

Measuring the Performance of the Development Team Regarding Business Intelligence Applications

Yasser Gamil Khalil

Ph.D. of Business Administration, Tripoli University, Libya
yaso.gamil2000@gamil.com

Abstract:

Business intelligence applications are in the front of demanding technologies. Companies need technology to adapt to changing requirements, to deal with a rich amount of data, to get correct information, to analyze data, and finally to quickly support decision-makers. Developing a Business Intelligence (BI) application can be defined as a short-delivering software application. This process is based on frequently adapting to changing requirements, involving customer participation, and delivering high-quality applications. Agile teams need a set of reliable metrics to measure their performance at different three levels: functionality, content, and scalability. This paper proposes Goal Question Agility Metrics (GQAM) that can be used in measuring the performance of agile teams working in developing business intelligence applications. GQAM is based on the Goal Question Metrics (GQM) method that was developed by Victor Basili in 1994 [19]. In addition, GQAM depends on agile and BI concepts. GQAM proposes a set of metrics that are used to measure performance. The GQAM will be subjected to experiments using a real data set in the future.

Keywords: Team Performance, Business Intelligence, Software Application, Goal Question Metrics.

1- Introduction

The rapid change in the world market, business rules, uncertain data sources, and shifting customer preferences represent challenges between competitors. That means

the organizations live in the race to get a competitive advantage. They frequently require decisions in a short period [1]. These decisions are based on updated reports with new data sets, the ability to drill down the reports, keeping historical data, visualization reports, and statistical analysis [6, 20]. Business Intelligence (BI) is a successful way for organizations to be intelligent to improve performance, increase revenue, create good customer relationships, and support decision-making [61]. BI is defined as a set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information used to enable more effective strategic, tactical, and operational insights and decision-making as shown in figure1 [18, 63]. BI application is different from the traditional application [62]. BI application has an adaptive and dynamic nature. It continually changes to answer new and different business needs. In addition, it begins small and grows incrementally. In BI applications, business users and technical teams work together closely.

BI is an umbrella for different technologies [2, 3, 8]:

- **Data sources:** various data sources represent challenges for customers. Customers become untrusted in the new data set. These come from duplicate reports, replaced trained trusted data sets, and new reports.
- **Data Warehouse (DW):** collects data from different sources into a single place. ETL tool is used to extract transaction data and collect them in DW. DW is defined as “it is a simple, complete, and consistent store of data obtained from a variety of sources and made available to users in a way they can understand and use it in a business context”. DW is a multidimensional data structure. The data set comes with different structures: structured, semi-structured, and unstructured. Normally, technology tools are designed for specific data types.

- **Data mart:** is the access layer of the data warehouse. It is used to get data out to the users. Data extraction is related to a single department for decision-makers. The data warehouses and data marts are needed together because the information in the DW is not organized in a way that makes it easy for companies to find what they need.
- **OLAP:** allows faster generation of new reports, which analyzes the data and supports decision-making.
- **Reports:** statistical and visualization analysis in a unified format.

The BI environment can be divided into data warehouse and analytical environments. The data warehouse is limited to build the BI architecture. An analytical environment (i.e., OLAP, Reporting) is considered to analyze the current business and forecast the future [62].

Building successful BI applications is based on four factors which are [67]: adaptability, cross-functionality, multi-project, short delivery, and end users' involvement. Adaptability means that BI methodology facilitates change and manages business processes and services. Cross-functionality means that the team should be cross-functional and self-organizing. The BI methodology is not limited to technical staff. It needs a multidisciplinary team. Multi-project means the ability to apply more than one project in parallel. Short delivery means that the delivery time is a critical factor for a successful BI application. The business managers and decision-makers make decisions in a short period.

The traditional software development life cycle doesn't match the BI requirements. It spends a lot of time on the requirement elicitation. They aren't determined fully in the early stage of the project. It takes a long time to deliver applications [7]. The end user's role ends at requirement elicitation. The agile methodologies have a

dynamic and adaptable nature. The agile methodologies are based on some principles [8]: changing requirements, incremental delivery, and user participation.

There is a necessity for combining agile methodologies and BI. BI applications can be divided into small iterations based on user stories. Each story represents “release”. Finally, these releases can be integrated into one project. Agile BI is based on the “Think Big Start Small” approach and no end of BI project. Agile BI is a current demand for most business companies. However, the number of research papers in the agile business intelligence area is small.

Since agile BI application represents multi-task application with multiple goals. Teams need to measure their progress in the development cycle. Teams try to be on the right track and can correct the plan or add new functions in the next increment. Teams try to answer the following two questions. Can teams use guidance for choosing the right way to track the business? How can teams ensure that business incorporation with agility solutions feeds the project's success?

This paper guides teams with the metrics they need and provides a framework for directing them to achieve business goals. So, measurements will be more realistic and good indicators for the current business environment. In this paper, the researchers use GQM to determine the goals of the system and metrics that can be used to evaluate the goals. In addition, the metrics show whether those goals have been met. This paper proposes goal question agility metrics (GQAM) to help teams draw a blueprint for measuring their progress in the development of agile business intelligent applications. The researchers will conduct with almost all BI organizations via online surveys or meetings and interviews to collect the measurements and evaluate GQAM in real business intelligence applications in the future.

This paper is organized into six sections: section 2 explains the agile business intelligence, section 3 introduces the related works, section 4 introduces the goal question metrics and section 5 introduces GQAM for agile business intelligence. Finally, the conclusion is introduced in section 6.

2- Agile Business Intelligence

Agile BI can be defined as a fast and flexible process that uses an agile method to enable rapid development and allow companies to be intelligent and support strategy, tactical, and operation insight [21, 22]. Agile means the ability to adapt. There are seven agile methods: Scrum, Dynamic System Development Method (DSDM), Crystal Method, Feature-Driven Development (FDD), Lean Development (LD), eXtreme Programming (XP), and Adaptive Software Development (ASD). The Scrum and XP are commonly used in the business intelligence applications [16].

2-1 Success Factors of Agile BI

There are many success factors of agile BI applications. In [26, 33] the authors summarized the success factors as follows:

- a) Iterative development cycles.
- b) Automate ongoing BI processes: Agile BI development teams must automate any repetitive tasks/processes to allow more time and focus on developing and delivering software.
- c) Agile BI projects should be more flexible and responsive to meet changing consumers' requirements. In Yellowfin survey [64], 45 % of respondents said that their current BI applications were "somewhat difficult to learn and navigate". 77 % of participants stated that they do not have access/cannot create custom reports independently and must ask data analysts to generate reports for them.

d) The team workers should be cross-functionality, self-organizing, and powerful. They should consist of the following team: customer representatives such as product owners in the scrum, Data analysts, Report developers, and ETL developers. The success factor for team workers can be summarized as [66]:

- Team worker with high competencies and experiences
- Team member with great motivation
- Team workers understand well agile process.
- Coherent and self-organizing team.
- Good customer relationships.

2-2 Agile BI Framework

The authors in [28] proposed an agile BI framework as shown in Figure (1). The framework highlights the agile BI strategy and the related activities. It is based on the best practices of BI projects. This framework combines the advantages of waterfall software development (i.e., discovery phase) and the advantages of the agile method (i.e., modeling in the design phase and development phase). It consists of four phases as follows:

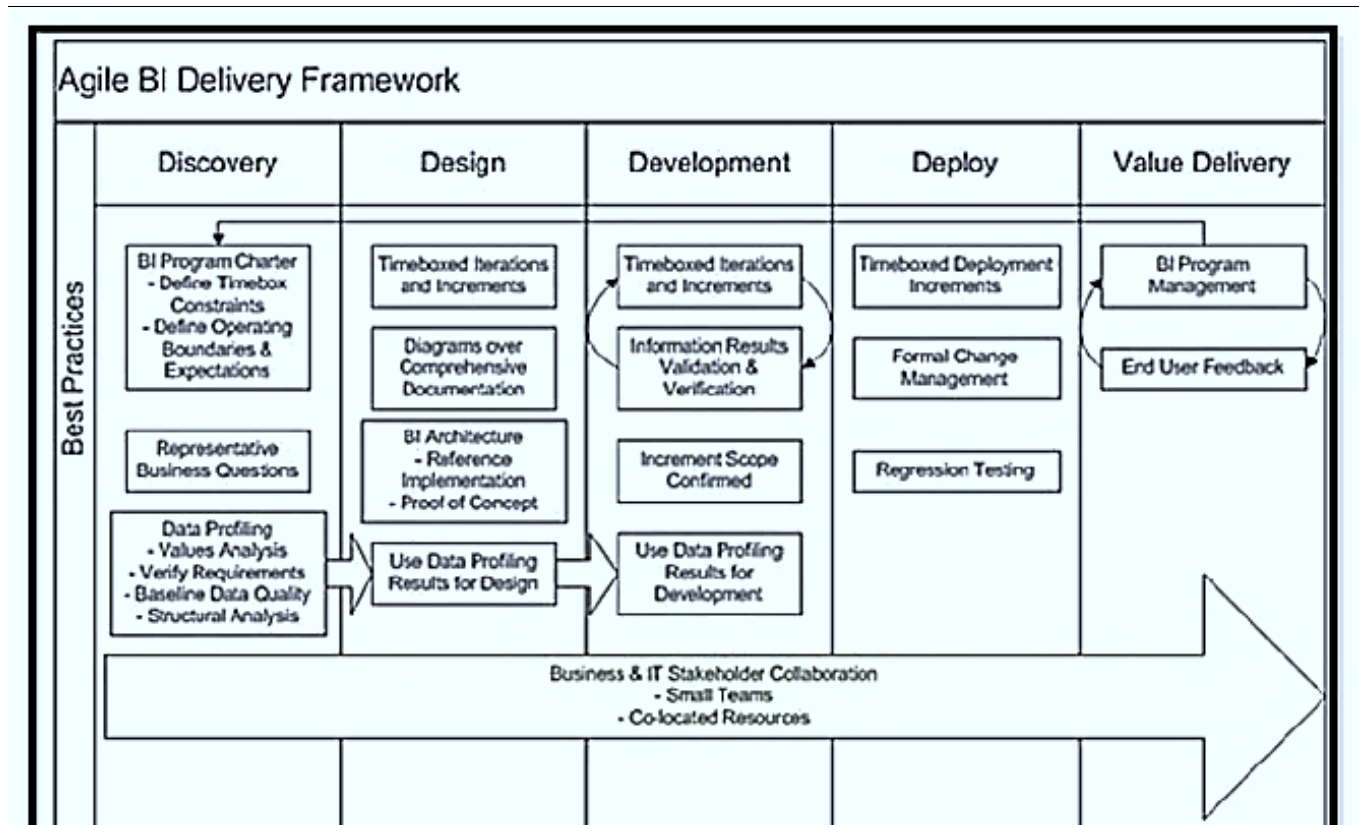


Figure (1): Agile BI Framework

- Discovery Phase:** The stakeholders need automated tools to increase understanding or analysis of requirements. The stakeholders can use outlining business questions techniques. These techniques provide insight into data sources, dimensions, and facts needed. Data profiling techniques are data demographics and descriptive statistics such as frequency distribution, high and low values, blank attributes and records, exceptions to domain values, dependencies between attributes, unknown constraints, mean, median, mode, and standard deviation.

The knowledge gained from analyzing data demographics provides the basis for data quality metrics and can be used later in the remainder phase of the life cycle.

- **Design:** It begins with drawing a BI architecture diagram. It includes data models, data flows, process flows, and infrastructure diagrams. Architecture decisions can't be easily reversed once implemented. The prototype and proof of concept (POC) can be used in validating architectural decisions. The design phase consists of iterative modeling and mapping activities. Modeling activity prioritizes requirements, data demographics, and provides a stable scope for the increment. Mapping activity is also known as a source to target mapping. The source-to-target mapping will be evolutionary frequently within the scope of the increment.
- **Development:** The goal of development is to deliver working software frequently. In BI, development deliverables may be ETL processes analysis, and data warehouse or reporting capabilities. In development, stakeholders can refine requirements, and design. Stakeholders can also confirm information results through the validation of business rules and verification of output.
- **Deploy:** In agile methods, testing occurs constantly through the interactions of stakeholders. A regression test suite for the BI system is essential for the BI project. The incremental delivery approach provides new functionality in the next increment and ensures the validity of the existing solution.

2-3 Technology Tools of BI

It is useful for teams to use information technologies for the success of BI applications. However, the unsuitable or slow technology tools lead to the failure of BI projects. The choice of a technology tool to be used in the BI application is based on the following criteria:

- **Easy-to-use:** Business users must be able to create and distribute their own reports and perform analytical queries without the need for IT support.

- **A single integrated application:** All the components of the BI tool should be accessible via a single unified interface.
- **Able to connect and report off multiple data sources:** In-memory analytic tools [65] eliminate the need to store pre-calculated data in the form of OLAP cubes or aggregate tables. It provides business users with faster analysis and access to analysis of large data sets, with minimal data management requirements.
- **Business users:** have access to self-service analysis and IT departments can spend less time on query analysis, cube building, aggregate table design, and other time-consuming performance-tuning tasks.
- **Fast communication:** Business and IT leaders agree that technology is the primary driver of agile BI. Agile BI can be defined from a technological point of view as the ability of a business to adapt rapidly and cost-efficiently in response to changes in the business environment. Cloud computing and virtualization technologies are means of fast communications and management systems in a single location. 72% of respondents have deployed cloud computing. They believe the cloud plays a key role in IT agility [29] and show that cloud computing enhances IT agility leads to leverage business agility and therefore corporate performance. There is a direct relation between cloud computing and business agile. The cloud computing can be implemented as private or public or both. Hybrid cloud computing is more cost-saving. It is beneficial to companies that they consider unpredictable changes in the business environment. Hybrid clouds mean common platforms, management, and security [32]. Virtualization means the ability to run more than one “logical machine” on a single piece of hardware [30, 31]. With virtualization, it can become possible to run two or more completely different servers and databases on a single piece of server platform. Virtualization means saving money on hardware, fast time to deploy the applications, and reducing the test cycle.

2-4 Business Analytic Solution

BI applications are based on data warehouse and business analytical tools. If the users in a business organization work across large amounts of data and applications with only spreadsheets as the interface between them [65]. There are several problems that appear: lack of visibility or unclear critical data, disjointed group problem-solving, and delayed decision-making. The need for new analytic solutions is critical for business users and these solutions must be characterized by easy-to-use interfaces, high-performance analytics, free application configuration, scalability, and an IT-friendly and low-maintenance environment [35]. This solution guarantees the following:

- a) The integration between all components, all data, and metadata across different applications.
- b) Each user can ask and report from the same interface without moving to another application and without facing multiple user interceptions.
- c) Business analytics solutions provide advanced features for quick analyzing and reporting such as
 - Customized interfaces with the ability to browse reports and to use templates for planning and analytical applications.
 - Basic tools such as wizards, workflow, visualization, and pre-built databases.
 - The ability to change variables or the business model. The ability to see the changes and to compare them with historical data or other applications.
 - The ownership and users can work together to develop, adjust, and maintain business models.
- d) Concurrent read or write for planning processes.
- e) Parallel scenarios and assumptions with on-demand recalculation.
- f) Instantaneous availability of model or data changes.

- g) Multi-dimensional data analysis.
- h) The solution should support dozens to hundreds of concurrent users.
- i) Easy to install, deployed, and running in a matter of weeks.

3- Related Works

This section introduced the related works in agile BI. Some paper discussed the agile BI to enhance, and success BI projects. Other papers try to track the performance of teams in BI applications. In addition, agile BI was mainly discussed in the non-academic discussion.

- The authors in [68] followed the maturity model and developed model for assessing their BI application and how it could reach the best performance level. The Pilot test and the empirical investigation carried out to validate their maturity model for BI application. They concluded that the stages were determined by technical aspects that are more advanced than other stages that were processed and related to people. The basic maturity level in the last stage proves the Moroccan small and medium-sized enterprises have to launch a new project to improve their BI application.
- The authors in [4] addressed the question: how could agile BI be broken down and defined with success metrics that take into account the particularities of BI? They followed exploratory and qualitative research design for answering the pervious question. They conducted interviews with a number of companies under two extensions levels. The study concluded that, it was advisable to split agile BI according to architectural layers into data acquisition agility, data storage agile BI, data analysis agility, data administration agility, and frontend agile BI. As well as it is advisable to split agile BI into content, functional, organizational, and scalability. It was advisable to differentiate between agile BI measures with respect to the architectural. Finally, they contributed that the developed indicator

system was designed to support the steering of BI approaches under agile objectives. Agile BI issues could be expected to gain further extension.

- The authors in [23] discussed the most comprehensive way how a set of existing complexity metrics of software were modified and adapted by researchers to provide useful information on complexity of the BPM. They followed GQM approach for measuring the understandability and maintainability of BPM. In this paper, the researchers agree with the authors that GQM ensures that each metric has a purpose, and no metrics are defined without a purpose. The authors got results by the survey with useful metrics for measuring the understandability and maintainability of business process model, introducing the best useful metrics.
- The authors in [12] introduced the assessment model for assessing data warehouse projects for agile methodology. They conducted with real projects. The challenges would face poor data quality, user acceptance testing carried out on historical data and uncovered pattern that didn't discover in the requirement and changing requirements. The agile methodology avoids some failure projects.

4- Goal Question Metrics (GQM)

The GQM originated from the research of defect evaluations in the NASA 1984 [19, 25, 27]. GQM is one of the most powerful approaches for metrics definition [43]. GQM paradigm is a top-down approach and goal driven approach to define the goals behind measuring software processes and products, use these goals to decide precisely what to measure (i.e., choosing metrics) [44], and evaluate the quality of product based on the measurements. It consists of both a generic model and a process that describes how to instantiate the generic model for a specific situation. Then how to collect the measurements [49]. GQM approach consists of three steps:

- Step 1: Develop a Goal (Conceptual level).
- Step 2: Define the Questions (Operational level).

- Step 3: Metric (Quantitative level).

In step 1, the teams in business applications would be developed a set of corporate, division, or project (i.e., development or maintenance) goals for enhancing the productivity, and quality attributes (i.e., customer satisfaction, on-time delivery, improved quality). The goals are frequently determined by brainstorming and stakeholders' requirements [47]. On the other hand, the measured goal describes what the knowledge to be gained from the measuring activity to make suitable decision about the success or failure of related goal [45]. To formulate a goal, it must be defined for a measured object for a variety of reasons with respect to various quality models. In addition, it must be defined from various points of view and relative to a particular environment [46]. More specifically, the goals should be discussed the following items:

- Object: What is being examined?
- Purpose: Why object is being examined?
- Focus (issue): attributes being examined.
- Viewpoint: perspective of examination.
- Environment: context of scope of examination.

In step 2, the measured goals are defined in an operational and traceable way by a set of quantifiable questions. Questions are used as guidelines for extracting the appropriate information to fulfill the measured goal [45]. Questions try to characterize the measured object with respect to selected quality attributes. In addition, questions describe either the quality attributes from the selected point of view or the factors may impact on the quality attributes [48].

In step 3, questions specify the metrics that define what quantitative data need to be collected to answer the questions [45]. Several metrics is determined by answering the questions that provides contributions toward defined goals. Questions can move

the organization to new and different directions [42]. For this reason, the executives need to treat the metrics as powerful agents of change. The metrics can drive the unparalleled improvements or put the organization into chaos and confusion. Therefore, the development teams need an aid for defining the right metrics for each question. So that metrics could be classified into different types as follow [36]:

Outcome Metrics: is known as lagging indicators. It measures the achieved goals. Formally the output of business activity is measured for a strategy that is designed to achieve. For example, if the organization's strategy achieves 12 %of the return rate. The outcome metrics might be return rate per month. They measure a past activity that has already happened and cannot be changed [59].

- **Driver Metrics:** is known as leading indicators. They are tactical metrics. Their purpose is tracking the progress of the current activity. The executives can make necessary adjustments to meet or exceed the outcome for the period [58]. They measure business activity at different periods in which the outcomes are measured. For example: if an outcome metric is monthly sales, a typical driver metric might be weekly or daily sales.
- **Predictive Metrics:** organizations often use the regression algorithms to predict future outcomes. They are based on the current activity so the teams can see whether they are going to meet targets at the end of period.
- **Activity Metrics:** They provide additional context about the performance that helps businesspeople to make suitable decisions. For example, activity metrics include top 10 lists such as top 10 suppliers or bottom 10 suppliers are based on time delivery.
- **Risk Indicators:** It differs from performance indicators which measure how well something is being done. Risk indicators measure the riskiness of the operations and of a business activity. A risk indicator provides an early warning sign to identify the events that may harm the continuity of existing

processes. Risk indicators have goals associated with them like performance indicators [60].

In GQAM, the researchers select a set of appropriate metrics that will cover all previous metrics types.

5- Goal Question Agility Metrics (GQAM)

GQAM is based on GQM for identifying a set of metrics in a systematic way. GQAM is applied on agile BI layers from the business point of view. GQAM is used for the division of agile BI into three layers [4]: the functionality, scalability, and content layers. The functionality layer means to quickly introduce or evaluate a new analytic or frontend functionality. The scalability layer regards various workloads in data analysis and data provision as well as resources. The content layer considers data repositories. It is constructed with respect to the role of agile in BI applications. BI could be also arranged in 3D cube layers by intersecting the concept of agile BI with previous the three layers.

GQAM can be described as follows:

- a) Goal: "Improve the quality of functionality, scalability and content layers for agile BI internally and externally from the business point of view". The goal is composed of the following:
- The object would be the internal and external layers of BI.
 - The purpose is improving the quality of functionality, scalability, and content layers for agile BI.
 - Issue would be the quality of the layers.
 - The viewpoint would be from business perspective.
 - Finally, the environment could be firms or organizations that apply BI solutions in their business works.

The researchers propose the following five questions:

- Question 1: Does agile BI able to react to unforeseen or volatile requirements of markets and customers?
- Question 2: Does the incorporation of agile with BI save costs?
- Question 3: Do business users use appropriate tools and technologies?
- Question 4: How satisfaction is the stakeholders?
- Question 5: Are teams of agile BI applications increasing their performance of work?

The researchers propose a set of effective metrics that may provide the best answers on the above questions that should be used for tracking the performance of teams in agile BI.

In question1, the teams concentrate on the market, consumers, requirements, and delivering applications in high speed. Thus, the better metrics could measure the impact of this question on the goal: timeliness of data delivery, replaying efficiency, reporting time [21] and service level management (SLM) [50, 51]. Timeliness of data delivery measures the replaying time for requests and market directions. Agile BI features are frequent appear in this metric. BI must use the agile BI to improve the replaying time and the responding to rapid changing market requirements. On the other hand, researchers should consider the efficiency that replaying phases. Measurements should be considered to track its efficiency. However, reports should be always updated and subjected to new changes and manipulations. Finally, delivering services as mentioned in the standards as well as accurately measuring performance guarantee service level management [51].

In question 2, business owners always seek for saving costs by using the ways that promise the efficiency of the work. Costs could be represented in different forms i.e. money, time, labor and so on. They were realized to the most effective metrics that

would give good insight about critical functions: quick Ratio[37], budget deviation [40], service level management (SLV) [50] and reporting time[21]. Quick ratio metric specialized in measuring how the organization can cope the financial requirements specially the short- term. For example monthly bills or daily liabilities and so on. The budget deviation metric focuses on calculating the deviation value from the original one. This metric can capture any deviation that would affect on the budget. SLV and reporting time were explained in the previous question. However researchers found that these metric affect on the organization cost (time). Therefore researchers use these metrics for answering the question.

In question 3, BI depends on technologies, techniques, and analytic tools for best manipulating data as well as extracting useful knowledge and statistics for users [5]. Also, the processing of these data is a very important aspect for getting the knowledge from the right source within convenient time [28]. This valuable knowledge is the main core of the decision-making process [28]. Therefore organization should take care of their technologies, tools, artifacts, and resources to get the correct, useful, and appropriate information. Researchers propose these metrics such as Data quality [12], Service outage duration [54] and Security-user authentications [55].

Data quality often dictates the success of a BI project [53]. The poor data quality has tangible and intangible impact [12]. The poor data quality leads users to abandon the system and create considerable rework in deploying the BI application [3]. Ensuring complete and consistent data set the true foundation of the successful BI environment. Therefore measuring data quality is essential in tracking progress of BI systems. Reports and dashboards help to get full insight on data quality, compare it and get its developments [52]. Also, service outage duration metric specifies the technology that does not get in the way; this is the percentage of actual equipment

uptime relative to the total planned uptime. Security and user authentications measure the confidential level of data and securing platforms.

In question 4, the most important stakeholders are highly effect on the progress of the work from two sides: consumer side and the working team side [7]. It is worth to be mentioned that introducing agile feature to our BI system by default helping in increasing the satisfaction of consumers and working team. Agile with its iterative process gets the team working together to extract the most useful knowledge. On the other hand, core agile BI gives the capabilities that empower business users to be self-sufficient in their BI environment with little or no involvement from technology professionals. Satisfaction from both sides is the important indicator for success or fails the system. Thus, researchers introduce the following metrics that best measure the degree of satisfaction. Metrics for this category often measure by surveys. Metrics are velocity, team engagements [7], customer's satisfaction [39], self-report efficiency [13] and call Abandonment [40, 56].

Velocity metric measures the production that could be done by a team. Members ought to be more productive when they do not have to waste time compiling reports or searching for information that is now readily available through the BI platform [11]. The effect should be measurable, at least for knowledge workers and targeted categories of customer service and operations employees [57]. Team engagements metric measures how employees feel about their jobs and the company. This information is often obtained via a survey as it is a qualitative metric [39]. On the other hand, customer satisfaction metric is often captured in surveys after an interaction with the helpdesk [11]. Also, Call Abandonment metric measures the number of callers that hang up before they can be connected to an agent [56]. Finally, the most important metric specialized with this question is self-report efficiency. Self-report efficiency makes use of agile BI feature by measuring the efficiency of whether users could integrate with BI processes and build their desired report and

dashboards [21]. It also depends on technology and tools (such as dash boards). It's being used and their capability to integrate with external ads or applications [33, 13]. Report efficiency and aid should also be measured. All these metrics are often measured by surveys.

In question 5, Performance metrics are a critical ingredient of performance management. A performance management aligns the performance of the current strategy. The Performance management harnesses information technology to monitor the execution of business strategy and to help organizations achieve their goals [15]. In other word, researchers must assess the performance toward achieving goals. Chosen metrics help us to measure, monitor, and manage the effectiveness of tactics and progress toward achieving strategic goals [2]. The metrics are variance [15], attrition Rate/churn rate [40], security and users' authentications [55], and return-on-investment (ROI) [14, 37, 38]. Variance metric measure the gap between actual and target values. The actual and target values are self-explanatory and usually displayed with text.

Variance metric displayed using text or a micro bar chart or bullet chart. Variance percentage is displayed against the targets [15]. On the other hand, attrition rate (churn rate) metric measures the number of employees that leave over a certain period; normally expressed as a percentage. High attrition rate will affect the performance progress [40]. However, return-on-investment (ROI) compares the magnitude and timing of investment gains directly with the magnitude and timing of costs [14]. A high ROI means that gains compare favorably to costs. Finally, Security and users' authentications metrics were defined in question 3 metrics, however researchers found that the performance of BI system also basically relaying on the security and level of confidence must be felt as well as protecting data from harmful things.

Hierarchical level of GQM is plotted in Figure (2) to illustrate the goal across the questions and the metrics. Some metrics would contribute to more than one question. Table (1) summarizes the GQAM metrics distributed across agile BI layers.

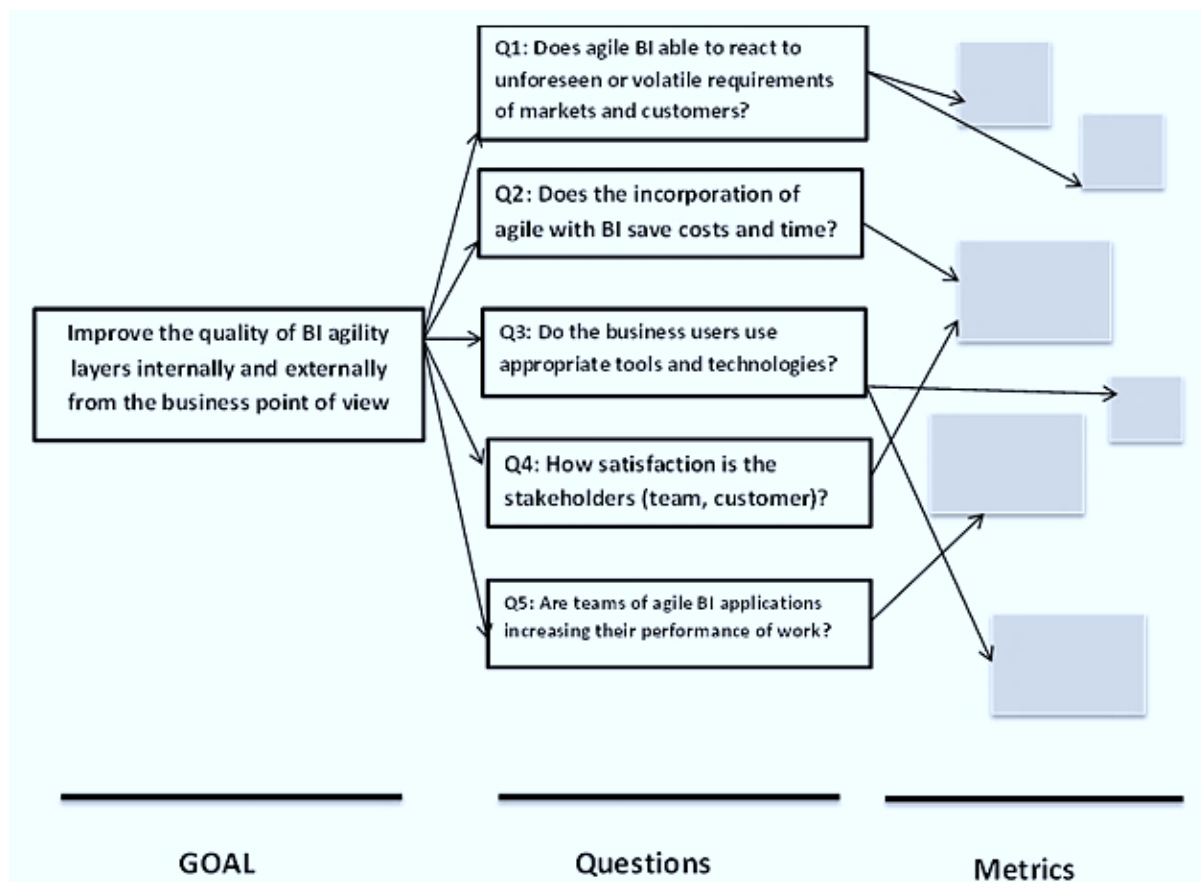


Figure (2): Hierarchical level of GQM

Table 1: Summary of GQAM			
Goal improve the quality of agile BI layers internally and externally from the business point of view			
	Questions	Metrics	Affected layer
1	Does agile BI able to react to the unforeseen or volatile requirements of markets and customers?	1.1 Timeliness of data delivery 1.2 Replaying efficiency 1.3 Reporting time 1.4 Service Level Management	Functionality Content
2	Does the incorporation of agile with BI save costs and time?	2.1 Quick Ratio 2.2 Budget deviation 2.3 Reporting time 2.4 Report changing time	Functionality Content Scalability
3	Do business users use the appropriate tools and technologies?	3.1 Data quality 3.2 Service outage duration 3.3 Security and user authentications	Content Scalability
4	How satisfaction is the stakeholders (team, customer)?	4.1 Team engagements 4.2 Velocity 4.3 Customers satisfaction 4.4 Self-report efficiency 4.5 Call Abandonment	Functionality Content Scalability
5	Are the teams of agile BI applications increasing their performance of work?	5.1 Variance 5.2 Attrition Rate/churn rate 5.3 Security and users authentications 5.4 Return-on-investment(ROI)	Functionality Content Scalability

6- Conclusion

This paper introduces GQAM for measuring the performance of teams in agile BI applications. GQAM depends on three levels which are scalability, functionality, and content. GQAM is based on the GQM approach that has three parameters: goals, questions, and metrics. The goal represents the thing that wanted to be measured. Questions help to identify the metrics. Metrics are the quantification measures for goals. GQAM provides guidance for teams to achieve the desired performance in agile BI. GQAM depends on five questions that were introduced with respect to the defined goal. Then a set of efficient metrics were chosen to answer these questions.

These metrics may provide the best answers to the questions and provide measurements for the performance of teams' work.

References

- [1] Celina M. Olszak, Kornelia Batko, "Business Intelligence Systems New Chances and Possibilities for Healthcare Organizations", Business Informatics, Wroclaw, vol. 3, issues 25, pp.123-138, 2012.
- [2] Jayanthi Ranjan, "Business Intelligence: Concepts, Components, Techniques and Benefits", Journal of Theoretical and Applied Information Technology, vol. 9, No. 1, pp.60-70, 2009.
- [3] Martha Bennett, Boris Evelson, "Best Practices: Maximize Your Chances of Business Intelligence Success", Forrester Research Inc, 2013.
- [4] Baars Henning, Zimmer Michael, "A Classification for Business Intelligence Agility Indicators", Proceedings of the 21st European Conference on Information Systems, AIS Electronic Library, 2013.
- [5] Olbrich Sebastian, Knabk Tobias, "Agile Behavior of Business Intelligence Systems: an Empirical Study on the Impact of In-Memory Technology", Proceedings of the 21st European Conference on Information Systems, AIS Electronic Library, 2013.
- [6] Mohammad Moniruz zaman, Sherah Kurnia, Alison Parke, Sean B. Maynard, "Business Intelligence and Supply Chain Agility", Australasian Conference on Information Systems, 2015.
- [7] David Stodder, "Achieving Greater Agility with BI", TDWI Research, 2013.
- [8] Surendra Devara Palli, Rikard Lindgren, "Agile Business Intelligence Development Core Practices", Master thesis in Informatics, 2013.
- [9] Boris Evelson, "Agile BI Out of the Box", Forrester, 2010.
- [10] Irina-Bogdana Pugna, Dana-Maria Boldeanu, "Integration of Knowledge Management and Business Intelligence Initiatives in a Collaborative Intelligence Framework", Researchgate, 2013.

-
- [11] Saeed Rouhani, Amir Ashrafi, Ahad Zare Ravasan, Samira Afshari, “The impact model of business intelligence on decision support and organizational benefits”, Journal of Enterprise Information Management, vol. 29, issue 1, pp. 1-28, 2016.
- [12] Kuldeep Deshpande, Bhimappa Desai, “Model for Assessment of Agile Methodology for Implementing Data Warehouse Projects”, International Journal of Applied Information Systems, vol. 9, No.8, pp. 42 -50, 2015.
- [13] Gartner, “A practical framework for business intelligence and planning in midsize companies”, 2009.
- [14] Elliot King,” Key Metrics for Determining ROI for Business Intelligence Implementations”, Unisphere, 2007.
- [15] Wayne W. Eckerson, “Performance Management Strategies”, IBM, 2009.
- [16] Ian Sommerville, “Software Engineering”, Pearson, 2011.
- [17] Evelson, B., “Agile Business Intelligence Platforms” Forrester's, 2014.
- [18] <http://competitive-intelligence.mirum.net/business-intelligence/definition-business-intelligence.html>
- [19] Victor Basili, Gianluigi Caldiera, Dieter Rombach, “Goal Question Metrics paradigms”, John Wiley & sons, 1994.
- [20] Dominique Ferrand, Daniel Amyot, “Towards a Business Intelligence Framework for Healthcare Safety”, Journal of Internet Banking and Commerce, vol. 15, no.3, 2010.
- [21] Michael Zimmer, Henning Baars, Hans-Georg Kemper, “The Impact of Agility Requirements on Business Intelligence Architectures”, Hawaii International Conference on System Sciences, IEEE, pp. 4189-4198, 2012.
- [22] Robert Krawatzeck, Barbara Dinter, Duc Anh Pham Thi, “How to Make Business Intelligence Agile: The Agile BI Actions Catalog”, IEEE, pp.4762 – 4771, 2015.
- [23] Abdul Azim Abdul, Ghani Koh Tieng, Wei Geoffrey, Muchiri Muketha, Wong Pei Wen, “Complexity Metrics for Measuring the Understandability and Maintainability of Business
-

-
- Process Models using Goal-Question-Metric”, IJCSNS International Journal of Computer Science and Network Security, Vol.8 No.5, pp. 219-225, 2008.
- [24] Baars, Henning, Zimmer, Michael. “A Classification for Business Intelligence Agility Indicators”, Proceedings of the 21st European Conference on Information Systems, pp.1-12, 2013.
- [25] Carlos Villar Corrales, Daniel Amyot, Dominique Ferrand, “A Goal-Driven Methodology for Developing Health Care Quality Metrics”, PHD of Science in Electronic Business Technologies, University of Ottawa, 2011.
- [26] Mihaela Muntean, Traian Surcel, “Agile BI – The Future of BI”, Informatica Economică, Vol. 17, No. 3, pp. 114-124, 2013.
- [27] Robert E. Park, Wolfhart B. Goethert, William A. Florac, “Goal-Driven Software Measurement —A Guidebook”, Carnegie Mellon University, 1996.
- [28] Asim Abdel Rahman El Sheikh, Mouhib Alnoukari, “Business Intelligence and Agile Methodologies for Knowledge-Based Organizations: Cross-Disciplinary Applications”, IGI Global, 2012.
- [29] Vmware, “Business Agility and the True Economics of Cloud Computing”, 2011.
- [30] AMD, “Realizing Agile Business Execution with Virtualization”, 2008.
- [31] CDW, “Taking I.T. Agile with Server Virtualization”, 2012.
- [32] Andrew Mazer, “Private Clouds: Efficiency and Agility in the Next Generation Data Center”, Dell.
- [33] IDG TechNetwork, “Smarter Business Requires Intelligent Systems”, windows Embedded.
- [34] Redhat, “The Agility Gap in Today’s Private Clouds”, 2013.
- [35] IBM, “Business analytics: The perfect fit for the agile enterprise”, 2009.
- [36] Wayne W. Eckerson, "Performance Dashboards Measuring, Monitoring, and Managing Your Business", John Wiley & Sons, second edition, 2011.
-

-
- [37] QAD Enterprise, "BI Metrics Demonstration Guide", technical report, 2015.
- [38] QAD Enterprise, "Operational Metrics Data Sheet", 2015.
- [39] KPI-Partners Oracle Partner, "The Top Five Metrics Business Intelligence for HR Departments", <http://www.kpipartners.com>.
- [40] Tech Excel, "IT manager Guide- performance efficiency: technical report, <http://www.techexcel.com>.
- [41] Michael Harris, David Consulting Group, "Measuring the Business Value of IT", 2007.
- [42] Victor R. Basili, Gianluigi Caldiera, Dieter Rombach, "Goal Question Metric Paradigm", Encyclopedia of software Engineering- 2Volume Set, John Willy & sons, 1994.
- [43] Peter Hantos, "Strengths and Weaknesses OF The GQM Approach in developing Software Size Metrics", Xerox Corporation, 1998.
- [44] Christiane Differding, Barbara Hoisl and Christopher M. Lott, "Technology Package for the Goal Question Metric Paradigm", Internal Report, 1996.
- [45] V. Basili et al., "Aligning Organizations through Measurement", the Fraunhofer IESE Series on Software and Systems Engineering, Springer International Publishing Switzerland, 2014.
- [46] Hong Yang, Rong Chen and Ya-qing Liu, "A Metrics Method for Software Architecture Adaptability", Journal of Software, Vol. 5, No. 10, October 2010.
- [47] Robert T. Futrell, Donald F. Shafer and Linda I. Safer, "The Basili Goal/Question/Metric Paradigm", Prentice Hall, 2002.
- [48] Dirk Hamann, Dietmar Pfahl, Janne Järvinen, and Rini van Solingen, "The Role of GQM in the PROFES Improvement Methodology", 1999.
- [49] Anna Wingkvist, Morgan Ericsson, Rudiger Lincke and Welf Lowe, "A Metrics-Based Approach to Technical Documentation Quality", 2010.
- [50] Len Di Costanzo, "Why Service Level Management is Mission Critical for all IT Service Providers ", Auto task White Paper, Auto task Corporation, 2010.
-

-
- [51] Adrian Paschke, Elisabeth Schnappinger-Gerull, "A Categorization Scheme for SLA Metrics", Technische Universität München, Germany, 2005.
- [52] Mo Masud, Lisa Wester, "Tools for Performance Metrics and Business Intelligence", Deloitte Development, 2007.
- [53] Prashant Pant, "How to build successful BI strategy", Deloitte Development, 2008.
- [54] Orical Agile, "Oracle Product Lifecycle Analytics", Oracle Data Sheet, 2011.
- [55] AP Business Objects, "Business Intelligence Platform Administrator Guide", SAP affiliate company, 2015.
- [56] Zendesk, "Creating Service Desk Metrics", Information Technology Infrastructure Library, ITIL.
- [57] Boris Evelson, "Agile Business Intelligence Platforms The 13 Providers That Matter Most and How They Stack Up", the Forrester Wave, 2015.
- [58] Micro Strategy Incorporated, "Business Intelligence and Retail: Major Applications of Business Intelligence Software in the Retail Industry", 2007.
- [59] Gartner, "Gartner's Business Analytics Framework", 2011.
- [60] IBM, "Seven risk dashboards every bank needs", White Paper, March 2009.
- [61] Gartner, "Step by Step approach to successful business intelligence", IBM, 2011.
- [62] Vince Leat, ASEAN SW Group, "Introduction to Business Intelligence", IBM, 2007.
- [63] Mykola Pechenizkiy, "Introduction to Business Intelligence", <http://www.cs.jyu.fi/~mpechen/TIES443>, 2006.
- [64] Yellow Fin, "Making Business Intelligence Easy- Agile business intelligence", 2010.
- [65] Yellow Fin, "Making Business Intelligence Easy- in memory analytics", 2010.
- [66] Tsun Chow, Dac-Buu Cao, "A survey study of critical success factors in agile software projects", Journal of Systems and Software, vol. 81, pp. 961- 971, 2008.
-

-
- [67] J. Fernández, E. Mayol, J.A. Pastor, “Agile Approach to Business Intelligence as a Way to Success”, IGI Global, 2012.
- [68] Faycal Fedouaki, Chafik Okar, Semma El Alami, "A maturity model for Business Intelligence System project in Small and Medium-sized Enterprises: an empirical investigation", International Journal of Computer Science Issues, Vol. 10, Issue 6, No 1, November 2013.
- [69] Markus Strohmaier, Herwig Rollett, “Future Research Challenges in Business Agility: Time, Control and Information Systems”, 2004.