Research on Quality Management of Supply Chain Based on Information Quality in the Context of Big Data

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Abstract. Quality management of supply chain refers to management of producing, forming and realizing of production quality, so to achieve the quality assurance of product quality in the supply chain environment. Therefore, the establishment of a complete and effective supply chain quality management system, to ensure that the supply chain has a sustained and stable quality assurance capabilities, so that the needs of customers and the market can be responded rapidly, and to provide better service to customers. With the arrival of the information age, the quality of data has become a key point in the quality management of supply chain, and the source of data problems is put forward, and the quality of data is considered in the whole supply chain quality management process. Six Sigma management system framework based on data quality is established.

Introduction

Supply chain management, is originated from distribution and transportation services, logistics, integration and information of suppliers of materials, and then gradually rise during 1990s. Nowadays, supply chain management calls for the management of the products and services in the whole process from raw materials procurement to the sale of final product to customers. The core of supply chain management is to conduct a comprehensive optimization combination on the resource in the supply chain, taking effective control on logistics, information flow, funds of the whole supply chain, so as to make better management on the process from raw materials to products and ultimately improve customer satisfaction, reduce inventory, then enhance the competitiveness of the enterprises. Along with the advancement of global economic integration, traditional supply chain management began to face continuous dynamic changes of the market and a strong competitive pressure.

In quality management of supply chain, manufacturing enterprises are usually set as the core enterprise, to be the organizer and the initiator of the whole supply chain, as well as the main body of the whole quality management of supply chain. In order to ensure the competitiveness and cooperation efficiency of the supply chain, update of members often occur within supply chain regularly, so there is an obvious dynamic throughout the supply chain. While the members of the supply chain have a complete internal quality management system itself, they play different roles throughout the quality management of supply chain. At the same time, members of the supply chain are usually geographically dispersed, the whole quality management system has a large span in space, so the communication between members of supply chain mainly depend on network information technology, then, data as the basis of the whole management process, its quality directly affect the operation of the whole management system, therefore, data quality is the important influencing factor of quality assurance system.

Data is the carrier of information, with the advent of the era of big data, large number of enterprises began to use information management system to assist operations, which result in the data basement of production, transportation, service, thus the quality management of data become the important composition of quality management, whether the data can be collected and delivered successfully through supply chain decides the performance of the supply chain. But at this stage, quality management system based on data quality has not yet been established, as well as the data quality assessment system is not so comprehensive nowadays, so the article sums up the causes of
data quality issues in supply chain, and proposes a framework for six sigma management based on the data quality, in view of the data quality issues, failure mode and effect analysis is put forward for improvement measures, and thus improve the quality of data under the environment of supply chain, then enhance the core competitiveness of supply chain members.

Causes of Information Quality issues

With the rapid development of supply chain, data exchange between the members of the supply chain becomes more and more frequent, decisions are made on the basis of the data obtained, data quality significantly affects the quality of the supply chain. Data quality management including error prevention, discovery and fixing of errors, Yang put forward ten chief causes of data quality problems, and combined with the characteristics of the supply chain, summarizes the common causes of data quality issues in supply chain environment:

An excess of data sources: When there are multiple data sources of the same data, it may lead to the emergence of different values; Under the environment of supply chain, because each member has its own information management system to manage the enterprise data, and its different role in the supply chain, it may cause divagation upon the record of the same data, however, the efficient operation of supply chain needs data to be consistent.

Subjective judgment in recording data: When data is transmitted between each part in the supply chain, data loggers usually add their own subjective judgment in the process, which can cause data distortion; Especially under the environment of supply chain, each enterprise need to send its orders to their upstream suppliers in a certain period of time, and the determination of specific data is followed by its downstream sales data, but in most cases, in order to ensure the continuous sales of goods, buyers will choose an extra 5% or so of the orders on the existing data, this subjective incensement is delivered step by step, and finally cause the bullwhip effect.

Limited computing resources: Loss of data and errors in the process of delivery can also be resulted from lack of adequate network information hardware support. In today's information age, most of the enterprise has adopted information system to manage the daily operation, but many of the traditional supply chain members ignore the update and use of information systems because of the condition or size of enterprises, then resulting in the lower level of information, and unable to support large-scale real-time data transmission.

Security and accessibility considered. The accessibility of data and data security, privacy and confidentiality is contradictory in essence. Data consumers are eager to access all data of high quality, while for personal interests, the data owner may encrypt the data for protection, and even refuse to provide accurate data. Although information sharing is promoted under environment of supply chain, games of inventory and price still exists between upstream and downstream enterprise, which may influence the active position in the game by sharing relevant information.

The amount of data: Amount of data is an important factor affecting the quality of information, deficiencies in data volume can lead to lack of relevant information, which affects the overall quality of the information; But more amount of data does not mean higher data quality, large quantities of redundant data will slow down the pace to obtain real and effective data, and also block for the data required for the position.

Six Sigma Management Framework Based on Quality Management of Supply Chain

Today the six sigma concept is completely beyond its statistical meaning. The six sigma management method was applied to supply chain quality management based on data quality, in order to effectively discover defects, prevent errors and correct mistakes.

Six sigma management in general is divided into five stages, namely the DMAIC, and there is no exception for quality management of supply chain based on data quality.
Define

In definition phase, the main goal is to clarify the research target and scope, determine the key quality, and evaluation system is put forward.

Also known as key features, key quality, is the most important characteristics of the output results of the process from the customer perspective, and the determination of key quality is the foundation of the whole process of six sigma management. In this paper, the main research is quality management of supply chain based on data quality, data quality is the key to the whole research process. Whether information can be delivered accurately under the enterprise external environment is the key factor to assure normal operation of the whole supply chain. From the view of enterprise internal supply chain environment, data quality is priority as well.

As the quality of data is much difficult to be objective scored, and can be influenced easily by human factors, in order to quantify the entire supply chain information quality level, this article introduced the following indicators as the assessment criteria:

1) No Error Rate. No Error Rate refers to the accuracy of information during its delivery in the entire supply chain, inaccurate information in the supply chain often lead to bullwhip effect, resulting in large inventory in some links, therefore, the indicators can be assessed by the ratio of terminal order quantity and the initial order quantity, which is:

\[
\text{No Error Rate} = \frac{\text{initial order quantity}}{\text{terminal order quantity}};
\]

2) Completeness. Completeness mainly considers whether the information can be transmitted in a complete way, so that all links in the chain can obtain correct and complete information. In the entire supply chain, whether the product produced by the manufacturer can be accepted by one-time, can be regarded as the description of Completeness of data. Therefore, the Completeness rate can be equal to a one-time acceptance rate, namely:

\[
\text{Completion rate} = \frac{\text{one acceptance rate}}{\text{acceptance batch / total batch}};
\]

3) Timeliness. Timeliness reflects the update level of the data for the user of data. In the supply chain, the transmission of data sometimes may be blocked for subjective or objective factors, thus affecting the timeliness of the data.

Among them, the present value = release time - input time, release time refers to the time of data generation; the input time is the time that the consumer receives the data, and the fluctuation means the time length when the data keep valid. Sensitivity coefficient s can be different from the different environment, in order to control the sensitivity of the parameters.

\[
\text{Timeliness} = \left\{ \max[0,(1 - \frac{\text{present value}}{\text{fluctuation}})] \right\}^s \tag{1}
\]

4) Accessibility. Accessibility reflects the ease of data acquisition, and the data can only be used when it reach its users in its lifetime. The accessibility of the data measures the degree of access to other aspects of the supply chain.

\[
\text{Accessibility} = \left\{ \max[0,(1 - \frac{\text{time interval from sending requirements to get the data}}{\text{lifetime of data}})] \right\}^s \tag{2}
\]

Measurement

The measure process is the measurement of the evaluation index proposed above, the main items of the project can be carried out through the collection of information, some of the data need to be measured. The content to be collected includes the interval from the data consumer's request to the data delivery time, the initial order quantity of the enterprise, and the final receipt amount in the end of supply chain. The data that needs to be acquired through measurement is the one-time acceptance rate and the lifetime of one piece of data.

The acceptance rate is an important indicator of sampling, usually judged through the help of sampling operation characteristics curve. Assume that the size of a total batch of products is N, which contains nonconforming products D, then randomly select from the size of n samples to test,
the probability of containing a number of \( d \) disqualified goods:

\[
P_d = \frac{C^{n-d}_{N-D} C^d_D}{C_N^n}
\] (3)

In the case of a primary sampling scheme \((n, c)\), the probability of acceptance can be expressed as:

\[
L(p) = \sum_{d=0}^{c} p_d = \sum_{d=0}^{c} \left( \frac{C^{n-d}_{N-D} C^d_D}{C_N^n} \right)
\] (4)

Among this, \( c \leq n \leq N \), \( D \) is an integer.

In this case, the product's acceptance probability is used instead of the measurement of the Completeness of the data, regardless of the failure of the product due to the quality defect.

**Analysis**

After clarifying the objectives of the project, it is necessary to determine the process output points and process results of the project, first determine the input point and the main output of the project, and then the project team members need to make a macroscopic analysis of the existing data and Mind Storm to find the key points of the project difficulty, also making forecast and prevention for the adverse consequences project may cause. The main considerations include the following:

The upstream and downstream enterprises influence each other in data quality in supply chain. Taking the transmission of the supply chain into account, the data transmission process will also be a data link, once quality problems occurs on a node of the data link, it will directly affect the links afterwards. Therefore, selecting proper cooperative enterprises for the supply chain is a key point, and the regular inspection of the partners usually include quality factors, price factors, on-time delivery factors, variety flexibility, while the supply chain system considered data quality need to take the level of enterprise information systems, data sharing level into the assessment system.

The analysis of the causes of Data Quality Problems. In the current supply chain management, the quality of data is usually at a low level, so it cannot be avoided to meet with data quality problems, to improve on this problem, analysis can be conducted on the collected data, supplemented by the help of cause and effect charts, so as to find the causes of Data quality problems, which can timely and effectively solve or alleviate the problem.

**Improvement**

The improvement phase is a stage and a most innovative stage for the improvement activities on the basis of the analysis phase. At this stage, it is necessary to form a solution for the key factors in the definition and analysis process, and to make a comprehensive assessment of the risk of conducting the improvement, at this stage, FMEA is a commonly used means. According to the causes of data problems summarized in the previous chapter, we get the failure mode and effect analysis of data quality problem.

<table>
<thead>
<tr>
<th>Failure mode</th>
<th>Failure influence</th>
<th>Failure causes</th>
<th>Risk evaluation</th>
<th>Suggestions</th>
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<td></td>
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<td>S  O  D  RPN</td>
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<tr>
<td>The entire supply chain has two different values for one title</td>
<td>A lot of time is wasted on Mistakenly think that the data is the same, then try to merge it so that leads to erroneous results</td>
<td>An excess of data sources</td>
<td>4  5  4  80</td>
<td>Remain one data source and updates can only be allowed on this copy</td>
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<tr>
<td>The data keeper add its subjective moods when recording the data</td>
<td>The formation of bullwhip effect in the supply chain</td>
<td>Subjective judgment in recording data</td>
<td>6  9  2  108</td>
<td>Keep the rules same and make the data consumers recognize some of the subjective</td>
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</table>

Table 1. Failure mode and effect analysis of data quality problem.
Unsmooth and incomplete transmission of data caused by unreliable information management system | Resulting in inefficient communication between the various links in the supply chain, limiting the accessibility of data and possibly causing data loss | Limited computing resources | 5 | 5 | 2 | 50 | Conduct cost-benefit analysis, improve the enterprise information system according to enterprise situation

Real inventory of downstream is not visible for upstream enterprises | information sharing in supply chain is limited, affecting the efficiency of supply chain operation | Security and accessibility considered | 5 | 7 | 2 | 70 | Develop consistent policies and processes that take security and accessibility both into account to ensure data sharing on the basis of own interests protection

Can not accurately locate the required data due to large amount of historical data or for no historical data and relevant data | It takes a long time to get accurate data, or cannot find the required data | Unreasonably amount of data | 4 | 8 | 1 | 32 | Accurately collect data for consumer's needs and use proper databases

## Control

As the last stage of the DMAIC process, the control phase is a key point too. In normal quality management, control charts are usually used in this stage to reflect and distinguish the normal fluctuation and abnormal fluctuation. The main function of control charts is to prevent abnormal, analyzing the factors that affect the quality of product, and then solve these problems in its nascent state. Quality management of supply chain based on data quality can also be helped with control charts.

## Conclusions

As the market competition becoming more and more fierce, in order to improve the core competitiveness of enterprises, it is obvious that internal quality management has been unable to meet the demand of enterprises, quality management of supply chain came into being in this situation, also with the arrival of big data era, data has become a major factor in the competition, which directly affects the operation efficiency of the whole supply chain management system. Therefore, this paper puts forward the concept of quality management of supply chain based on data quality, and applies the quality management tool Six Sigma management to this system, and puts forward the framework of six sigma management on supply chain based on data quality.

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