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A PRELIMINARY STUDY ON ADOPTING SIX-SIGMA QUALITY MEASUREMENT FOR APTS TECHNOLOGY OUTPUTS

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Abstract

Six-sigma quality means a failure rate of 3.4 defects per million process opportunities; however, the term in practice is used to denote more than simply counting defects. Six-sigma can now imply a whole culture of strategies, tools, and statistical methodologies to improve the bottom line of any operations. Achieving the six-sigma level means cutting down huge costs and thereby the wasted dollars. Studies associated with public transportation service performances always focus on the passenger's perspectives, i.e. comfort and time saving of passengers. However, the evaluation would be somehow from an operator's/provider's view, means that the evaluation focus could be like that of manufacturing, i.e. the providing/production reliability. To evaluate those reliability qualities, six-sigma approach could be an alternative. Therefore, this study proposes some Advanced Public Transportation System (APTS) technologies possibly for the pilot six-sigma quality measurement.

Keywords: Six-sigma quality, public transportation, reliability, APTS, output measurement

INTRODUCTION

In general, a process is considered capable if the natural spread, plus and minus three-sigma, was less than the specification tolerance. However, six-sigma measures the capability of a process to perform a nearly defect-free operation. Six-sigma means a 99.9997% yield. Moreover, the term in practice is used to denote more than simply counting defects. Six-sigma can imply a whole culture of strategies, tools, and statistical methodologies to improve the bottom line of operations. The principal concepts of six-sigma are critical to quality (attributes that matter most to the customer), variation (what the customer sees and feels) and processes in control (giving a consistent product/process). In the general cases, world-class companies typically operate at about four-sigma.

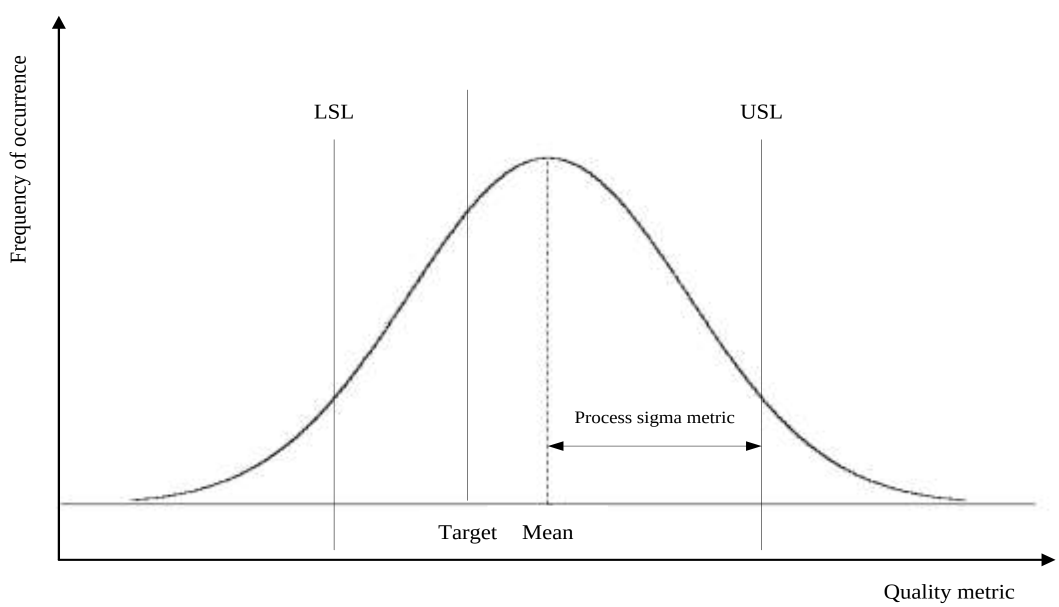
Studies associated with public transportation service performances always focus on the passenger's perspectives, i.e. comfort and time saving of passengers (Fu & Xin, 2007; Litman, 2008; TCQSM, 2013). However, APTS technologies should also be evaluated from the operator's perspectives. Moreover, the evaluation would be somehow from an operator's/provider's view, means that the evaluation focus could be like that of manufacturing, i.e. the providing/production reliability. In addition, APTS applications are always consisted of many different sub-functions, and that will cause the rolled throughput yield like a multistage process. Therefore, it is important to keep a high quality level for each sub-function. To evaluate those reliability qualities, six-sigma approach could be a choice. Some APTS technologies possibly for the six-sigma quality measurement are therefore proposed in this study.

The following sections will first explain the basic logic of six-sigma quality, and then proposed some provisional APTS technologies possibly for the six-sigma quality measurement. Finally, a brief concluding remark is given.

OVERVIEW OF SIX-SIGMA QUALITY

Given the fixed lower specification level (LSL) and upper specification level (USL), any operations process could make an outcome distribution as shown in Figure 1. When process sigma metric is equal to six-sigma, it is said that the process achieves the six-sigma quality.

Figure 1. Process Sigma Metric



Source: Bhote, 2002.

Moreover, to evaluate what the process sigma level means, Table 1 is applied to the manufacturing operations, and Table 2 is for service ones (Tennant, 2002; Truscott, 2003).

Table 1. Levels of Quality in Manufacturing.

Process Sigma	**Quality Rating**	**Yield* (%)**
6	World class	99.99966
5	Excellent	99.9767
4	Good	99.379
3	Average	99.32
2	Poor	69.1
1		30.9
0		6.7

*With the standard sigma shift of 1.5.

Table 2. Levels of Quality in Services.

Process Sigma	**Quality Rating**
6	
5	
4	World class
3~4	Excellent
2~3	Good
1~2	Average
0~1	Poor

PROVISIONAL MEASUREMENT ITEMS OF APTS OUTPUTS QUALITY

Referring to the six-sigma quality measurement for transportation, Goulias (2006) has proposed six-sigma approach as one of the performance measures for transportation systems. Moreover, British “Network Rail” deployed a six-sigma performance improvement and training to the delays in the rail networks (Bourton Group, 2009). In addition, Brown (2006) has given a study of quality programs survey from the 45 departments of transportation (DOT) in United States, surveyed in 2003 and 2005 respectively. Their survey results of the types of organizational improvement programs being used are shown in Table 3. Respondents can give multiple responses if their agency uses more than one program. Where the NQI/NPHQ stands for the quality programs proposed by Canadian national quality institute and United States national partnership for highway quality. Baldrige stands for the Malcolm Baldrige National Quality Award approach of United States. Moreover, Deming stands for W. Edwards Deming’s approach, mainly for his “Fourteen Points” and “Plan, Do Check, Act (PDCA) problem solving cycle.”

Table 3. Quality Programs Reported

Quality Programs	Number of Responses*
NQI/NPHQ	35
Baldrige	44
Deming	19
Six-Sigma	1
ISO	9
Lean	0
Other	19
None	15

*Average of years 2003 and 2005.

From the results in Table 3, it is found that "six-sigma" and "lean" approaches are still new for most American transportation departments. However, since the importance and abilities shown in other non-transportation businesses, they may be more widely applied in transportation for the future. Therefore, APTS technologies which are possible evaluated by six-sigma approach are proposed in this study, accompanied with their provisional measurement, as listed in the Table 4.

Table 4. Proposed APTS Technologies for Six-Sigma Measurement

APTS Technologies	Measurement
Communication Systems	Failure rate of process opportunities
Mobile Data Terminals	Failure rate of process opportunities
AVL	Incorrect and failure rate of process opportunities
APCs	Incorrect and failure rate of process opportunities
Transit Signal Priority	Failure rate of process opportunities
Electronic Fare Payment Devices	Incorrect and failure rate of process opportunities
Fare Products (Media)	Incorrect and failure rate of process opportunities
In-Vehicle Information Systems	Incorrect and failure rate of process opportunities
Stops/station Information Systems	Incorrect and failure rate of process opportunities
Remote Information	Incorrect and failure rate of process opportunities
Onboard safety and Security	Failure rate of process opportunities
Station/Facility Security	Failure rate of process opportunities
Incident Response	Incorrect and failure rate of process opportunities
Advanced Vehicle Safety Systems	Failure rate of process opportunities
Vehicle Guidance/Automation	Failure rate of process opportunities

Moreover, for a calculation example, given the operation data of an electronic fare payment device, with 5 fails in total of 10,000 transactions. Then the calculated "defects per million opportunities (DPMO)" is 500, yield is 99.95%, and process sigma level is 4.79. Finally, if a poor sigma level is found, further improvements for Six-sigma implementations are needed. That is the well-known DMAIC approach, which means to "define" process goals in terms of key critical parameters, i.e. critical to quality or critical to production, on the basis of customer requirements or voice of customer (VOC.) "Measure" the current process performance in context of goals. "Analyze" the current scenario in terms of causes of variations and defects. "Improve" the process by systematically reducing variation and eliminating defects. "Control" future performance of the process.

CONCLUSIVE REMARKS

World-class companies typically operate at about four-sigma or 99% perfection. Getting to the six-sigma level means a company can cut down on huge costs and thereby the wasted dollars. Therefore, the six-sigma approach is already widely applied in non-transportation businesses.

In addition, previous studies associated with public transportation service performance always focus on the passenger's perspectives, i.e. comfort and time saving of passengers. However, APTS technologies should also be evaluated from the operator's perspectives, i.e. the system operating reliability. Although the six-sigma approach is still in its infancy for transportation, this study tries to propose some APTS technologies which are possible evaluated by six-sigma approach, and to suggest the provisional measurement of these technologies.

The general principle is, for APTS technologies which provide information content or counting function, measurement of their correctness and system failure rate is necessary. On the contrary, for the technologies which provide only communication function, measurement of their failure rate is enough. However, this general principle proposed herein still needs to be more detailed; in addition, to be deployed in some empirical cases is also encouraged in future studies.

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