

Dwarves' Forge or High Tech Manufacturer? Bombardier's Quality Crisis^{1, 2}

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ABSTRACT

The objective of this paper is to resolve the quality control issues at Bombardier™ Inc., recipient of a \$1.2 billion contract to manufacture 204 light rail vehicles (LRVs) for the Toronto Transit Commission (TTC). It has identified a major crisis in the municipal transportation system of Canada's largest city, Toronto, which is also North America's third largest city. In the ten years since the contract was awarded, Bombardier has missed every single delivery deadline many times over, threatening the operational network of the TTC. The author has referenced and researched news articles and opinion, as well as corporate financial and legal documentation and industry publications to arrive at the conclusions. It was discovered that Bombardier has few problems with timely LRV delivery from its European manufacturing plants, but many from the plants in Ontario, Canada and Mexico. In conclusion, it is recommended that the application of stringent Root Cause Analysis (RCA) methodology be implemented in all of Bombardier's Transportation division.

Key words: Quality control, Just-in-time (JIT), Bombardier, Toronto, Toronto Transit Commission (TTC), Work breakdown structure (WBS), Pareto, Root Cause Analysis (RCA), define-measure-analyze-improve-control (DMAIC), Six Sigma (6σ), Supply Chain, quality pre-warning mechanism (QPWM),

INTRODUCTION

A Toronto Transit Commission (TTC) engineer characterized the assembly of vehicles in Thunder Bay as being "hand-built." A factory worker characterized it more bluntly: "*They take f--king hammers and they smash the steel into shape, like it's a f--king dwarves' forge.*"

¹ Editor's note: Student papers are authored by graduate or undergraduate students based on coursework at accredited universities or training programs. This paper was prepared as a deliverable for the course "International Contract Management" facilitated by Dr Paul D. Giammalvo of PT Mitratata Citragraha, Jakarta, Indonesia as an Adjunct Professor under contract to SKEMA Business School for the program Master of Science in Project and Programme Management and Business Development. <http://www.skema.edu/programmes/masters-of-science>. For more information on this global program (Lille and Paris in France; Belo Horizonte in Brazil), contact Dr Paul Gardiner, Global Programme Director, at paul.gardiner@skema.edu.

² How to cite this paper: Wang, F. (2018). Dwarves' Forge or High Tech Manufacturer? Bombardier's Quality Crisis, *PM World Journal*, Volume VII, Issue VI (June).

“Bombardier has been shut out of a \$4-billion contract to supply subway cars to New York City because of past delivery delays.”

These statements dramatically demonstrate the quality management crisis facing Bombardier Inc., the largest producer of railcars in the world. In 2009, the TTC inked a contract with Bombardier for a \$1.2 Cdn billion order for 204 new low floor “Flexity” light rail vehicles (LRVs) to replace the existing 30-year old dilapidated fleet. Since the commencement of the order, a host of contractual problems have significantly delayed production, so much so that Toronto Mayor John Tory called the repeated delays a “farce” in October 2017.

It was announced in the 1998 Bombardier Annual Report to Shareholders that ...” The Six Sigma program will be a key contributor in our aim to reach our new five-year pre-tax target profit margin of 10%. After its successful introduction at Bombardier Aerospace in 1997, the Six Sigma quality and productivity improvement program is now being implemented company-wide.”

It has not worked.

In 2016 the TTC exercised a legal claim against Bombardier for \$50 million. The proceeds of the lawsuit are to be used to repair existing surface transit vehicles as well as to commission buses to replace them, resulting in fewer buses for existing routes. The importance is that Toronto requires a reliable and efficient transit system NOW, not years down the road.

How can Bombardier improve quality control and supply chain management to ensure it meets its contractual agreements for future deliveries?

METHODOLOGY

Step 1 - Problem Definition

Bombardier has delayed in delivery of light rail vehicles (LRVs) to TTC many times, and these indicated quality-control problems have persisted for years. Through study and research on this real case, it is obviously that quality control is the most important reason leading to contract failure between both parties of the contract. In such circumstances, an appropriate quality improvement methodology appears to be particularly important for this manufacturing industry.

Step 2 - Feasible Alternatives

Thorough research into the quality control issues at Bombardier, at manufacturing plants in Europe, Canada and Mexico, both historic and contemporaneous, have suggested four markedly different approaches to its serious quality control problems.

- 1) Do nothing
- 2) Add capacity by opening an additional shift at a European plant

- 3) Reinforce and reinvigorate the existing Six Sigma program, with emphasis on RCA studies
- 4) Make full use of quality early warning mechanisms to improve product quality.

Step 3 – Development of Outcomes of the Alternatives

1) Do nothing

Bombardier has been extending delivery deadlines for nearly 10 years using this approach, and only recently has contended that all TTC deliveries will meet a 2019 deadline. In this they have been aided by the courts. The TTC exercised its option to sue Bombardier for \$50 million, only to have the courts intervene and demand the two parties go to mediation. Advantage: Bombardier. According to its latest Financial Outlook 2017 Q3, Bombardier Transportation has an order backlog of \$30.1 billion. It is suggested they can perpetuate this laissez-faire attitude without concern for imminent financial risk.

2) Add capacity by opening an additional shift at European plant (ACAS)

The Company has already added shifts at an available facility in La Pocatière, Québec. For 20 years it has built similar Flexity LRVs at its plant in Bautzen, Germany with few quality control issues. In order to meet its TTC contract deadlines, the Company could modify the European version on a temporary basis and ship the units to the two plants in Canada for final assembly.

3) Reinforce and reinvigorate the existing Six Sigma program, with emphasis on RCA studies (RCA)

It is suggested a thorough review of all quality control systems in Bombardier's Rail Division be conducted, with special emphasis on the powerful and incisive Root Cause Analysis (RCA) method. RCA is a component of Six Sigma. Bombardier attempted a quality control fix in Mexico by dispatching German welding experts to the plant in Sahagun, Mexico. It is believed they left the factory too soon... a classic case of too little, too late. The Company can consider hiring top level quality control experts from a firm like McKinsey & Company, whose website for Rail and Public Transport states "We support companies and municipalities in transformations that improve efficiency, lower costs, and increase customer satisfaction." This would be a case of spending money to save money.

4) Make full use of quality pre-warning mechanisms to improve product quality (QPWM)

There's no doubt that timely quality checks should be considered and emphasized, which means solving problems during the time of production. For most manufacturers, this may be a painful task, because it is risky to recognize the existence of quality problems in the production process. However, in order to guarantee high quality and increase profits on the basis of reducing costs, Bombardier's LRV manufacturers really need to do such timely quality control during the pre-warning process.

The Well-known quality management scientist Philip B. Crosby has stated - "quality is free".

“His belief was that an organization that establishes good quality management principles will see savings returns that more than pay for the cost of the quality system: “quality is free”. It is less expensive to do it right the first time than to pay for rework and repairs.”

Compared with the “project post-mortem” examination method, timely quality data collection, timely monitoring, pre-warning, and timely positioning analysis are better choices.

Step 4 – Selection of the Criteria

The current quality management system is complicated, fragmented and even uncontrolled in Bombardier’s LRV project. In this paper, the dominance approach will be used for the criteria selection, and the importance of all attributes in this case equally considered.

- **Customer Satisfaction**
- **Performance**
- **Cost**
- **Time Factor**
- **Reach Key Milestones**

ATTRIBUTES	Do nothing	ACAS	RCA	QPWM
Customer Satisfaction	poor	Excellent	Excellent	fair
Performance	fair	Good	Excellent	Excellent
Cost	fair	poor	fair	fair
Time Factor	poor	fair	Excellent	Excellent
Reach key milestones	poor	Excellent	Excellent	Good

Figure 1. MADM model analysis for criteria

FINDINGS

Step 5 - Analysis of the alternatives

- *“Your problem will never go away until you deal with it.”* It’s common sense, not only for an individual, but also for a famous manufacturing company. Productivity will not be improved when problems occur, especially quality problems when people do nothing about it. In the case of Bombardier LRV deliveries, if they take a do nothing approach, customer satisfaction, time factors and milestones reach will be directly affected. While the performance and cost might stay the same in the short run, it’s necessary to make full preparations for dealing with long-term risks.

- It is noted that Bombardier has already taken some measures to deal with a few quality control issues. As the case stands, the solution of modifying the European version on a temporary basis and shipping the units to the two plants in Canada for final assembly could help meet its TTC contract deadlines. It could be seen that customer satisfaction, time factor and milestones reached will be improved after this scheme is adopted effectively. On the other hand, it means costs will be increased, with no change in the time factor.
- Over the years, some well-known companies have implemented overarching processes like Six Sigma, a rigidly data-driven quality-management program originally designed to tackle manufacturing problems. At present, Six Sigma is well utilized in Bombardier's aircraft manufacturing operations, but it needs to be transferred and greatly emphasized in the LRV division. As well, it can be used to support companies and municipalities in transformations that improve efficiency of performance, customer satisfaction, time factors and milestones reached with little impact on cost.
- A “quality pre-warning mechanism” can be an alternative to reduce the risk of poor quality. From the principle of integrating theory with practice, if the problem can be identified and handled in a timely manner, the loss can be lowered or even avoided. In the case of Bombardier's LRV quality problems, such timely quality control during the pre-warning process is recommended. If this mechanism can be fully implemented, the performance and time factor will be improved while performance, customer satisfaction and cost will remain the same.

Criteria	
Poor	0
Faire	1
Good	2
Great	3

ATTRIBUTES	Do nothing	ACAS	RCA	QPWM
Customer Satisfaction	0.00	1.00	1.00	0.33
Performance	0.33	0.67	1.00	1.00
Cost	0.33	0.00	0.33	0.33
Time Factor	0.00	0.33	1.00	1.00
Reach key milestones	0.00	1.00	1.00	0.67
Total	0.66	3.00	5.33	3.33

Figure 2. MADM model analysis result

Attributes	Relevant Rank	Normalized Weighting(A)	RCA		Do nothing		QPWM		ACAS	
			(B)	(B)×(A)	(C)	(C)×(A)	(D)	(D)×(A)	(E)	(E)×(A)
Customer Satisfaction	1	1/15=0.07	1.00	0.07	0.00	0.0	0.33	0.02	1.00	0.07
Performance	2	2/15=0.13	1.00	0.13	0.33	0.04	1.00	0.13	0.67	0.09
Cost	4	4/15=0.27	0.33	0.09	0.33	0.0	0.33	0.09	0.00	0.0
Time Factor	5	5/15=0.33	1.00	0.33	0.00	0.0	1.00	0.13	0.33	0.1
Reach key milestones	3	3/15=0.2	1.00	0.2	0.00	0.0	0.67	0.14	1.00	0.2
SUM	15	1		0.82		0.08		0.42		0.46

Figure 3. Additive weighting method



Figure 4. The ranking of four alternatives

Step 6 - Selection of a preferred alternative:

Through intensive research and analysis, the alternative “Reinforce and reinvigorate the existing Six Sigma program, with emphasis on RCA studies (RCA)” is the best solution amongst these four criteria. As illustrated in figure 1 and figure 2, through Multi Attribute Decision Making (MADM) method analysis, it is obvious that the alternative of Reinforcing and Reinvigorating the existing Six Sigma program, with emphasis on RCA studies (RCA) can maximize the five items of criteria. As in figure 3 in the analysis of additive weighting method, it clearly demonstrates that RCA is the best choice to maximize meeting the attributes. In fact, the alternative of RCA is the preferred method amongst these four alternatives after the research and analysis into Bombardier’s case.

Step 7 - Performance monitoring and post-evaluation results

1) Performance monitoring

With the realization that CRA is a “reactive” method, maintaining historical data is critical. One must properly describe and define each quality control problem - its magnitude, location and the timing. It is recommended that a timeline sequence be established, to include conditions, behaviours, location in the supply chain, and managements’ responsibilities and accountability.

The bottom line of CRA is this - we must understand the problem before we can come up with a solution.

2) Post-evaluation results

Adoption of reinforcing and reinvigorating the existing Six Sigma program, with emphasis on RCA studies to reduce the defects of quality in order to achieve the objective of on-time delivery for the Bombardier LRV project, could result in many tangible and intangible benefits.

Firstly, cooperation between Bombardier and its various suppliers will be enhanced, and the culture of quality will be improved continuously.

Secondly, since Six Sigma is a methodology based on data, it will standardize the quality of products.

Thirdly, rigorous process management will be established, and the ability of “quality, delivery, safety and cost” will be improved.

Overall, reinforcing and reinvigorating the existing Six Sigma program can effectively improve the quality of products and increase market share.

CONCLUSION

Based on analysis and the comparison of alternatives, it is recommended that Bombardier implement a professional level standard of well-known and documented processes for conducting a Root Cause Analysis, an important component of its existing Six Sigma program and the International Railway Industry Standard (IRIS) certification based on the ISO 9001 standard. In this way, Bombardier can improve quality control and supply chain management to ensure it meets its contractual agreements for future deliveries.

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