# Quality Assurance and Quality Control in ERP Systems Implementation

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**Abstract**

Many factors are effecting to the successful Enterprise Resource Planning Systems (ERP). Quality Control and Quality Assurance is the most important point for successful and effective ERP system. Quality Control of ERP system mean detecting and removing defects from the system and Quality Assurance mean plan and systematic approach to ensure the ERP system process. To ensure about quality of ERP it must concern about Data Quality. Data Quality is measurement of value of a specific set of data, utilized in a specific manner towards a specific goal. It is highlighted in ERP due to the increasing amount and diversity of data as well as data's critical impact on success of ERP systems. Since that for successful, effective ERP systems it is not enough to take reactive actions for data quality issues by Quality Controlling. It must focus on Quality Assurance methodologies to achieve high Data Quality of ERP.

*Keywords:* ERP; Quality Control; Quality Assurance; Data Quality

## 1. Introduction

### 1.1. ERP systems

Enterprise Resource Planning (ERP) systems are software packages composed of several modules, such as human resources, sales, finance and production, providing cross- organization integration of data through embedded business processes [1]. These software packages can be customized to cater for the specific needs of an organization [1].

Processing many procedures in different business units by sharing databases is common feature of all ERP systems [1]. Many employees in different divisions like accounting and sales use same information for their various needs [1].  It is not  practical  to  forcing employees to maintain separate  databases and spread  sheets that have to be manually  merge to  generate  reports  in real time  business  process [2]. So ERP software Offer some degree of synchronized reporting and automation.  As well give chance to organization members to pull reports from one system [2]. Having portal or Dashboard which give chance to understand performance of the business environment is main feature of the ERP systems. It Help to get quick overview of current business situation [2].

Enterprises need Data Quality to achieve high market place.  Data  Quality  (DQ)  is a vast concept;  commonly used dimensions describing  the  quality  of data  are  for instance  accuracy,  completeness,  timeliness,  or accessibility [3].  Hence it is one of the main quality dimension fact of ERP systems that makes data unfit for use [3]. A Data  Quality  problem can  hence be defined as a difficulty  in one or more  quality  dimensions  that makes  data unfit  for use [3]. There are two types of Data errors.   Data errors can be caused by both conceptual (design) and operational problems (operational) [3].

## 1.2. Research Problem

In the  business  world lack of quality of ERP systems has high risk to get employee satisfaction    in the organizations.  Usually companies conducted testing continuously before releasing the ERP software package. ERP companies have spent lots of time to testing and debugging their systems.  This testing project budgets are huge disadvantage for companies in today business world [3]. Volume and criticality of ERP  implementations, testing  occupy nearly  fifty percent of the  total  ERP  budget  due to lack of Quality  Control  and  Quality Assurance  standard methods.

## 1.3. Objective of the research

Effective successful ERP systems have standard methods to achieve high quality.   Standard Quality obtained via continuous Quality Controlling methods and Quality Assurance methods.  They have processed through design and operational phases of the implementation of ERP system.  ERP systems face failures, risks because of no quality standard. This survey  going to  identify  what  are  the  main  impact  from Quality  Assurance and  Quality Control of the  ERP  system  with  respect  to  Data  Quality  and  how it  can process in the design phase of the  ERP  implementation.  As well this focus to identify better solution it can be minimized those Data Quality risks and failures in the design phase.

## 2. Content
### 2.1. Introduction to ERP Systems

Enterprise Resource Planning  (ERP) systems  are  software  packages composed of several  modules,  such as  human  resources,  sales,  finance  and  production, providing  cross- organization   integration  of data through  embedded  business  processes [1]. ERP  is an acronym to Enterprise Resource Planning which is mostly  using  term  in business  man - agreement.  There are linked various processes that are using to maintain,

business, accounting, customer relationship management, including inventory and order management and etc [2]. ERP software integrates multiple functions and gives one complete system for whole organization [2].

ERP systems are using shared databases to support different business units with multiple functions [2]. In practical scenario to store the same information for their specific needs like employees in different divisions, Accounting  and sales ERP using this process [2]. ERP facilitates employees by offering some degree of synchronized reporting and automation instead of maintaining separate databases and spreadsheets that have to be manually merged to generate reports [1].

ERP solutions allow staff to pull reports from one system.  For instance,  with sales orders automatically flowing into the financial system without any manual re-keying, the order management department can process orders more quickly and accurately, and the finance department can close the  books faster [2]. Maintaining Portal or dashboard for employees to quick understand of the business performance is well known common feature of ERP systems [2].

ERP handling  Front Office functions  such  as Sales Force  Automation (SFA),  Marketing Automation and Ecommerce  and  expanded  to handle  Business  Intelligence  (BI) [3]. Success records  coming out  of these systems  in the  companies  in a vast  range  of industries with the product  improvement where wholesale distribution to Ecommerce  by using ERP solutions [3].

## 2.2. The Business Value of ERP systems

ERP helps to remove barriers when doing jobs between business units and helps employees to do their jobs more efficiently [2]. Characteristics of ERP systems have mention below [2].

- Real time, global business visualization of companies to address concerns proactively and drive improvements.
- Improve financial compliance by minimizing risks and giving business standard.
- Automates core business operations such as lead-to-cash, order-to-fulfillment, and procure-to-pay processes.
- Facilitate customer services with sources of billing and relationship tracking.

ERP system for company businesses add up these advantages. With these ERP solutions employees able to make better decisions faster with help of accurate information. Not only that but also ERP systems eliminate unwanted cost of overall business through reducing redundant processes and systems [4]. When considering whole system this is customizable software package according to the neediness of an organization [4].

ERP is the most famous administrative tool for collecting, catalog, processing, analyzing and communicating appropriate information to make financial decisions [1]. ERP  based on many factors like staff qualifications, internal  control, company  size, support top management, Data  Quality  (DQ),  coordination, analysis and observation of the organization [4].

Same time, ERP system is a group of individuals, equipment procedures, software, communications, databases, operated manually, mechanically or automatically, to gather in- formation, stored, processed and then sent to the beneficiary [3].

## 2.3. ERP Risks

Today global ERP systems face many risks. There are six categories of risk of ERP implementation [8]. They are organizational, business-related, technological entrepreneurial, contractual and financial risks [8].

Technical risks play major responsibility of success and failures of ERP systems [8]. Techno- logical risk is related to the information processing technologies such as operating system, database management system, client/server technology and network required to operate the ERP system[8].

Among those risks Database management is in very high position when consider the process of ERP systems [16]. Data Quality is next topic arise with respect to Database management [16]. Usually many companies try to overcome data quality issues by implementing data management or data warehouse systems [15]. Data warehousing failures affect to the organizations critically to their success. In order to address both organizational and Information Technology perspectives an integrated approach to Data Quality is required [15].

### 2.3.1. Data Quality Definition

The simplest definition of data quality is measurement of value of a specific set of data, utilized in a specific manner towards a specific goal [15]. Data quality is multidimensional and multifaceted concept in a database, data have no actual quality or value, they only have potential value that is realized only when someone uses that data to do something useful [15].

### 2.3.2. Security Risks

Security errors can be occurred because lack of the data quality [9]. Today it is high important that companies and organizations much have high web security for their web application servers [9]. Because ERP systems are interconnected with web applications [9].When miss one point regarding these security vulnerabilities of this web applications become high and decrease the quality of the software [9].

Web Application without proper security suffers from Cross Site Scripting (XSS) and SQL injection [9]. SQL injection is a technique where a would-be intruder modifies an existing SQL request to post hidden data, to crush important values, or to process dangerous orders for the database [9]. That is made when the application retrieves data sent by the Internet users, and uses it directly to build a SQL request [9].

Cross Site Scripting (XSS) is an attack exploiting a weakness of a Web site that fails to validate the parameters entered by the users [8]. XSS users various techniques for injecting (and executing), scripts written in languages such as JavaScript [8]. The aim of this Kind attacks is to keep cookies containing information identifying users, or to mislead them later so that they provide these data to the attacker [9].

But in ERP security is most important because clients do transactions via web applications in the ERP systems [9]. So it should keep in mind of all the phases of development cycle. But in the design phase of the application it must get best attention [9]. Security precautions built inside applications minimize the probability that hackers will be able to manipulate applications and access critical data [2].

### 2.3.3. Dirty Data

Day to day operations planning and decision-making functions in ERP is highly dependent on transaction data [3]. This data can be entered electronically and manually. After that organized, managed and extracted for decision-making [3]. Entered data can be used to facilitate building, shipping, and invoicing goods and extracted data can be used to evaluate factory and sales force performance in the short term [10]. Long term data using to operate and make decisions regarding business such as relative efficiency of operations or protecting is data integrity [11].

Data which has used for many years by the organizational users are called as dirty data dissimilar data structures for the same customer data (spelling discrepancies, multiple account numbers, address variations), incomplete or missing data, lack of legacy data standards, actual data values being different from meta-labels, use of free-form fields etc [11]. Those problems can be solved by cleaning up those disparate data stores in the companies.

These data can be caused to incorrect order taking, products not built to specification, or errors in packaging, documentation, or billing [2]. The result is dissatisfied customers, loss of shareholder confidence, labor and unnecessary material costs, real and opportunity costs of time spent correcting errors resulting from dirty data. If we are not aware to check in the System that Avoid human error, we will have dirty data [11]. "Bad data can put a company at a competitive disadvantage" some computer-literate criminals who are staging crashes and taking advantage of dirty data in corporate databases [11]. The study found out that in one case several insurance firms lost fifty six million dollars to one fraud ring because of dirty data [11].

### 2.3.4. Data Integrity

Data integrity means that after data entry systematically edited or edited by 'Experts' and removing errors. "Duplicate data or data that is incomplete or extraneous". Anything that is entered incorrectly [5].

Data integrity requires awareness and dirty data controlling. A collection of data has integrity if the data are logically consistent and accurate. Data integrity requires that data additions or changes be reflected in each of the locations where that data is stored and that data is consistent across the storage medium (s) used. Data integrity also requires that the users of that data understand the meaning of the data within the context of the business [5]. Maintaining data integrity requires a systematic approach to data processing, storage, sharing, manipulation, and reporting. Errors in data can cost a company millions of dollars, alienate customers, and make implementing new strategies difficult or impossible. Any business that has to issue debits and credits or that throws out surplus, unusable inventory, understands the costs of data integrity. Each credit or debit is estimated

to cost the company seventy five million dollars for the clerical efforts of analyzing, generating and disseminating the document [5]. Otherwise it will be high cost to testing these ERP software packages [5].

## *2.4.    ERP Testing*

Poor data quality is pervasive and increases the cost [15]. It is estimated that data quality problems cost US economy over six hundred billion dollars per annum. Numerous business initiatives have failed and losses generated because of data quality problems.  Average perceived cost of poor data areas high as ten percent of organizations revenue [15].

To compete with global market and to survive in these companies must maintain high quality.  Facing this competition needs efforts, money, people and time.  Time is very precious and  one cannot  go back  to  find mistakes and  errors committed during  the  process as it involves cost, time  and  resources.  Whatever is done should be consider as first and last time [15].

It cannot be tested whole software till there is no bug. Finding  the  defect  in the  soft- ware  is more  difficult because  it  is so complex  task. Continuous checking is not either guarantee about correctness of any   software [7]. All of the  possible  failure  criteria  need to  be tested  and  verified,  but  it  cannot  be exactly  complete testing.  Exhaustively testing a simple program to add  only two  integer  inputs  of 32-bits  (yielding  2 to the power 64 distinct  test  cases)  would  take  hundreds of years,  even  if tests  were performed  at  a rate  of thousands per second [7]. The  software  testing  consist of Design tests,  Executing tests,  Identifying  problems and  Getting  problems  fixed [7].That is why Software  Quality Assurance  Process(SQAP) is very important as it builds quality  into the products [7]. After  finding the  failures  it  should  be fix  and  improve  high  quality of the  product.  With regarding to statistics in real world Software testing typically represents forty percent of a software development budget [7].

When defining the quality in Software Development Life Cycle (SDLC) is keep quality process itself and keep application operational quality. For this developers must give at tension to associate with quality in the first phase of the SDLC. Poor design decisions made hundreds of implementation issues [11]. To ensure the proper protections to confidentiality, integrity, and availability all developers of ERP system must follow quality assuring  standards [10]. If it is not so those applications become overly complex, expensive, and hard to maintain.  So it should not be lets to ERP application system not suffer from quality problems [10].

## *2.5.    ERP Failures*

Successful business of any area 'quality' is the most important factor in this area [6]. Companies must consider about their high quality because it cannot be correcting errors after shipping the products to customer.  Not only that correction after shipping consumes more money and affect for company creditability [6]. As well organizations cannot lose customers due to those kinds of  problems.  Overcome  problems  like these organizations must follow standard quality management methods the products [6]. Maintaining Quality for product is very important for ERP implementation organizations as every Company is running towards automation. Failure in real time software systems like ERP can have serious consequences [6].

ERP systems give support for maintain continuous standard business progress within organizations [7]. ERP systems are completely integrated software package that can be used to achieve its business goals [7]. There is strong evidence that many ERP systems implementation projects are not completed on time and within budget and there ERP implementation failure. ERP systems implementation projects are complex and careful planning is critical [7].

## 2.6. *Overcome ERP failures and Risks*

By eliminating those failures and risks it can be assure about effective and efficient ERP system which can achieve its goal [9]. In this process it should make sure to follow standard procedures and methodologies. Quality Assurance and Quality Control is main standard approach of successful ERP implementation. It's aimed towards prevention and if followed will result in the production of quality ERP system [8].

### 2.6.1. *Quality Assurance*

Software Quality Assurance (SQA) is a planned and systematic approach to ensure that software processes and product and products confirms to the goals of SQA are to improve software quality by appropriately monitoring both software and the development process the ensure full compliance with the established standards and procedures [10].

Keep balance between quality and productivity of software packages like ERP need standard quality assurance progress [10]. Software quality assurance must not limit to only one phase [10]. It should go through all over the software development process and making sure that problems can be found and can dealt with them on standard process [11]. It is focus on preventing the bug generation and increase in the production of software quality. Software Quality Assurance is software development methodology which produces quality software [11].

### 2.6.2. *Quality Assurance Impact*

The statics shows that buggy or flawed software cost businesses one 175 dollar billion worldwide in 2001[9]. Those bugs have affected banking systems, stock exchanges, medical institutions, educational. Institutions and even the Social Security Administration because of major computer system failures were caused by software bugs, and its consequences [11].

Identified most bugs and their effects can be minimized by having strict software quality control methodologies of Software Quality Assurance [11]. Software Quality Assurance is active in all over software design, coding, source code control, code reviews, configuration and change and release management activities with maintaining reliable full documentation for functional completeness [12]. These quality assurance methods also not give hundred percent error free environments for soft ware's [12]. But reach at least satisfied fug free soft- ware version this quality assurance methods must be followed although Quality Assurance is rough process. It is essential [12].

It has mention like this – Microsoft Chief Executive; Steve Ballmer said that "any code of significant scope and power will have bugs in it. And only one percent of bugs in Microsoft Software are causing half of all reported errors. Find and fix one percent of your software bugs, and ninety percent of your system problems go away, say experts [11]."

### 2.6.3. Quality Control

Quality Control (QC) is the detection (testing) and removal of software defects [13]. Quality controlling areas like testing is the software verification process that determines correct or proper application behavior for only one user, testing is verifying that what was working in a previous application release still works in subsequent release, testing is the recess of testing an application to determine if it can perform properly with multiple concurrent users, possibly thousands is done by Functional testing, Regression testing and Load testing respectively [13].

### 2.6.4. Quality Control Impact

Maintaining high quality in the organizations is increase revenue, reducing costs and improving productivity [10]. Quality has emphasized as main strategy of every industry [10]. Efficient data quality management, however, is not just about error detection, control, and prevention [10]. It speeds reporting cycles, provides deeper traceability and insight into the numbers; results in a more-auditable and compliant process; and boosts management's confidence in financial statements, budgets, and performance scorecards [10]. In the end, every person-hour carved out of the process through better quality or improved interfaces translates to an extra person hour spent on value-added activities [14].

### 2.7. Data Quality
### 2.7.1. Importance of Data Quality

In the life cycle of the Software development life cycle design phase is mostly concerned with selecting the ERP systems and the finalizing the scope of the project and building system architecture [7].

In the global business world Data Quality is the key of commercial success [3]. If there is no data quality it leads to lower customer satisfaction, lead to increased cost and lowered employee job satisfaction, no standards in decision making and insufficient Data Quality makes it more difficult to define and execute business strategies [10].

ERP projects are almost always associated with their engineering of business practices. Results from the desire to adopt the Data Quality "best practices" inherent in the chosen software solution rather than changing the software to match current business practices [4]. Due to that Data quality should concern with implementation phase of the ERP system [4].

### 2.8. Data Mining Concept

Normally ERP systems break down from their quality standards at the 'usual operational level'. Among those failures Data Quality flaws affect business success heavily [13]. When consider about data quality it should consider both design phase and organizational phase. In organizational phase there are common data quality issues.

Data quality problems must concern at the beginning of ERP design phase[13]. When building system architecture of ERP systems it must consider especially about data base management system and data quality [14].

Data mining is the most highlighted concept when consider about Data Quality issues [14]. Basic idea behind data mining can be divided as below [14].

1. Data Strategy: To overcome data issues companies have to implement formal Data Quality programs. So business critical data elements need special care at the start of the Data Quality Management. This Data quality management should focus to cost benefit process.

2. Error Prevention: On the technical side critical data must be obtain as much as pure when entering to the system.

3. Error Detection: Check Data Quality routines and reports must be designed on the technical side and users must be instructed on how to use them.

4. Error Correction: Specialized staff must be trained to use the system and handle the Data Quality problems and take right decisions.

Data Mining is combined with concepts like sampling, estimation and hypothesis testing from statistics, in addition to search algorithms, modeling techniques and learning theories from artificial intelligence, pattern recognition and machine learning [14].

Databases are normally used to store and process the mining data [14]. Preventing fraud, giving marketing advice, seeking profitable customers, predicting sales and inventory and correcting data during bulk loading of the database are the main advantages of the Data mining [14]. Two high-level Data Mining goals are prediction and description. The first one tries to find patterns to predict the value or behavior of some entity in the future and the second one tries to find patterns describing the values or behavior in a form understandable to humans [14].

Identify attributes of data entities is first step of Data Mining [14]. Data can be categorized also by its sparseness, structure and reliability to name a few possibilities [14]. The attributes describing the data have also many properties pertaining to them; at least type, quality, preprocessing needs and relationships. An over-simplified example of an attribute is a field of a relational database table [14]. When dividing data entities it should be concern Nominal, Ordinal Types nominal types essentially names giving just enough information to separate two entities from each other [15].

1. Ordinal types - allow ordering of entities.

2. Intervals - types to differences between values

3. Ratios - extend types to differences between values and value ratios

From these planning activities Data collection errors can be minimize. As well we should consider about Outliers, missing, inconsistent and duplicate values also need consideration of how to handle them in the source data [15].

Today there are several tools like My SQL, Oracle Enterprise Edition with Data Mining option, Microsoft SQL Server, SPSS Clementine, SAS and IBM Intelligent Miner for DB2 on the market to cover the data quality concept [16].

There are several methods can be categorize items according to some algorithms are varying application targets, from which some examples are Decision Tree, Bayesian networks, Sup- port Vector Machines (SVM) and Rule Induction [16]. Main advantages of this algorithm they can be implement inside the live systems which process with original data [16].

So clients no need to worry for more license or more cost on another separate soft ware's and data movement is not necessary, better security, easier data preparation and data freshness [16]. Better understand of data mining concept following areas must get high attention [16].

• Characteristics (Accuracy, completeness, consistency etc.)
• Inherent Data Quality
• System Dependent Data Quality

This is the ISO/IEC standard 25012:2008 standard general data quality attributes. To handle large transaction data sets of ERP systems following data mining techniques must be used [16].

1. Step one is the initial criteria for the algorithms to be used and presented. Better understanding of criteria like scalability, easy deployment, robust against over fitting give high appropriateness when choosing algorithms to Data Mining.

2. The second step is based on the data understanding. To understand this, Data should collects the data, explores it to find if any subsets of the data are particularly interesting, identifies data preparation needs and recognizes data quality problems.

3. Ratios - extend types to differences between values and value ratios

4. The third step is data preparation, which contains several tasks in a non-predetermined order, like, for example, transformations, views, transfers, loads, aggregation.

If system needs to prepare data, it must do sampling, dimensionality reduction, attributes selection, and attribute creation, discretization.  Main difference of this  is to prepare  the raw data  before feeding it to the DM algorithm  to make it more suitable  for mining and to handle  the  data  quality  problems  recognized in the previous  step[16]. Purpose of all these steps it to achieve high accuracy of prediction.

### 2.8.1.    Data Understand and Attribute Selection

Attribute selection is most important part  and consume more time because source data  sets may have hundreds of attributes in stock details  or invoices respectively [16].  So attributes cannot be discarded or eliminated easily [16].

In practice the attribute selection was simplest to do with views selecting as few attributes as possible from the source data [16].  The first  analysis of target  tables  was performed through  a specific SQL query and results were is explained  in the another  table [16].  For an example target tables gather information about Schema name, table name, attribute name, data type, column name, null able values, distinct values etc.

Sometimes  it  is not  concern  the  valid  values  for high  value  and  low value  but  they  are important to verify all the  values in each step to be still valid to avoid problems  at  later stages [16].  The selected attributes are presented with their brief description and they are also divided to categorical or numerical [16].

Example:  Consider Stock event source.   Attributes of Stock  Event   Company,  Item ID, Price, RecID, Rectype,  Unit  They  can be describe  like following Company    Logical company  name  (categorical) Itemed (Categorical) Price     (Numerical)  Now final stages tables show the real statics for one  attribute and one database table of collected information. After all of these real attribute values are shown in the data base tables.

### 2.8.2.    Data Preparation

Data cleaning was easier to do on the previously created views because only selected attributes had to be handled [17].  When using whole tables, the SQL queries become much more laborious and error prone to write [17]. Outlier handling, missing values and normalization were needed with almost all algorithms before working with the data [17].

Normalization was also a very common operation with minimum and maximum values as limits, while other choices would have been scaling or z score normalization [16].   The first normalization option was chosen if possible, because based on quick tests [16]. These steps ensure Data Quality of ERP systems [16].

### 3.       Conclusion

ERP is software package that can be adopted as the kind of the business.   Data quality plays major role in the ERP systems.  Since then it can increase or decrease the efficiency of the ERP systems. There are huge data sets

are transfer in the ERP systems per minute. Since there should be good data maintenance in those ERP systems to work effectively. Designing robust data flows from their start stage in the ERP database is extremely important to internal or external information customers.

The data quality effects to ERP systems at the operational and design phases. When talks about design phase those data sets should sample and minimize Data Model building time and specially need to avoid over fitting. It is based on Data mining concept. The goal of the Data mining is to give sign about possible erroneous input. Accuracy can improve high percentage via the data mining techniques. This is due to the fact that before knowing the source data set distribution, descriptive attributes and outlier types. When analyzing risks of ERP systems security of ERP systems that get first place. ERP systems can be attacked and exploited a weakness of ERP systems. So security of ERP system must have high importance and there should be standard process to assure security of ERP systems. Otherwise ERP Data Quality failures consume lots of organizational resources.

Avoid security, dirty data, data integrity failures and minimize the issues of ERP systems we must consider about data quality assurance and quality control. Quality Controlling is fixing issues after when they identified. But when we focus on prevent future issues of ERP systems we must give high importance to quality assurance other than quality control. It can be concluded that to assure data quality in successful, efficient ERP system we should focus on Data mining at the beginning of design phase of ERP project implementation.

Go through this stable process and achieve goals of ERP system in the design phases we must focus on developers of the ERP projects. Then there should be process of giving best knowledge transferring methodology to those employees of the organization regarding Data mining concepts, techniques (decision trees, neural networks, collaborative filtering, association rules, link analysis, survival analysis etc.), algorithms, targets, data sets.

As well Developers should be given best practices to use data mining tools such as Traditional Data Mining Tools (This establish patterns of data by using number of complex algorithms and techniques. These tools can install on the desktop to monitor the data and other specific information residing outside a database.), Dashboards (Monitor database information and reflects data changes and updates and enable the users to see how the business is performing, where things have changed etc.), Text mining Tools (Mine data from different kinds of text and can scan content and convert the selected part of data into database compatible formats, thus users have easy and convenient way to access data without opening different application.), Simple tools like EXCEL.

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