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The Role of Cultural Development When Improving Maintenance Practice in the Automotive Supply Chain

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Abstract

The automotive supply chain is an essential contributor to the UK economy. Production of commercial vehicles is expected to rise to an unprecedented 2.1 million in 2018. Contributing organisations are expected to be flexible, responsive and cost efficient which is a direct requirement of the Original Equipment Manufacturer (OEM) operating in a lean production context. To operate effectively within the supply chain relies on each department or function in the business working at maximum efficiency. At a granular level, the operation and deployment of the maintenance facility becomes crucial. Yet the strategy for maintenance deployment can often be influenced and even restricted, by managerial and cultural issues.

These issues are unique to this sector and a direct result of the constant demands of the OEM. They include an over reliance on buffer stock to mitigate the risk of maintenance failure, as well as a negative cultural influence on the business. Moreover, a complete absence of communication or technical support for maintenance across the supply chain, leading to isolated and immature practices. Consequently, suppliers are underperforming.

This paper reports on the challenges and contextual factors, which influence the maintenance strategy for automotive manufacturing suppliers. In addition, a solution will be offered to these damaging issues through the development of a maintenance strategy tool. The tool will look to address identified constraints through cultural development and the utilisation of a series of key performance indicators. These performance indicators will form a Maintenance Performance Measurement (MPM) system.

1. Introduction

The automotive industry in the UK is experiencing a period of growth and success. The subsequent contribution to the local, national and international economy is substantial and the importance of the industry as a whole, is increasing. The supply chain is an essential part of this process, with over 2000 registered automotive suppliers in the UK and approximately 78,000 people employed (1).

Lean production methods and Just in Time (JIT) delivery to the customer, ensure membership of the automotive supply chain is challenging. Furthermore, the success of these organisations depend on all internal departments functioning efficiently (2). Consequently, the importance of the maintenance function operating effectively becomes crucial to the success of the organisation. Recent empirical research by the author within the automotive supply chain identified ineffective maintenance practice and regressive working practices. Furthermore, contrary to lean principles, these companies were holding excessive safety stocks in order to mitigate poor maintenance performance (3). These were unexpected findings, given the automotive context. Furthermore, the results from follow-up interviews pointed to organisational culture as a possible factor affecting maintenance strategy within the case study organisations.

This paper presents findings from case study research carried out with automotive supply chain members in the North East of England. In addition, the role of organisational culture is explored including its effect on strategy across the case study sites.

The paper is comprised of a literature review in Section 2, empirical research findings in Section 3, a potential way forward in Section 4 and Section 5 concludes the paper.

2. Literature review

This section will begin with a review of literature on maintenance strategies. Subsequently performance measurement is discussed and the section will conclude with a reflection on organisational culture.

2.1 Maintenance strategy development

Maintenance is a fundamental component of an effective manufacturing business. Furthermore, the impact a maintenance function can provide towards the efficiency of a production department is substantial (4). The development or selection of any maintenance strategy must be done with a holistic, business wide perspective as recognised by (4–9). In addition to this perspective, (10) proposed a strategy development model which discussed the need to capture the human component of maintenance. This consisted of tacit knowledge, experience as well as motivation. Additionally, this is recognised by (11) and (12) as being a key consideration in effective strategy development and maintenance management. This is confirmed by (12), who discusses the importance of staff engagement, promoting the benefits to any maintenance strategy as well as to the organisation.

2.2 Automotive Industry specific strategies

Industry specific strategies are not unusual within maintenance management. Total Productive Maintenance (TPM) was formulated for use within the automotive industry in the late 20th century (11). TPM offers substantial department and organisational benefits (13), yet successful implementation requires a holistic approach, employee empowerment, education and training. Additionally, senior management engagement is crucial both financially and emotionally (2,5). (2) confirms that there is no simple recipe for its success, as any such programme cannot predict the skill profile or age range of the employed staff. The programme must be tailored to the needs of the site. Conclusively, the required financial investment for successful deployment can cause conflict with the business, where the specific measurement and financial efficiency of each business is at the very heart of automotive supply chain goals (14).

2.3 Maintenance Performance Measurement

Performance indicators are recognised as being a key component within any maintenance strategy, yet standard metrics will not provide the information that may be required by the senior management team. Several authors, including (15–17) recognise that the senior management team must be involved in the selection and refinement of any Performance Indicator (PI) system. Furthermore, a predefined set of indicators will not be satisfactory to an individual business. Additionally (18) recognised the importance of measurement of the human element within a maintenance department, in areas such as motivation and expertise. A review of EN15341 standards for maintenance performance measurement highlights the fact that there are few indicators for the human or indeed, cultural element.

2.4 Organisational Culture

2.4.1 What is culture?

Organisational culture is an intangible phenomenon and is difficult to quantify. (19) describes it as set of values beliefs and norms but clearly it is more than this. (20) yet discusses culture as being kinetic in its nature and constructed from personal interaction. It also encompasses leadership behaviours and everyday routines. Furthermore, (21) expanded on this by identifying levels of culture. These started with basic assumptions, rising to beliefs, values and attitudes and concluding with tangible artefacts. It is these artefacts, which are visible to any member of an organisation and examples are numerous. They include dress code, the manufactured product, meetings, posters, department layout and even the appraisal system. This exploration of cultural artefacts within a business reveal that even at a superficial level, recognisable items and tangible features are important and can have a positive or negative impact on the organisational culture of a department or business.

Summarising, organisational culture is formed over time and influenced by several factors. The influence of leaders within the organisation on the levels of culture including artefacts is not to be underestimated.

2.4.2 How does culture effect business performance?

The explicit characteristics that lead to a positive and successful organisational culture may be debated within literature, yet (22) highlights the importance of certain features linked to success. This includes the extent to which the culture of an organisation is homogenous. Where differing sub cultures between departments can emerge, and may be necessary, an increasing separation can lead to difficulties with cooperation and working practices. (19) discusses the necessity of an organisation allowing the organic growth of individual sub cultures, pointing to the organisational dangers of imposing a business wide culture. Crucially, (19) stresses the importance of departments with differing cultures, ensuring cooperation through inter-department integration and cooperation. A further feature is cultural strength or consistency, (21). (22) states this feature signposts the extent to which an organisational culture has an effect on the behaviour of its employees. (21) indicates some discernible features of an organisation with a strong culture. A summary of these include:

- Goal alignment. This reveals itself as not only agreement on the aims of the organisation, but also how they are going to achieve those aims.
- High employee motivation. This relies on the assumption that employees enjoy working for an organisation, which is distinctive and clear. As well as this assumption, an indicator can come from an engagement and rewards scheme.
- Experience. A strong culture is able to learn from previous organisational events. This may manifest itself in dealing with manufacturing, marketing or general business led issues.

Following this, (21) indicates these features, or enablers will translate into organisational benefits, whereby a negative culture may have an adverse effect. Tellingly, the strength or weakness of a culture can be directly affected by the turnover of the workforce. A static, loyal workforce can maintain an existent culture but a transient workforce with high staff turnover can dilute established cultural practices.

2.4.3 Changing the culture of an organisation.

Deploying a cultural change programme or maintenance strategy can be problematic and painful for an organisation (20–22), yet certain steps to achieve this process are noticeably common with maintenance strategy development. (20) identifies an eight-stage process to establish the required foundation to manage cultural change.

The change programme discussed by (20), has synergy between with the content of maintenance strategy development discussed earlier in Section 2. By deploying the key elements of a successful maintenance strategy can help change the working culture of a maintenance department. Table 1 identifies the common elements found in the processes of Maintenance strategy development and cultural change programmes.

Table 1: Commonality of content between maintenance strategies and cultural change enablers.

Characteristic	Maintenance strategy development	Cultural and change enablers
Senior management involvement	✓	✓
Clear objectives	✓	✓
Plan	✓	✓
Bespoke development	✓	✓
Communication	✓	✓
Involvement of the employee	✓	✓
Formal training	✓	✓
Feedback	✓	✓
Department Integration	✓	✓

2.5 Summary

The similarities between the content of maintenance strategy development and enablers in cultural change programmes demonstrate alignment between these two concepts. The robust development of a maintenance strategy appears to provide further additional benefits to the organisation, through the improvement in cultural strength of the department. The benefits to the organisation of an effective maintenance strategy are confirmed by (7,8,10), yet if the cultural enablers are also part of the maintenance strategy development process, then (21) confirms the organisation is more likely to become more successful. Furthermore, in addition to the key elements listed in Table 1, complimentary elements of maintenance strategy and cultural development may be considered where duality does not exist. These include a number of qualitative strategies such as training, skills development, staff turnover and a rewards and discipline scheme. Conclusively, although the quantitative nature of a maintenance strategy is essential for day-to-day operational management of a maintenance department, the inclusion of specific qualitative components which are identified as cultural enablers, may provide additional organisational benefits.

3. Empirical Research and Findings

The data collection for this paper was derived from doctoral research being carried out within the automotive supply chain. The data was primarily qualitative and derived from a range of Tier 1 suppliers. Analysis identified a number of key constraints which were problematic to the development and effectiveness of the maintenance function within the business. The findings are shown in Table 2.

Table 2: Constraints to maintenance effectiveness Adapted from (3)

Constraint profile	Cultural Enablers	Supplier 1	Supplier 2	Supplier 3	Supplier 4
Training	✓	✓	-	✓	-
Skills	✓	✓	-	✓	-
Staff Resources	✓	✓	-	✓	✓
Equipment and spares	-	✓	-	✓	-
Production Integration	✓	✓	✓	✓	-
Maintenance shift system	-	✓	-	✓	-
OEM	-	✓	✓	✓	✓
Supply chain partner	-	✓	✓	✓	✓
Parent Company	-	✓	✓	✓	-
Senior Management	✓	✓	✓	✓	-
Organisational Culture	✓	✓	-	✓	-
KPI's	✓	✓	-	✓	✓
Budget	-	✓	-	✓	-
Maintenance strategy deployed.		Reactive	Planned/ Preventative	Reactive	Proactive/ Planned/ Outsourced

Table 2 provides additional information to the constraint profile of each business. If a constraint is also a cultural enabler, this is indicated as it assists in demonstrating possible cultural impact. Finally, the incumbent maintenance strategy deployed within each supplier provides helpful context.

3.1 Key discussion points

3.1.1 Senior Management engagement and budget

Rich data from each supplier revealed varying levels of senior management engagement with maintenance development. The senior managers of Supplier 1 and Supplier 3 recognised the importance of maintenance to the business, yet were more passive in relation to the performance of the maintenance function. This included acceptance of poor performance measurement, overall strategy development and poor perception of maintenance within the

business. Supplier 2 and Supplier 4 agreed on the importance of maintenance to the organisation, but were more proactive in their involvement.

What is of interest is the possible link of senior management engagement and budgetary constraints to the maintenance function. Supplier 1 and Supplier 3 revealed that budgetary limitations were a large constraint towards any supplementary development of the maintenance department. Conversely, Supplier 4 and to a lesser extent Supplier 2 did not indicate any problem with the provided budget for the maintenance function. Interviews revealed the senior management team held the maintenance function in relatively high esteem, valuing its contribution to the business.

An unexpected issue which emerged from discussions, is the use of safety stock. Safety stock is deployed within each business as a buffer to accommodate any small production issues, whilst maintaining JIT or synchronous delivery requirements. Yet further discussions with Supplier 1 and 3 revealed safety stock was being used to mitigate the risk of the maintenance plan being ineffective. The level of safety stock within one site, had a stock value of over one million pounds, yet surprisingly the maintenance plan was reactive with a tightly constrained budget.

3.1.2 Department integration and Culture

Supplier 3 provided insight into the apparent disengagement with production, discussing the negative view the department had taken of the maintenance function. Maintenance was perceived to operate with irregular and disorganised working practices compared to the goal driven, systematic nature of production. This view was not unusual and offered with varying degrees from Suppliers 1, 2 and 3. Interestingly, research revealed Supplier 1 and 3 demonstrated distinct differences with production for several artefacts discussed by (20). These included department placement and management, methods of tracking performance and shift pattern. Supplier 4 offered a different perspective, indicating a more collective approach to production, with shared targets. The issue of culture was raised by Supplier 1 and 3 as being an issue, though not during senior management interviews. Further probing during interviews with other staff members revealed a perceived lack of respect, budget and working conditions afforded to the maintenance function.

3.2 Summary

It appeared that the extensive constraints listed for Supplier 1 and Supplier 3, could explain why a reactive maintenance plan was used in these companies. Additionally, the lack of department integration within these companies can be represented by the distinct differences in culture between the two departments. (19,22) both agree that an overly divergent department culture can cause problems to an organisation. Conversely, the more progressive approach used by Supplier 2 and Supplier 4, strengthened the literary claim of the importance of senior management engagement, supported by an appropriate budget, training and resources. Interestingly, Supplier 4 had few constraints. The extensive senior management engagement along with the close working between partner departments and the right resources, appeared to provide the foundation for a more developed maintenance plan. Furthermore, discussions revealed the business utilised several of the cultural enablers listed within Table 1 as part of its normal working practice. These included clear lines of communication, staff engagement, a rewards scheme as well as an extensive training programme. Conclusively, the overall organisation was financially successful, demonstrated by a significant increase in turnover over the previous four years.

The alignment between qualitative constraints identified from ‘rich data’ as well as the cultural enablers detailed within Table 1, offered a novel way forward. The departmental and organisational benefits of a strong pervasive culture, which was not entirely homogenous, could alleviate some of the identified constraints and improve the ability of the maintenance function to perform.

4. A way forward

Establishing relationships between cultural dimensions from this research within the context of maintenance and the automotive supply chain appears to be important. It provides a possible method of resolving long-standing

maintenance performance issues. Figure 1 shows these dimensions embedded within strategy tool resulting in a new qualitative and quantitative conceptual model.

Figure 1: A Maintenance strategy development tool for the Automotive supply chain

Constraint	Qualitative features	Quantitative features	
	Indicative characteristic (20,21,23)	KPI available (EN15341)	
Senior management engagement	<ul style="list-style-type: none"> Identify key project manager to facilitate development Establish reporting mechanism Establish aims and goals. Promote maintenance development to key staff and managers Maintain visible support for development Initiate maintenance planning cycle 		Cultural development
Skills and Training	<ul style="list-style-type: none"> Establish apprenticeship programme. Identify training requirements through appraisal system. 		
Staff resources	<ul style="list-style-type: none"> Employee engagement Suggestion and reward scheme Consultation and feedback mechanism Length of service and loyalty reward scheme 		
Production integration	<p>Establish symbiotic artefacts including:</p> <ul style="list-style-type: none"> Goals, targets, problem solving Communication of goals and achievement through emails, posters Meeting attendance with production facility. Embedded placement of maintenance technicians within production 		
Equipment and spares	<ul style="list-style-type: none"> Ensure robust resilience planning and critical spares analysis. 		
Budget	<ul style="list-style-type: none"> Identify key resources and justification for plan deployment Link budget requirements to business goals 		
Maintenance shift system	<ul style="list-style-type: none"> Assimilate with production shift pattern Integrate with maintenance plan and budget requirements 		
Buffer stock	<ul style="list-style-type: none"> Integrate monitoring process of buffer and align to maintenance performance 		
	Maintenance strategy development	Maintenance monitoring	

Figure 1 incorporates the issues noted within this research. It provides a conceptual model which can support the performance and advancement of the maintenance strategy within a particular business. Certain constraints such as ‘OEM’ and ‘parent company’ were omitted, as they were outside the sphere of influence. The model would not be used to develop a maintenance plan, but foster a method of guiding a business towards recognising how it may monitor, develop and enrich its own maintenance strategy.

Senior management engagement aside, each constraint has a quantitative and qualitative element which can be monitored and improved. Qualitative elements have been derived from the rich data and literature. The tool can be

used as follows. If the qualitative column is navigated vertically this suggests that the maintenance strategy can be improved through the development of the infrastructure of the maintenance department. Furthermore, vertical travel through the quantitative column will result in an improvement in monitoring of the strategy. Each area of interaction for an inhibitor requires, where possible, qualitative characteristics as well as quantitative monitoring to maximise the ability of the tool to be understood, then used effectively

The crucial nature of the ‘cultural element’ is often cited within maintenance strategy development (10,12,18). A reflection of literature has demonstrated that incorporating this within a strategy tool has proved elusive. Figure 1 demonstrates elements, which collectively, can lead to cultural strengthening within the business. The horizontal travel of key cultural aspects Senior Management, Skills and Training, Staff Resources and Production Integration will look to improve the cultural position of the department. As confirmed by (22) a shift in cultural strength as well as improving, the homogenous nature of both the maintenance and production departments will lead to organisational benefits. This may be confirmed by the performance of Supplier 4.

Due to the volume of indicators available, a colour code is utilised to indicate the extent of indicators which may be available with the EN15341 standards. The colour coding is simplistic in nature:

- Green indicating extensive indicators available to measure performance of that element
- Amber indicating limited metrics available. Moreover, amber is used to indicate the limited application of available indicators.
- Red provides an obvious demonstration that no indicators are suitable or available within the standard.

Finally, the model will include a PI to monitor buffer stock levels. This has been developed as part of this research and will provide an ongoing measure of maintenance improvement. It is anticipated this improvement will be welcomed in businesses where buffer stock is excessive.

5. Conclusions and Further Work

The findings of this research have demonstrated that continued underperformance of the maintenance department within the automotive supply chain might be linked to a lack of cultural development. The acknowledgement of key cultural enablers, such as senior management engagement, training, employee involvement and staff development have duality with recognised maintenance strategy elements. This duality imposes greater significance on these factors within maintenance development and further detailed investigation within this research is crucial. Additionally, acknowledging the contributing factors that will lead to department integration is important as it improves the ability of maintenance perform successfully. Conclusively, cultural development of a department and organisation appears to have a significant effect on the success of the business. The proposed conceptual tool acknowledges and incorporates these factors, providing aligned performance indicators with qualitative characteristics for each constraint. Further research is required to refine the model, thereby identifying and proposing a suitable selection of characteristics and indicators for use within the supply chain. These include addressing buffer stock levels as an indicator of maintenance performance.

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