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Effects of a production improvement programme on global quality performance: The case of the Volvo Production System

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Abstract

Purpose: How can multinational companies become more productive on a global scale? This paper investigates whether a production improvement programme can improve quality performance in a global network of factories. Specifically, we analyse the effects of the Volvo Group's production improvement programme on global quality performance.

Methodology: Our research approach is a case study of the Volvo Production System. We analyse the effects of the programme on global quality performance, using data from an implementation audit and a questionnaire survey. We triangulate the analysis with longitudinal quality performance data from three different plants.

Findings: We find a significant and strong positive relationship between implementation of the Volvo Production System and improvements in both process quality and product quality. Hence, we suggest that tailored production improvement programmes have clear positive effects on global quality performance.

Research limitations: As with all case studies, we should use caution when generalising beyond the specific case. However, the Volvo Group is a broad and diversified corporation, which mitigates this limitation.

Originality: While many studies have investigated the effect of production improvement programmes on performance, very few have looked at the effect of a corporate multi-plant programme. This study represents one of the first attempts to do so. We also provide a case description of the Volvo Production System that readers might find valuable in its own right.

Keywords: *improvement programme; quality management; quality performance; production system; global operations management; lean production; Volvo*

1 Introduction

As a result of the increasing globalisation of firms, it has become a trend to roll out group-wide production improvement programmes. Inspired by the success of the Toyota Production System (TPS), such a programme is often labelled 'your-company-name-here' production system (XPS). By implementing an XPS, a corporation aims to adopt, synthesise and adapt well-known production philosophies, such as total quality management (TQM), just-in-time (JIT), six sigma, lean production and so on, in view of its specific environment, characteristics and needs.

Even though a positive link between different types of improvement programmes and resulting performance is well established in the literature, there is surprisingly limited knowledge about the performance effects of a global, group-wide approach. In this paper, we contribute to the on-going debate about the effectiveness of production improvement programmes by investigating the Volvo Group's global implementation of the Volvo Production System (VPS).

Launched in 2007, the VPS provides principles, tools and guidelines for how all units in Volvo's global production network should work to reach operational excellence. The overall aim of implementing and sustaining the VPS is to reach world-class performance in six defined competitive priorities: safety, quality, delivery, cost, environment and people (abbreviated to SQDCEP) (Volvo Group, 2010a). As illustrated in Figure 1, VPS is a never-ending endeavour to improve SQDCEP. To support this effort, Volvo uses *VPS assessments* in which gap-analyses identify what practical tools and techniques to deploy in each plant.

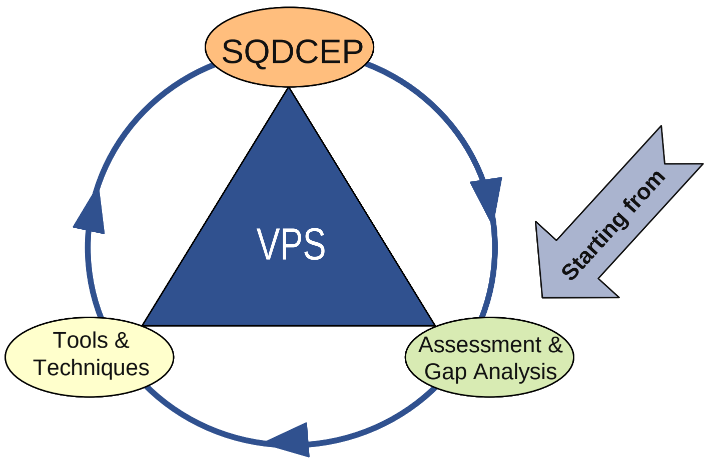

Figure 1. The never-ending VPS implementation loop (source: Volvo AB).

In this paper, we focus on the system's effect on global quality performance (the 'Q' in SQDCEP). We investigate the association between implementation of the VPS and quality improvement in Volvo's global production network. We choose to focus explicitly on quality because it is considered the most fundamental capability to build (Ferdows and De Meyer, 1990). Improving quality performance has always been a common objective of all improvement philosophies (Schonberger, 2007). We therefore ask: does an XPS deliver the promised quality improvement across plants in a global production network?

2 Background

To improve productivity on a global scale, many multinational companies have developed their own company-specific production systems (XPSs) (Neuhaus, 2009; Netland, 2013). For example, Honnef *et al*. (2000) described how the XPSs of Ford, Opel, Audi, Daimler Chrysler and Mercedes-Benz were developed. Lee and Jo (2007) showed how the TPS was 'mutated' into a similar, yet distinctive, Hyundai Production System. Netland (2013) analysed the content across 30 such systems—including the Alfa Laval Production System, Bosch Production System, John Deere Quality and Production System and Scania Production System, to mention only a few.

The guiding objective of an XPS is that the corporation as a whole operates in alignment with the same set of principles and improves according to the same system. This way, XPSs can be seen as an advancement of *integrated management systems* (IMSs) (Khanna *et al*., 2010; Leopoulos *et al*., 2010; Casadesús *et al*., 2011). IMSs emphasise the need for a holistic improvement system that has a broader scope than ISO certification[i] (Asif *et al*., 2010). The aim is to reuse proven operational practices in multiple locations to leverage knowledge and ultimately increase competitiveness (Netland and Aspelund, 2013).

For Deming (1986), competitiveness starts with *quality*. It makes sense to distinguish between *process quality* and *product quality* (Taguchi, 1986; Garvin, 1988). Process quality describes the quality of the manufacturing processes, whereas product quality specifies the quality of the result. It is possible to achieve good process quality without good product quality and to achieve good product quality without good process quality. The first would be the result of an ineffective—but efficient—production system based on a poor understanding of the customer's need. The latter would be the result of an inefficient—but effective—production system characterised by wasteful processes. Both, of course, are undesirable: the intention of an XPS is to improve process quality and product quality simultaneously.

The literature suggests that implementation of quality practices leads to improved quality performance—both in terms of product quality (e.g. Forza and Filippini, 1998; Cua *et al*., 2001; McKone *et al*., 2001) and process quality (e.g. Flynn *et al*., 1995; Shah and Ward, 2003). Positive associations with improvements in quality performance have been established for various improvement programmes, such as TQM (e.g. Fotopoulos and Psomas, 2010), JIT (e.g. Fullerton and McWatters, 2001), total productive maintenance (TPM) (e.g. McKone *et al*., 2001), six sigma (e.g. Swink and Jacobs, 2012), IMS (e.g. Casadesús *et al*., 2011), high-involvement work practices (Wickramasinghe and Gamage, 2011) and lean production (e.g. Shah and Ward, 2003). Also, meta-reviews of the literature have found convincing support for the positive relationship (e.g. Sousa and Voss, 2002; Nair, 2006; Mackelprang and Nair, 2010).

This is why 'research on practices has begun to shift its interest from the justification of the value of those practices to the understanding of the contextual conditions under which they are effective' (Sousa and Voss, 2008, p. 697). We investigate whether the same set of quality practices, packaged together with other practices in an XPS, can be effective if deployed simultaneously in a global network of plants. A contingency perspective would suggest a limited effect. Considering the existing literature on single-plant implementation, however, we hypothesise that it is an effective strategy:

- Hypothesis 1: *The implementation of an XPS will be positively associated with process quality performance in the plants.*
- Hypothesis 2: *The implementation of an XPS will be positively associated with product quality performance in the plants.*

3 Methodology

In order to test our hypotheses, we employed a case study methodology (Stake, 1994; Yin, 2003). A case study can be defined as 'empirical research that primarily uses contextually rich data from bounded real-world settings to investigate a focused phenomenon' (Barratt *et al*., 2011, p. 329). Specifically, we investigated the worldwide implementation of VPS in the Volvo Group. The research was performed in close cooperation between Volvo Group practitioners and the first author, in line with the Scandinavian research tradition in operations management (Karlsson, 2009). We used multiple sources of data—both quantitative and qualitative—to triangulate our analyses and hence improve the validity of the results (Voss, 2009).

3.1 The Volvo Group and the Volvo Production System

The Swedish Volvo Group develops and produces high-tech products in the transportation industry. With its more than 100.000 employees, sales operations in 185 countries and plants in 20 countries, it is a truly global company. As a growing and increasingly dispersed and fragmented company, the Volvo Group decided in 2005 to carry out a group-wide XPS initiative. Many Volvo plants experienced extensive price competition from new economies such as China, and needed to embark on lean production projects in order to lower production costs while improving quality and reducing delivery times. An internal pre-study concluded in 2005 that 'the benefits of a common Volvo Production System would be maximum use of resources, better communication within the company group, sharing of the best practices, industrial and personnel mobility and reduced duplication of effort' (Hill, 2006, p. 1).

The VPS[ii] was launched in 2007. Its key difference from earlier improvement projects is that it was designed to function as a never-ending programme: 'The work with VPS is never finished. This is not a new campaign that will lose focus after a while. It's a way of thinking. A programme that will continue at all times' (Volvo Group, 2009, p. 23). In other words, implementing the VPS is a continuous process. The VPS is intended to instil a more unified Volvo culture. The VPS provides 'the vision and framework of principles and tools designed to guide us in creating value for our customers by increasing the quality, securing the delivery, and lowering the cost of the products we produce' (Volvo Group, 2010a). The VPS model is shown in Figure 2. It consists of five main principles: teamwork, process stability, built-in-quality, continuous improvement and just-in-time. At the foundation are the corporate values (the Volvo Way), and the inherent customer orientation is represented at the top of the pyramid. The VPS comprises 22 modules, including a range of tools and techniques.

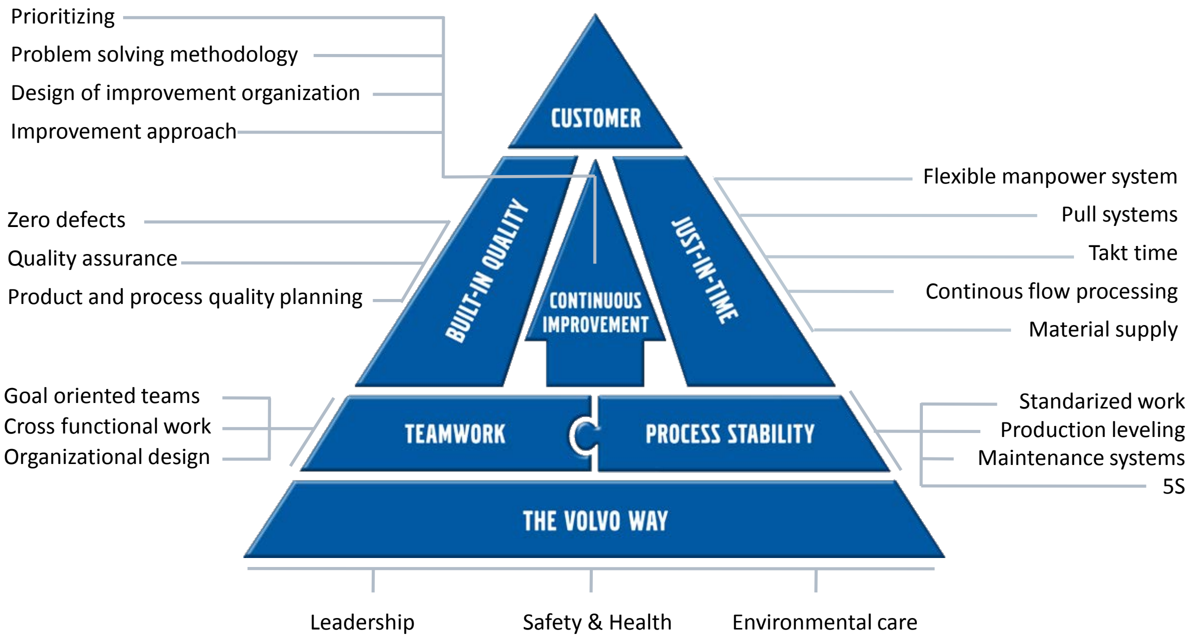

Figure 2. The Volvo Production System pyramid (Source: Volvo AB).

3.2 *Independent variable: Implementation of VPS quality practices*

In order to measure the level of implementation of the VPS in the plants, we took advantage of full access to original VPS assessment data. These data have been qualitatively collected through a standardised VPS assessment led by employees from the centralised VPS Academy. The assessments are carried out through a physical plant visit over three to four days, led by two VPS assessors from the Academy together with assessors from other Volvo plants. The assessments follow a standard procedure. A clearly defined assessment score scheme is used, in which the plants are assessed according to their implementation of the 22 VPS modules.

The assessments determine whether the system is in place and whether business results are improving in the correct order for continuous improvement (cf. SQDCEP): ‘The assessments should be seen as one source that will help the plants to prioritise the efforts on the most urgent and beneficial areas. The objective of the plant assessment is also to stimulate the discussion around deepened capabilities and create renewed motivation to improve. The assessments are also a way to create transparency of the use of VPS principles across all plants within the Volvo Group, and a way to follow the development of each individual plant over time. The assessments help the VPS Academy to collect best practices and then share them within the Volvo Group’ (Volvo Group, 2010b). For all VPS principles, a continuous scale from 0 to 5 is used to assess implementation (0 = nothing, 1 = basic initiatives, 2 =

structured approach, 3 = established, 4 = outstanding, 5 = perfection). For a thorough discussion of the VPS assessment, see Harlin *et al*. (2008).

Because we focus on the quality dimension, we used the plant assessment scores for the built-in-quality (BiQ) principle (see the VPS pyramid in Figure 2). The BiQ principle consists of four modules with approximately 100 items[iii] to assess. The four modules are quality culture, zero defects, quality assurance and quality planning. A lower BiQ score suggests a poorer implementation of quality tools and techniques in the plant (but not necessarily poorer quality performance). Correspondingly, a higher BiQ score indicates that a better quality system is in place. Because the BiQ score is a composite quality measure, we maintain that it represents a robust and valid measure of the plant's overall implementation of quality practices. We have assessment data for 48 plants in Volvo's network. For the purpose of eliminating the bias of different assessment versions, we normalised all the data within the different versions when we compared the plants.

3.3 Dependent variables: Process and product quality performance

To measure the dependent variable, we chose key performance indicators (KPIs) that represent process- and product quality performance, respectively. A suitable measure for *process quality* is *first-time-through* (FTT)[iv]. FTT measures the percentage of units that are produced correctly—without flaws or need for rework—the first time they pass through the process or value stream. If products are produced correctly the first time, it signifies a good process quality. We measured *product quality* with the KPI *customer satisfaction* (CS). CS is typically measured inversely as 'number of customer complaints' (CC) in parts per million (ppm) for all orders delivered. Customers are expected to be satisfied with the product quality only if it meets or exceeds their expectations. For triangulation purposes, we collected the data from two different sources: a questionnaire survey administered in all Volvo plants and longitudinal KPI data collected from three in-depth case studies of plants.

First, the survey directly asked the following questions: 'How has VPS affected the FTT in the last two years?' and 'How has VPS affected the CS in the last two years?' Both questions were measured on a five-point Likert scale from 'significant negative impact' to 'significant positive impact'. In order to control for moderating factors, we included measures for *plant size* (current number of employees), *plant age* (decade of start-up) and *unionisation* (degree of union membership). The survey was distributed to contact persons in Volvo's 60 plants on all six continents. We asked for three to eight respondents drawn from managers at different hierarchical levels in each plant, depending on the size of the plant. After several iterations of reminders, we received 305 responses from 56 plants. On average, 5.5 managers in each participating plant responded to the survey. Responses from each plant were merged into a single average score for that plant.

Second, we collected longitudinal performance data from a few representative plants to triangulate the results from the survey analysis. We chose three different plants, each located in a different part of the world and representing a different product group: a South American truck powertrain plant, a Scandinavian construction equipment plant and a European truck assembly plant. All plants had records of FTT performance (the calculations differ among the plants). Whereas two plants measured CC as complaints in ppm, the third plant measured CC as the number of claims from the customer after first month of use ('fault frequency first month').

4 Analysis

We first investigate the two hypotheses quantitatively, using data from the global survey and the VPS assessments. Thereafter, we analyse longitudinal performance data from three plants that have worked seriously with the implementation of VPS since 2007. Triangulating the results from these different analyses, we explore the effects of VPS implementation on both types of quality performance.

4.1 Global survey data

A correlation analysis shows a significant and strong positive correlation between VPS implementation and the two dependent variables: Pearson's r is 0.41 for FTT and 0.46 for CS, both at a 0.01 significance level. We included plant size, plant age and degree of unionisation as control variables. However, as we found non-significant and weak correlations between the control variables and both dependent variables, we did not include them in the subsequent regression models. In Figures 3 and 4 we have plotted the two hypothesised relationships for the 45 plants in the sample and added the corresponding linear regression models.

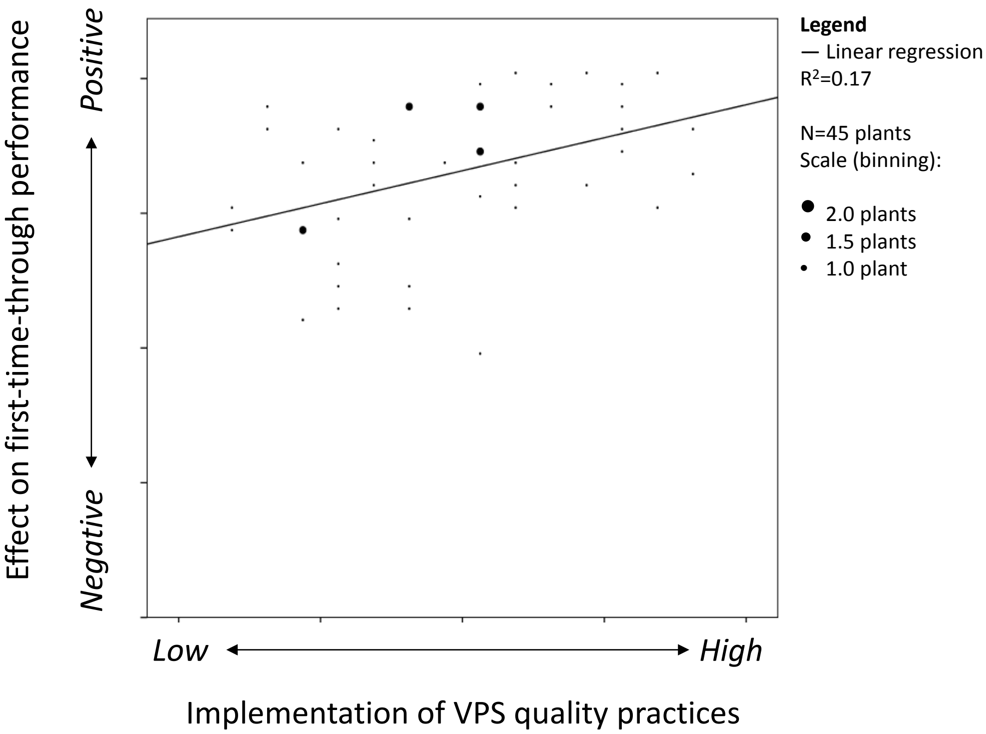

Figure 3. The effect of VPS implementation on FTT performance (Hypothesis 1).

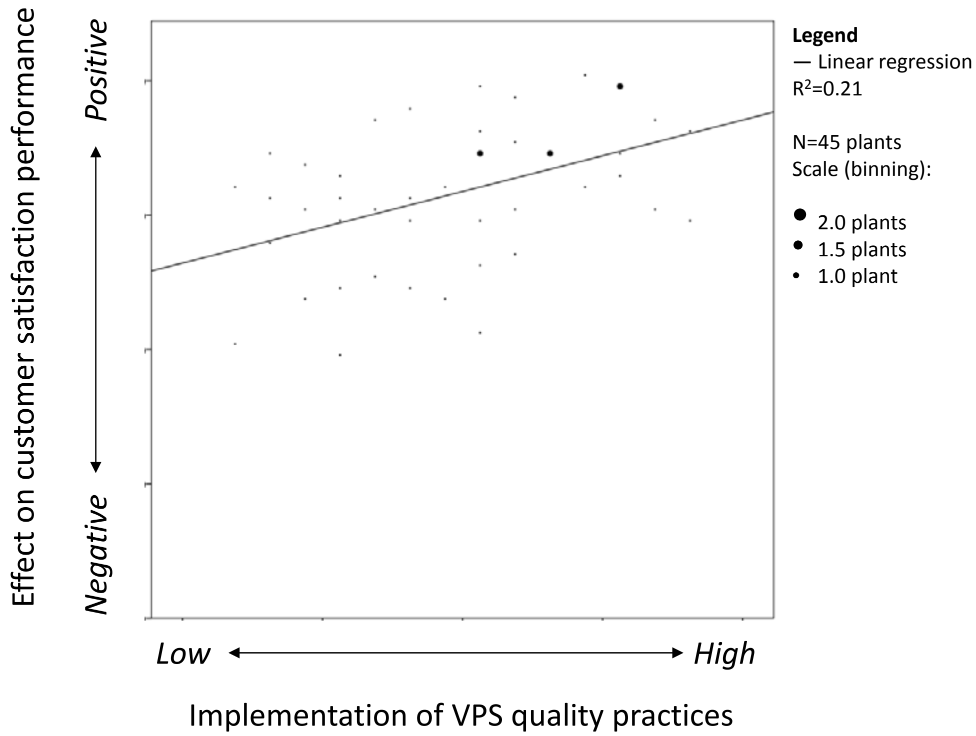

Figure 4. The effect of VPS implementation on CS performance (Hypothesis 2).

The linear regression models support the causality we hypothesised. We find that the implementation of VPS quality practices explains 17% of the variation in FTT performance (the coefficient of determination, R^2, is 0.17). Similarly, implementation of the same practices explains 21% of the variation in CS performance (R^2 is 0.21). Both are significant at a 0.01 significance level. Thus, this analysis lends support to both hypotheses.

4.2 Case 1: Powertrain plant in South America

The first plant we choose to investigate is one of the few plants that have been subject to four VPS assessments. The plant manufactures transmissions and cylinder blocks and assembles truck engines. It employs 400 people. The method used for implementing the VPS in the plant is the *world-class manufacturing* (WCM) method developed by Professor Hajime Yamashina at Kyoto University in Japan. Despite a challenging 2011 with several new start-ups, it was 'the plant's best year ever'. The VPS manager convincingly claims: 'I can assure you; this comes from our VPS work using the WCM method'. Table 1 shows the development of BiQ scores, FTT and CC from 2007 to 2011.

Table 1. Longitudinal KPI data for truck powertrain plant in South America (2007-2011).

KPI \ Year	2007	2008	2009	2010	2011	Average annual improvement
BiQ score	2,0	2,5	2,4	n/a	2,9	10%
First-time-through	78,5%	88%	94,2%	95,5%	96,1%	5%
Customer complaints	12.100 ppm	2465 ppm	1466 ppm	1221 ppm	905 ppm	41%

Since the introduction of VPS in 2007, the plant has shown rapid improvements. Whereas the implementation of quality practices, on average, has increased by 10% annually, FTT has improved by 5% annually, and the number of customer complaints has decreased by 41% annually. The data from this plant support both our hypotheses.

4.3 Case 2: Construction equipment plant in Scandinavia

The second plant employs approximately 900 people. It manufactures powertrain parts for heavy construction equipment. In this plant, the journey to lean production started with an extensive reengineering project in 2007. Before that, there had been isolated attempts at TPM, work place organisation (5S) and so on, none of which were sustained for a significant period. As a result of the reengineering, the plant changed from a traditional layout, where machining was done in functional cells and operators built complete transmissions and axles on stations, to a flow orientation, where machining is done in flow-oriented cells and assembly is performed on small lines. The transformations were carried out cell station after cell station, with three proceeding transformation projects at a time lasting 12 weeks each. Ten VPS coaches supported and led the transformations from 2007 to 2010. Since then, the plant has worked relentlessly to implement VPS in daily work and throughout the organisation. Table 2 shows the development of BiQ scores, FTT and CC from 2007 to 2012.

Table 2. Longitudinal KPI data for construction equipment plant in Scandinavia (2007-2012).

KPI \ Year	2007	2008	2009	2010	2011	2012	Average annual improvement
BiQ score	0,67	n/a	0,94	n/a	1,61	n/a	22%
First-time-through	n/a	n/a	n/a	n/a	94,2%	95,4%	1,3%
Customer complaints	n/a	9414 ppm	8683 ppm	3068 ppm	1995 ppm	1889 ppm	28%

Because this plant started with less practices implemented than the previously discussed plant (cf. BiQ scores), it has been relatively easier for it to implement more practices faster than for the first plant. We only have FTT data for the last two years, but we believe that since 2007 the process quality has improved much more rapidly than the suggested annual improvement of 1.3%. As demonstrated by the 28% annual decrease in CC, product quality has been gradually improving at the plant. Again, the data from this plant lends support to both hypotheses.

4.4 Case 3: Truck assembly plant in Continental Europe

The third plant we investigate is a truck plant in Europe. More than 2000 people are employed at the site, which consists of several factories in a truck-building supply chain. The plant launched its own XPS already in 2005. However, the VPS manager explains that 'before 2007 there were no big improvements'. Then, in 2007, there was a top-management requirement to restart the programme as VPS. With helpful coaching from Japanese Volvo employees, the plant has since made significant improvements in productivity. The VPS manager stresses the following: 'VPS is a success. It makes us work on all processes simultaneously, and not in isolation. Before we did not have a common culture, but today, we have a common language, and all work in the same way. It is almost like a religion'. Table 3 shows the development of BiQ scores, FTT and CC from 2007 to 2012.

Table 3. Longitudinal KPI data for truck assembly plant in Europe (2007-2012).

KPI \ Year	2007	2008	2009	2010	2011	2012	Average annual improvement
BiQ score	n/a	2,33	n/a	2,48	2,43	n/a	1%
First-time-through	47%	65%	73%	74%	76%	75%	10,7%
Customer complaints*	n/a	0,18	0,15	0,17	0,14	0,08	16%

** Measured as claims from the customer after one month of use ('fault frequency first month')*

This plant has made considerable strides in implementing the VPS. It is highly regarded in its region for its operational excellence. By 2008, the plant had already reached a relatively high level of VPS implementation. The 1% improvement in VPS implementation is better than it seems, as the requirements for a high score in the assessment have intensified a great deal over the years. Both the process quality (measured by FTT) and the product quality (for this plant, measured by 'fault frequency first month') have improved considerably since 2007. Again, the performance data and the stories of managers leave minimal reason to doubt that VPS implementation has had a positive effect on the plant.

5 Discussion

The analyses of the survey data and case data establish a positive association between implementation of VPS quality practices and aggregate quality performance. Hence, our paper supports the literature that claims positive links between quality improvement programmes and quality performance. An original insight of our study is that quality practices seem effective also when they are packaged with other improvement practices in an XPS and deployed simultaneously in a global network of plants (also outside the Toyota case). Based on our data and in-depth knowledge of the Volvo plants, we suggest and discuss three plausible explanations for why XPSs prove effective in improving quality performance:

- Some quality practices are universally effective.
- A holistic XPS approach to improvement is effective.
- External pressure for implementing an XPS in a plant is effective.

One explanation for the positive relationship might simply be the universal validity of some superior quality practices. Nair (2006, p. 948) writes that 'it is now widely believed that the underlying practices in quality management are fundamental and essential for effective management and competitive survival of organisations'. The considerable amount of empirical research that finds a positive effect of various quality practices lends strong support to this explanation. Thus, even if contingencies matter, they might not matter much for quality practices such as those in the VPS. After half a century of research on quality practices—from quality circles to total quality management, six sigma and lean production—we know what works.

A second potential explanation for the positive results is that an XPS represents a *holistic* approach to improvement. In an XPS, the ‘best of’ JIT, six sigma, TQM, lean production and so on can be strategically selected by the firm. It might be that quality practices are effective, precisely because they are packaged with complimentary practices in the XPS. Researchers like Cua *et al*. (2001) and Flynn *et al*. (1995) suggest that the *concurrent* implementation of TQM and JIT yields synergies that go beyond the sum of their individual effects. This argument finds further support in the literature on IMS that suggests a holistic approach to improvement (e.g. Khanna *et al*., 2010) and in the contingency perspective that suggests that improvement programmes should be tailored to individual corporate strategies (e.g. Sousa and Voss, 2008).

A third explanation is that the XPS—in contrast to many other temporary improvement *projects*—is a serious and lasting improvement *programme*. For the plants, the XPS comes with lasting pressure and support from the headquarters to implement the system. Abundant research has established that management commitment is the most important critical success factor (e.g. Crosby, 1979; Deming, 1986; Garvin, 1988; Brady and Allen, 2006). Because embarking on an XPS is a costly decision, top management ensures that the necessary management commitment is sustained over time in the dispersed network of plants. Volvo’s assessment scheme for VPS implementation is a good example of how this commitment manifests itself in both requirements and assistance over time. Such external pressure to implement an XPS is effective in improving performance.

Of course, a combination of the three explanations is most likely taking place. As the contingency perspective suggests—and our analysis of three different Volvo plants shows—different plants have different needs and motivations for the implementation of an XPS. This is also a likely explanation for why the plants experience different levels of quality improvement. Nevertheless, the XPS appears effective for all plants.

6 Conclusions

In this paper, we investigated the effects on global quality performance of deploying a corporate production improvement programme in a multinational company. We distinguished between process quality (measured by first-time-through) and product quality (measured by customer satisfaction) and hypothesised that the implementation of an XPS in a worldwide network of plants would improve both. The results of a survey questionnaire, administered in all Volvo plants worldwide, indicated strong and significant support for our hypotheses. We controlled for the moderating effects of plant size, plant age and degree of unionisation, but found that these factors could not explain the differences in performance. Three longitudinal cases affirmed that greater implementation of quality practices—as described by the VPS—co-occurred with increased factual quality performance in both dimensions for the plants. To the best of our knowledge, this is the first study to investigate the relationship between the implementation of an XPS and the associated quality improvement in a global production network.

Considering the importance and magnitude of XPSs in industry, we call for more research in this area. Research should elaborate on the effects of XPSs on *all* competitive priorities (SQDCEP) and ultimately aim to demonstrate the implications for overall costs and profits. Interestingly, we found that different plants follow different implementation routes and that they all tend to maintain that *their* roadmap is the right one. Hence, we encourage researchers to test and describe normative roadmaps that help multinational corporations to develop, deploy, manage and sustain better XPSs. As business continues to globalise, topics similar to the one discussed in this paper will only become more important.

7 Acknowledgements

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8 References

Asif, M., Bruijn, E. J. D., Fisscher, O. a. M. & Searcy, C. (2010) Meta-management of integration of management systems. *The TQM Journal,* Vol. 22, Iss. 6, pp. 570 - 582.

Barratt, M., Choi, T. Y. & Li, M. (2011) Qualitative case studies in operations management: Trends, research outcomes, and future research implications. *Journal of Operations Management,* Vol. 29, Iss. 4, pp. 329-342.

Brady, J. E. & Allen, T. T. (2006) Six Sigma Literature: A Review and Agenda for Future Research. *Quality and Reliability Engineering International,* Vol. 22, Iss. 3, pp. 335-367.

Casadesús, M., Karapetrovic, S. & Heras, I. (2011) Synergies in standardized management systems: some empirical evidence. *The TQM Journal,* Vol. 23, Iss. 1, pp. 73-86.

Crosby, P. (1979) *Quality is Free*, Mc Graw Hill.

Cua, K. O., Mckone, K. E. & Schroeder, R. G. (2001) Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. *Journal of Operations Management*, Vol. 19, Iss. 6, pp. 675-694.

Deming, W. E. (1986) *Out of the crisis: quality, productivity and competitive position,* Cambridge, Cambridge University Press.

Ferdows, K. & De Meyer, A. (1990) Lasting improvements in manufacturing performance: In search of a new theory. *Journal of Operations Management,* Vol. 9, Iss. 2, pp. 168-184.

Flynn, B. B., Sakakibara, S. & Schroeder, R. G. (1995) Relationship between JIT and TQM: Practices and Performance. *The Academy of Management Journal,* Vol. 38, Iss. 5, pp. 1325-1360.

Forza, C. & Filippini, R. (1998) TQM impact on quality conformance and customer satisfaction: A causal model. *International Journal of Production Economics,* Vol. 55, Iss. 1, pp. 1-20.

Fotopoulos, C. V. & Psomas, E. L. (2010) The structural relationships between TQM factors and organizational performance. *The TQM Journal,* Vol. 22, Iss. 5, pp. 539 - 552.

Fullerton, R. R. & Mcwatters, C. S. (2001) The production performance benefits from JIT implementation. *Journal of Operations Management,* Vol. 19, Iss. 1, pp. 81-96.

Garvin, D. A. (1988) *Managing quality : the strategic and competitive edge,* New York, Free Press.

Harlin, U., Moestam Ahlström, L., Medbo, L. & Svenningstorp, J. (2008) A Production System Assessment Approach within Swedish Automotive Industry. *The Swedish Production Symposium, SPS 2008.* Stockholm.

Hill, B. (2006) *The Volvo Production Systems pre-study results,* Gothenburg, Volvo Technology. http://goo.gl/1mmZc Accessed 4 April 2010

Honnef, H.-G., Hoffmeyer, W., Spanner-Ulmer, B., Springer, R., Ritter, J. & Lentes, H.-P. (2000) Produktionssysteme im Vergleich. In Hofman, A. (Ed.) *Arbeitsorganisation in der Automobilindustrie - Stand und Ausblick.* Köln, Wirtschaftsverlag Bachem.

Karlsson, C. (2009) *Researching operations management,* New York, Routledge.

Khanna, H. K., Laroiya, S. C. & Sharma, D. D. (2010) Integrated management systems in Indian manufacturing organizations: Some key findings from an empirical study. *The TQM Journal,* Vol. 22, Iss. 6, pp. 670 - 686.

Lee, B. H. & Jo, H. J. (2007) The mutation of the Toyota Production System: adapting the TPS at Hyundai Motor Company. *International Journal of Production Research,* Vol. 45, Iss. 16, pp. 3665-3679.

Leopoulos, V., Voulgaridou, D., Bellos, E. & Kirytopoulos, K. (2010) Integrated management systems: moving from function to organisation/decision view. *The TQM Journal*, Vol. 22, Iss. 6, pp. 594-628.

Mackelprang, A. W. & Nair, A. (2010) Relationship between just-in-time manufacturing practices and performance: A meta-analytic investigation. *Journal of Operations Management,* Vol. 28, Iss. 4, pp. 283-302.

Mckone, K. E., Schroeder, R. G. & Cua, K. O. (2001) The impact of total productive maintenance practices on manufacturing performance. *Journal of Operations Management,* Vol. 19, Iss. 1, pp. 39-58.

Nair, A. (2006) Meta-analysis of the relationship between quality management practices and firm performance--implications for quality management theory development. *Journal of Operations Management*, Vol. 24, Iss. 6, pp. 948-975.
Netland, T. H. (2013) Exploring the phenomenon of company-specific production systems: One-best-way or own-best-way? *International Journal of Production Research*, Vol. 51, Iss. 4, pp. 1084-1097.
Netland, T. H. & Aspelund, A. (2013) Company-specific production systems and competitive advantage: A resource-based view on the Volvo Production System. *International Journal of Operations & Production Management*, Vol. 33, Iss. 12, pp. Forthcoming.
Neuhaus, R. (2009) Produktionssysteme in deutshen Unternehmen - Hintergründe, Nutzen und Kernelemente. *Fachzeitschrift Industrial Engineering*. REFA Bundesverband e.V.
Schonberger, R. J. (2007) Japanese production management: An evolution - With mixed success. *Journal of Operations Management*, Vol. 25, Iss. 2, pp. 403-419.
Shah, R. & Ward, P. T. (2003) Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, Vol. 21, Iss. 2, pp. 129-149.
Sousa, R. & Voss, C. A. (2002) Quality management re-visited: a reflective review and agenda for future research. *Journal of Operations Management*, Vol. 20, Iss. 1, pp. 91-109.
Sousa, R. & Voss, C. A. (2008) Contingency Research in Operations Management Practices. *Journal of Operations Management*, Vol. 26, Iss. 6, pp. 697-713.
Stake, R. E. (1994) Case Studies. In Denzin & Lincold (Eds.) *Handbook of qualitative research.* Thousand Oaks, Sage Publications.
Swink, M. & Jacobs, B. W. (2012) Six Sigma adoption: Operating performance impacts and contextual drivers of success. *Journal of Operations Management*, Vol. 30, Iss. 6, pp. 437-453.
Taguchi, G. (1986) *Introduction to Quality Engineering: Designing Quality into Products and Processes* Tokyo, The Organization.
Volvo Group (2009) *Annual Report 2008*, Gothenburg. http://goo.gl/OXI2y Accessed 3 March 2010
Volvo Group (2010a) *Annual Report 2009*. http://www3.volvo.com/investors/finrep/ar09/ar_2009_eng.pdf, Accessed 1-52010
Volvo Group (2010b) *VPS pages on Violin - the Volvo Group's Intranet*. http://violin.volvo.net, Accessed 3 March 2010
Voss, C. (2009) Case research in operations management. In Karlsson, C. (Ed.) *Researching Operations Management.* New York, Routledge.
Wickramasinghe, V. & Gamage, A. (2011) High-involvement work practices, quality results, and the role of HR function: An exploratory study of manufacturing firms in Sri Lanka. *The TQM Journal*, Vol. 23, Iss. 5, pp. 516 - 530.
Yin, R. K. (2003) *Case study research: design and methods*, Thousand Oaks, CA, Sage.

Notes

[i] International Organization for Standardization (ISO) is responsible for the ISO 9000 quality management standards, ISO 14000 environmental care management standards and other international standards (www.iso.org).
[ii] In this paper, we are concerned with the Order-to-Delivery processes (OtD). VPS OtD shall improve the manufacturing operations in all Volvo plants. Volvo has also developed similar, but separate, VPS models for the product development processes and for the business services processes.
[iii] Number of items vary slightly for different versions of the VPS assessment (version 2.0 had 99 items).
[iv] FTT is also known as first-pass-yield; first time quality; direct runners; direct OK: and direct green tag. The FTT score depends on the number of quality control gates in the process (the more gates, the harder to get a good score).