposed to use in Requirements Engineering challenges are chosen based on use of analytics in a literature survey.

**Table 3.** Proposed types of analytics in Requirements Engineering challenges

Requirements Engineering challenge	Types of analytics
Incorrect understanding of the requirements	Business analytics; Game analytics; Predictive analytics; Prescriptive analytics; Text analytics; Web analytics.
System knowledge may be fragmentary, distributed and tacit	Big Data analytics; Descriptive analytics; Learning analytics; Visual analytics
Lack of information	Big Data analytics; Descriptive analytics; Text analytics
Conflicting requirements	Descriptive analytics
Random/ uncertain/ unclear requirements	Descriptive analytics; Diagnostic analytics; Predictive analytics, Prescriptive analytics
Unrealistic requirements	Business analytics; Descriptive analytics; Diagnostic analytics
Change/ volatility of requirements	Big Data analytics; Descriptive analytics; Diagnostic analytics; Predictive analytics, Prescriptive analytics; Text analytics, Web analytics
Requirements quality issues	Business analytics; Descriptive analytics; Diagnostic analytics
Neglect of non-functional requirements	Big Data analytics; Text analytics
Incomplete requirements	Descriptive analytics; Diagnostic analytics; Predictive analytics, Prescriptive analytics

Types of analytics that are provided in Table 3, only points out some of the analytics that can be used to improve or overcome Requirements Engineering challenges. For example, (i) business analytics can be used to understand the reality, if we will apply this analytics to Requirements Engineering it will help to better understand the requirement and its meaning, (ii) if we identify conflicting requirements using descriptive analytics data can be classified and meaningful information about requirements can be found or (iii) using text analytics with keywords about the system we can identify some additional information to reduce lack of information. To summarize all methods of analytics that can be used to overcome Requirements Engineering challenges a literature study must be provided with focus on analytics and use cases, where methods of analytics are used.

## 5 Conclusions

In this paper Requirements Engineering challenges are discussed and the use of analytics to overcome these challenges envisioned. The paper contributes (i) a preliminary survey on the use of types of analytics in different industries, (ii) summary of Requirements Engineering challenges in Requirements Engineering phases and (iii) proposal to the use specific types of analytics to overcome identified Requirements Engineering challenges. Survey can be further researched collecting publications from different years, industries, main topics and use cases.

Use of analytics in Requirements Engineering has a big potential, but nowadays use of analytics in Requirements Engineering is still limited, the issues addressed in this work are rarely surveyed, structured and organized, so the knowledge of the use of analytics in Requirements Engineering could be reused and utilized effectively.

In previous research [16], first insights of use of analytics in Requirements Engineering were collected and this research is a step towards the effective utilization of different types of analytics in Requirements Engineering.

The presented research has several limitations – more sources of analytics and Requirements Engineering challenges can be identified, analytics can be grouped by the usage and use of analytics in Requirements Engineering challenges can be explained using examples.

Nevertheless, the contribution of this research in progress provides insights about possibilities of use of analytics in Requirements Engineering. The further research will include overcoming of the above listed limitations.

## References

1. Chaffey D. & Patron M. From web analytics to digital marketing optimization: Increasing the commercial value of digital analytics. In *Journal of Direct, Data and Digital Marketing Practice*. Vol. 14. Springer, 30-45 (2012).
2. Dankov Y., Birov D.: *General Architectural Framework for Business Visual Analytics*. Business Modeling and Software Design, Springer, 280-288 (2016).
3. Dick J., Hull E. & Jackson J. *Requirements Engineering: Fourth Edition*. Springer, p.239 (2017).
4. Eradze M., Valjataga T. & Laanpere M.: Observing the Use of e – Textbooks in the Classroom: Towards “Offline” Learning Analytics. In *proceedings on International Conference on Web-Based Learning (ICWL 2014)*, pp. 254 – 263 (2014).
5. Gartner. *Gartner Glossary: Diagnostic Analytics*. Available at: <https://www.gartner.com/en/information-technology/glossary/diagnostic-analytics>. Accessed – 23.01.2020.
6. Ghozali R.P., et al.: Systematic Review on Decision-Making of Requirements Engineering from Agile Software Development. In the *proceedings of the 4<sup>th</sup> International Conference on Computer Science and Computational Intelligence 2019 (ICCSCI)*, September 12-13, 274-281 (2019).
7. Hamilton R.H. & Sodeman W.A. The questions we ask: Opportunities and challenges for using big data analytics to strategically manage human capital resources. *Business Horizons* Vol. 63. January –February, 85-95 (2020).

8. Han L., et al. Who will use augmented reality? An integrated approach based on text analytics and field survey. *European Journal of Operational Research*. Vo. 281. 502-516 (2020).
9. Kahan E., Genero M., Oliveros A. Challenges in Requirements Engineering: Could Design Thinking Help? In proceeding of the International Conference on the Quality of Information and Communications Technology (QUATIC 2019), 79 -86 (2019).
10. Karlsson L., et al.: Requirements Engineering challenges in market-driven software development – An interview study with practitioners. *Information and Software Technology*, Vol. 49, 2007, pp.588-604 (2007).
11. Mantymäki M., et al. How Do Small and Medium – Sized Game Companies Use Analytics? An Attention- Based View of Game Analytics. In *Information Systems Frontiers*, Springer (2019).
12. Marcelino – Jesus E., et al.: A Requirements Engineering Methodology for Technological Innovations Assessment. In proceedings of the International Conference on Concurrent Engineering (CE 2014), p. 11 (2014).
13. McCarthy R.V. et al. Introduction to Predictive Analytics. In *Applying Predictive Analytics*. Springer, pp.1-25 (2019).
14. Mishra V., et al. Use of Visual Analytics and Durometer in Risk Reduction of Foot Problems in Diabetes. *Lecture Notes in Mechanical Engineering*. Springer, pp. 491-498 (2016).
15. Ngo J., et al. Factor – based big data and predictive analytics capability assessment tool for the construction industry. *Automation in Construction*. Vol. 110 (2020).
16. Pincuka M., Kirikova M.: Types of Analytics in Requirements Engineering. In proceedings of Business Informatics Research (BIR2018), pp. 25-32 (2018).
17. Pincuka M.: Master thesis: “Analytics in Requirements Engineering”, 2019, p.98.
18. Predictive Analytics Today. What is Text Analytics? Available at: <https://www.predictiveanalyticstoday.com/text-analytics/>. Accessed – 23.01.2020.
19. Reifferscheid K. & Zhang X. Enhance the Use of Medical Wearables Through Meaningful Data Analytics. In proceeding of International Conference on Digital Human Modeling and Application in Health, Safety, Ergonomics and Risk Management, Springer, pp. 281 -296 (2017).
20. Safwat A. & Senousy M.B.: Addressing Challenges of Ultra Large Scale System on Requirements Engineering. *Procedia Computer Science*, Vol. 65, pp.442-449 (2015).
21. Sawyer P., et al.: How the Web of Things Challenges Requirements Engineering. In proceedings of the International Conference on Web Engineering (ICWE 2012), pp. 170-175 (2012).
22. Schmid K.: Challenges and Solutions in Global Requirements Engineering – A Literature Survey. In proceedings of International Conference on Software Quality (SWQD 2014), pp. 85-99 (2014).
23. Schon E-M., et al.: Key Challenges in Agile Requirements Engineering. In proceedings of International Conference on Agile Software Development (XP 2017), pp.37-51 (2017).
24. Sun Z., Pambel F. & Wang F., Incorporating Big Data Analytics into Enterprise Information Systems. In proceedings of Information and Communication Technology – EurAsia Conference (ICT-EurAsia2015), pp. 300- 309 (2015).