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A framework for implementing cost and quality practices within manufacturing

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Abstract

Purpose – The techniques that help organisations implement leading edge cost and quality practices in manufacturing operations management are typically disparate and generic in nature. There is a need to identify integrated practices at the right level of granularity, based on a clear definition of the existing operations practices. This paper proposes a novel framework for achieving and maintaining good cost and quality operations management practice within a manufacturing environment.

Design/methodology/approach – The framework uses a new approach for identifying the profile of current activities and better practice activities for the roles of team leaders, cell leaders and operations managers within a manufacturing company.

Findings – The paper proposes a recommended set of context-specific activities for these roles. These recommended activities are utilised to develop a cascade of deployable recommendations.

Originality/value – The framework is illustrated within a manufacturing environment producing complex product ranges. The implementation of the framework enables improved operational efficiency and effectiveness. It also enables the benefits of improved operational standardisation and consistency.

Keywords Operations and production management, Manufacturing industries, Operating costs, Quality

Paper type Research paper

Introduction

Operations management is an enabler for all types of manufacturing organisation to meet their corporate goals; both for implementing corporate strategies and continuously sustaining and periodically refreshing the organisation's competitive advantage. Operations management, the direction and control of the processes that transform inputs into finished goods and services, is determined by the actions of people: managers, supervisors, operators, and the decision areas they individually and collectively address. The types of decisions in which operations management is concerned can be classified into: strategy, process, cost, quality, capacity, location and layout, operating decisions (Krajewski and Ritzman, 2002).

Cost and quality are influential factors of success in the product/service of many industries, particularly as customers increasingly expect higher quality at a reduced cost. This paper focuses on operations management in a manufacturing industry application; the term operations management will be used here in the context of the manufacturing industry definition.

The research reported here is concerned with realising better cost and quality operations management practice through an enhancement in the effectiveness of the roles of the supervisors and operations managers (OMs). The thesis is that cost and quality operations management effectiveness and efficiency is significantly

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determined by where management decisions are made and what management decisions are addressed at each organisational level. There are numerous, widespread, diverse and often fashionable initiatives that potentially help manufacturing organisations in implementing various best practices in operations management. Examples of these initiatives include total productive maintenance (TPM), total quality management (TQM), Kanban, 5S, six sigma, Kaizen and business process re-engineering (BPR). There are success stories that outline the achievements of companies through the implementation of these initiatives; there are many projects where these initiatives at least partially failed. The result is scepticism and confusion about what to adopt and how to adapt these disparate and generic initiatives in a specific environment. This challenge assumes greater significance as the capability of the operations management team moves up towards World Class level (Wheelwright and Hayes, 1985). The type of operations management environment to be realised after adopting one of the performance initiatives may be relatively well defined; the operating environment currently pertaining in a manufacturing company is usually not at all well defined. The gap between current practice and "best practice" for any individual initiative is fuzzy. In the context of a suite of initiatives the best practice gap is not at all clear. Hence, the risk of initiative failure is high and the unwillingness to adopt new initiatives is entirely reasonable.

There is a need to identify cost and quality manufacturing operations management best practices at the right level of granularity, and then implement these based on a clear understanding of the existing operations/structure in the company. A critical factor in the success of operations management projects is a fast but comprehensive analysis of the current practices/structure in the company. This can then be mapped to a comparative analysis of appropriate best practice companies and a quantified operations management gap identified.

This paper proposes a framework for achieving and maintaining better cost and quality operations management practice within a complex manufacturing environment. The new framework proposes a recommended set of activities for all the shop managers; team leaders (TLs), cell leaders (CLs), OMs, based on a thorough comparative analysis of the current company practices with better practices in other enterprises. The quantified best practice/current practice gap is then utilised to develop a cascade of deployable cost and quality actions for the company.

Specifically, the objectives of this paper are to:

- propose a framework for carrying out an appropriate granularity comparative analysis of the shop manager roles and the best practices, in order to develop a template of recommended cost and quality activities for each of these roles.
- develop a cascade of deployable recommendations/actions based on the proposed good practice scenario; and
- validate the framework using a case study within a complex high-performance manufacturing environment.

This section presents the problem statement, and the aim, objectives and structure of this paper. The next section establishes and presents the research gap that this paper is addressing. The proposed framework is then explained and illustrated using a real-life case study. Finally, the key advantages and limitations of this work, and the conclusions are discussed, respectively, in the last two sections.

Research gap

A brief description of the seven most popular best practice initiatives is identified by BenchmarkIndex (2002b) and augmented by the authors of this paper. A summary of these initiatives is presented in Table I.

These well-established initiatives are typically disparate and generic in nature. Implementation processes are initiative specific and stand alone. The importance of the joint implementation of these initiatives is demonstrated by Cua *et al.* (2001). There is a general assumption that the target organisation is currently at a low operations management performance level and implementation is therefore simple. The long timescales and significant sustained operations management team effort required to realise class leading performance level in any one initiative is overlooked.

Strategy implementation initiatives such as the Balanced Scorecard and Hoshin Kanri (detailed in Table II) do offer an interactive method of executing an actionable plan for the operation of the organisation. Though, both methods are, like many best practice initiatives, quite generic in their application. Hoshin Kanri can be used with TQM efforts (Witcher and Butterworth, 1999) though it is not designed to identify the correct best practice techniques for use within different parts of an organisation. Similarly the Balanced Scorecard, while valuable for communicating strategic organisational policy (Mooraj *et al.*, 1999), though is perhaps not as flexible as the framework detailed in this paper in the accommodation and coordination of other quality initiatives employed within an organisation. It is the recognition, selection, promotion and control of existing best practice initiatives that, in the opinion of the authors of this paper, sets the proposed framework apart from other best practice methods.

It is the opinion of the authors of this paper that the practice of operations management within a manufacturing environment requires a level of fine grain analysis that is not possible using just one of the above methods (from either Table I or Table II)

Initiative	Core idea
5S	Organisation and housekeeping (Hirano, 1996)
TPM	Continuous improvement of equipment and processes (Campbell, 1995)
TQM	Right first time (Oakland, 2003)
Six sigma	Systematic and continuous improvement (Pande and Holpp, 2001)
JIT (Kanban)	Remove inventory buffers that prevent learning (Ono and Ohno, 1988)
Kaizen	Cost reduction through the elimination of waste (Imai, 1986)
BPR	Reduction of complexity of workflow (Hammer and Champy, 2001; Sackett *et al.*, 2003; Nunes *et al.*, 2005)
Benchmarking	Search for best practice and identify operational and strategic gaps (Yasin, 2002)

Table I.
Best practice initiatives

Initiative	Core idea
Balanced scorecard	Links corporate measurement to strategy (Kaplan and Norton, 1996)
Hoshin Kanri	Strategic quality management (Akao, 1991)

Table II.
Strategy implementation initiatives

The implementation guidance for manufacturing organisations already deploying a suite of initiatives and operating at a competitive performance level is neglected. Baxter and Hirschhauser (2004) note that the tools and techniques used for cost and quality programmes can be implemented in a way that is superficial and trivial, and it is difficult to associate improving operations with them. In particular, there is a lack of decision support on who in the operations management team should do what in respect of any initiative. Tari and Sabater (2004) argue that cost and quality initiatives need to be across multiple levels of the organisation and involve as many employees as possible for maximum benefit to the organisation. The cost and quality operations management characteristics required to achieve each individual initiative are reasonably well defined in general terms; the need to clearly define the current state of manufacturing operation management in the target cost and quality environment is largely ignored. Hence, there is a need to identify integrated suite best practices at the right level of granularity, and support the implementation over time. Support needs to be based on a clear definition of the existing and developing operations management practices in the target organisation. There is a lack of methodologies in literature for proposing a recommended set of cost and quality activities for multiple levels of operations management.

This paper addresses the above research gap (Figure 1) by developing a framework for:

- exhaustively capturing the existing roles of the OMs (AS-IS);
- formulating leading cost and quality practices in a structure that enables direct comparison with AS-IS;

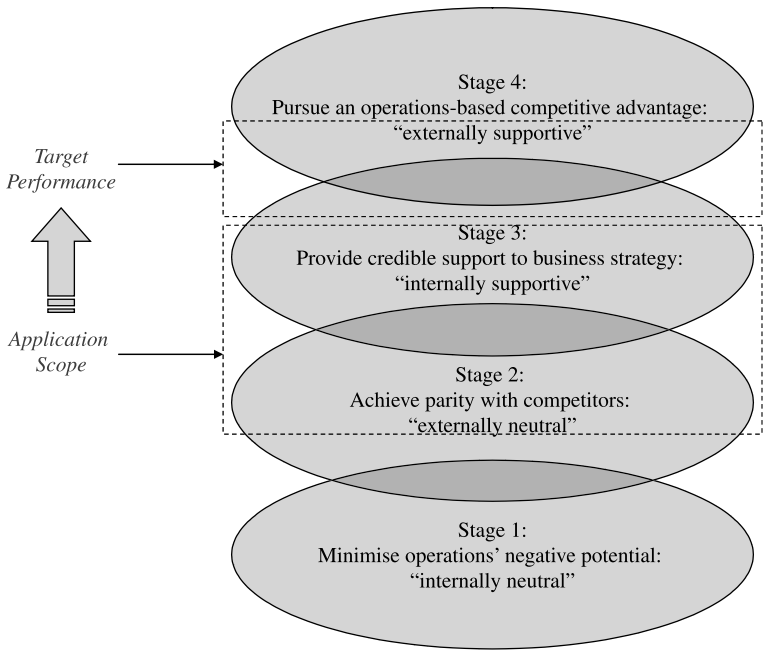


Figure 1.
Application scope of the cost and quality framework

Source: Adopted from Wheelwright and Hayes (1985)

- proposing a recommended set of activities for the supervisors and OMs (TO-BE) based on a detailed comparative analysis of AS-IS and best practices; and
- developing a cascade of deployable cost and quality recommendations based on the proposed TO-BE.

Methodology

Our methodology provides an updateable framework for achieving and maintaining better cost and quality operations management practice for an evolving manufacturing organisation. The output will be a recommended set of activities for the supervisors and OMs and a cascade of deployable recommendations that collectively narrow the gap between the existing and better practices, shown in Figure 2.

AS-IS capture

The existing roles of the supervisors and OMs (AS-IS) within a typical manufacturing environment are captured using the matrix shown in Figure 3.

This matrix captures the activities carried out by the three typical operations management roles within a manufacturing environment: TL, CL and OM. TLs and CLs are supervisory roles, with TLs reporting to CLs. CLs in turn report to the OMs. Activities for each of the three roles are captured under the following headings: safety (S), quality (Q), delivery (D), cost (C), communication (Comm.), and others (O). These categories are selected due to their popularity in both industry and academia as operations management focus areas. Within each of the boxes in the matrix, the activities are classified as maintain/running and improvement activities. An example of this is shown in Figure 3 for the delivery activities of the OM.

Best practice capture

The best practice activities are captured based on the seven initiatives discussed in Table I. Figure 4 shows the matrix used for capturing best practice activities. As can be

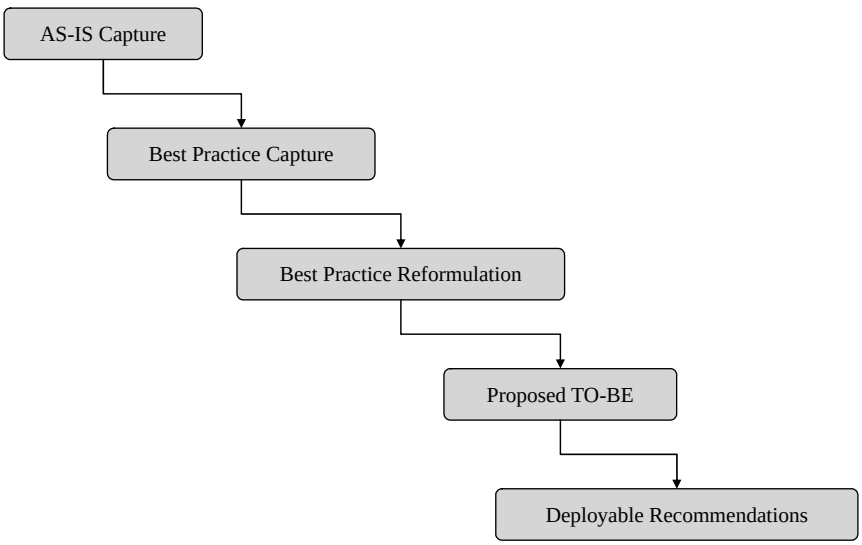


Figure 2.
Framework

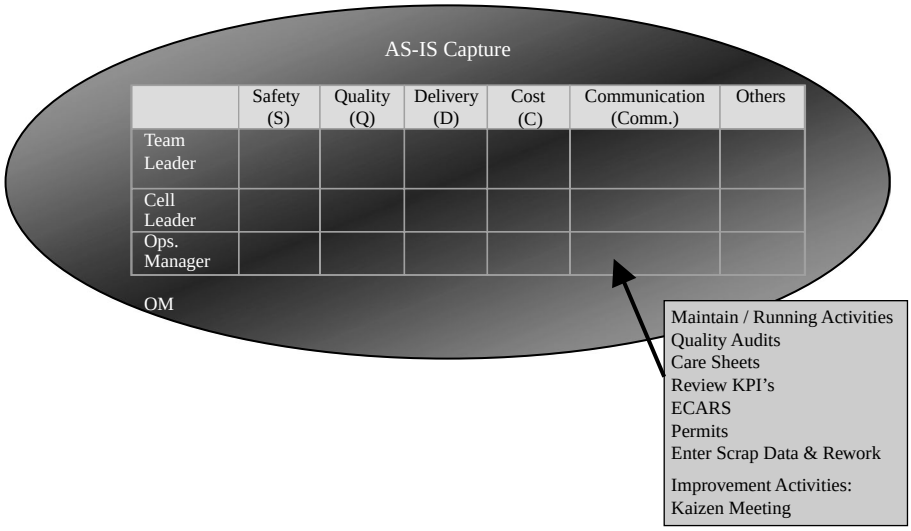


Figure 3.
AS-IS capture

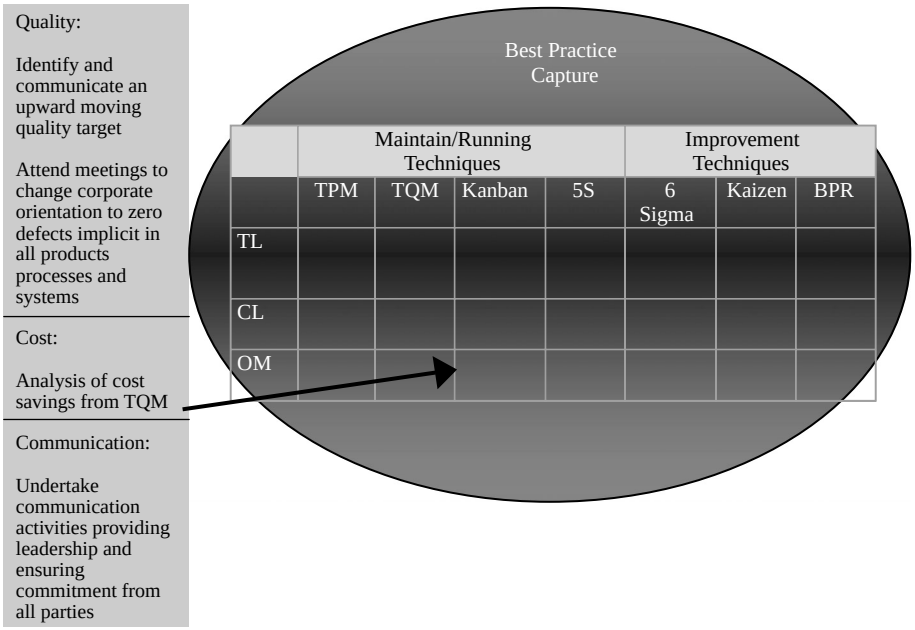


Figure 4.
Best practice capture

seen from this matrix, the initiatives (and hence the roles) are classified as maintain/running and improvement. Similar to the AS-IS capture, the three roles included are TL, CL and OM. As shown in Figure 4, within each of the boxes in the matrix, the activities are classified as safety (S), quality (Q), delivery (D), cost (C), communication (Comm.), and others (O). An example of this is shown for the Kanban activities related to the OM.

Best practice reformulation

Direct comparison of AS-IS and best practice matrices is not possible due to their different structures. Hence, activities within the best practice matrix are now re-arranged to obtain a matrix that has similar structure to the AS-IS matrix. This transformation is shown in Figure 5. The new best practice matrix can now be directly compared to the AS-IS matrix of Figure 3.

Proposed TO-BE

A recommended set of activities is proposed for the TL, CL and OM (TO-BE) based on a comparative analysis of the AS-IS matrix and the best practice matrix. This comparative analysis is shown in Figure 6. The resulting TO-BE matrix is shown in Figure 7. Each block of this matrix (such as the quality activities of the TL) is filled by directly comparing the corresponding activities in the AS-IS and best practice matrices. The resulting TO-BE activities are an integration of the corresponding AS-IS and best practice activities, with each activity being classified into one of the following categories:

(1) Current activities of the company that should be emphasised to enhance performance.

(2) Best practice activities that the company should initiate to enhance performance. These could be either new activities (2a) or those activities that are currently performed at another level (2b).

(3) Current activities that the company should continue doing.

(4) Current activities of the company that will gradually diminish in response to the overall enhancements in performance induced by (1) to (3).

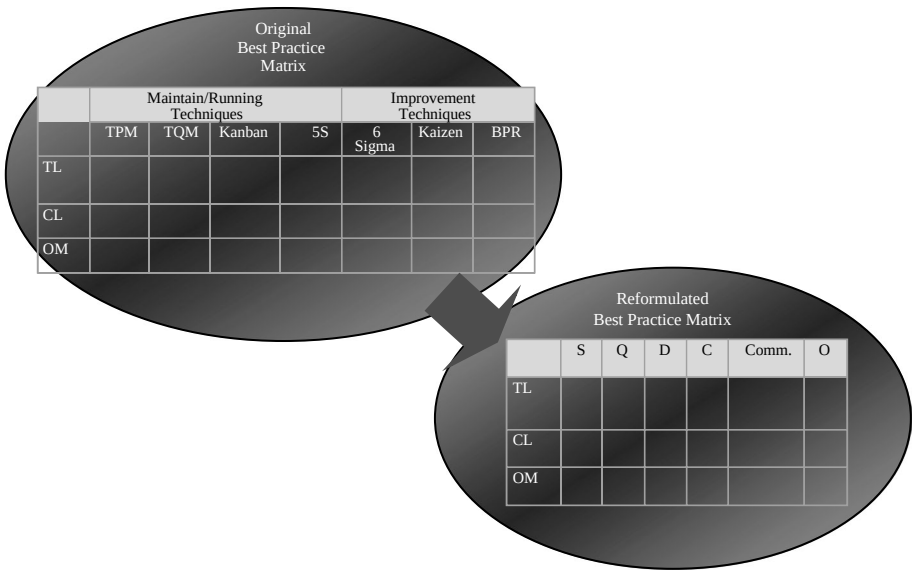


Figure 5.
Best practice reformulation

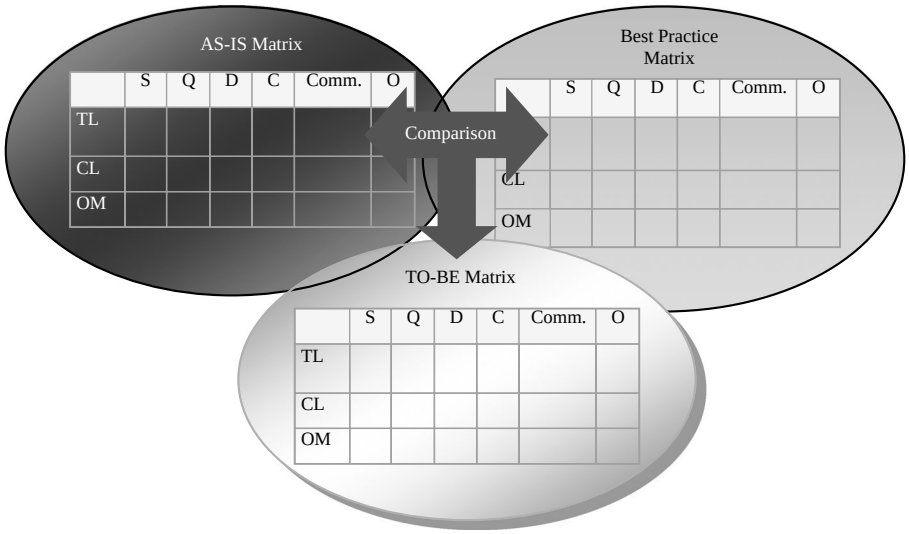
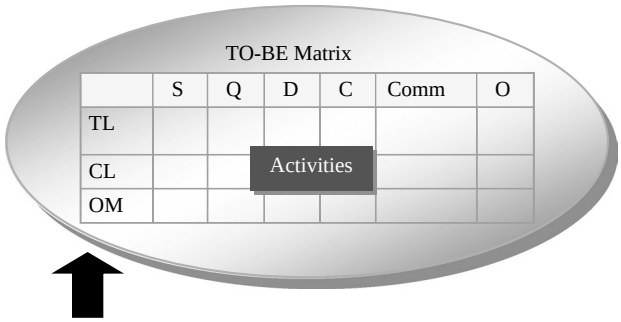


Figure 6.
AS-IS/best practice comparative analysis



Key for Activity Classification			
1 - Current activities of the company that should be emphasised to enhance performance	2 - Best practice activities that the company should initiate to enhance performance. These could be either completely new activities (2a) or those activities that are currently performed at another level (2b)	3 - Current activities that the company should continue doing	4 - Current activities of the company that will gradually diminish in response to the overall enhancements in performance induced by 1,2 and 3

Figure 7.
Proposed TO-BE

Deployable recommendations

A two-stage cascade approach to deriving deployable recommendations from the proposed TO-BE is adopted. The first stage cascade, starting with the overall project aim, and using a comparison of key performance indicators, identifies high-level objectives within broad areas of operations, such as safety, quality, delivery, cost, communication and others. This cascade illustrates the approach of best practice

performance comparison of high-level operational key performance indicators running in parallel with the organisational performance indicators and objectives. The second stage cascade uses the high-level objectives identified as a result of the previous cascade to identify activity recommendations for each role based upon the TO-BE developed in the previous stage of the framework. Key recommendations are derived from detailed level activity recommendations for each role, and they also include the recommendations for ensuring that the current organisational structure supports the achievement of operational objectives. Figure 8 is an overview of the various steps to reach the stage of offering recommendations.

Case study

The case study focuses on the cost and quality activities within a high-performance complex manufacturing environment. The Company is a leading supplier to the world's most advanced industries, specialising in solutions for gases, services and equipment to the semiconductor industry, and vacuum products for a variety of industries. The case study addresses the product ranges that are manufactured and assembled, primarily, in the UK. Four UK manufacturing sites and cell-centric units were within this scope. The case study included the OM, CL and TL organisational levels within the company.

This case study validates the proposed framework by:

- carrying out a thorough comparative analysis of the activities of the company OMs, CLs and TLs with the better practices;
- proposing a recommended set of activities for the company OMs, CLs and TLs based on the results of the above comparative analysis; and
- developing a cascade of deployable recommendations for the company.

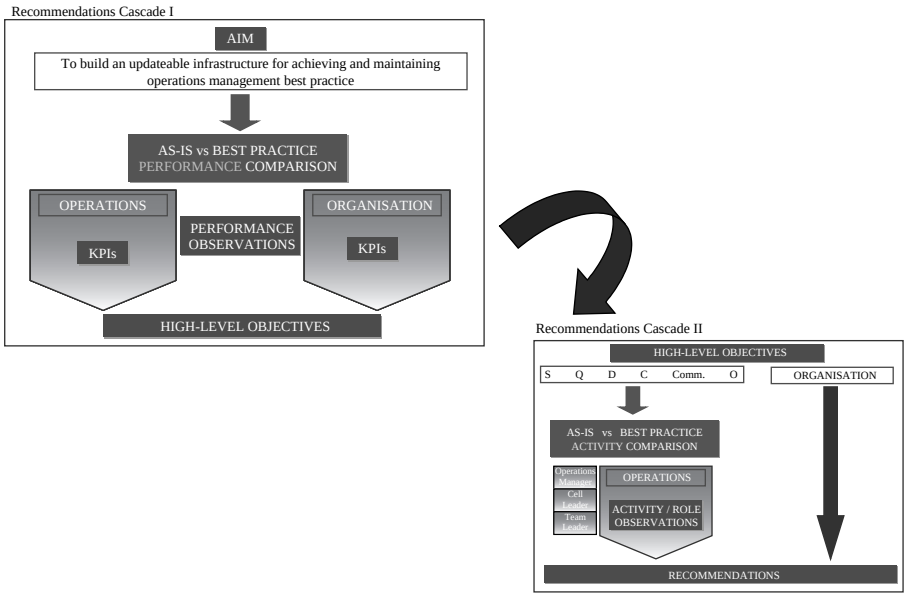


Figure 8.
Approach to develop recommendations to narrow the gap between current and best practices

AS-IS capture

The data collection for the AS-IS capture populated the AS-IS matrix of Figure 3 by establishing the activities of the following hierarchical roles: OM, CL and TL. Table III provides an overview of data collection that was carried out to establish the AS-IS. Four sites were visited. Each visit was for one week, with the exception of one site, where data collection took two weeks due to the size of the factory.

The following methods were used for data collection:

- *Interviews.* The primary approach taken to elicit the information was an open-ended, semi-structured questionnaire about tasks and activities (Pierron *et al.*, 2004), which was completed by the interviewer group during its interviews with the individuals. The questionnaire captured four main information elements. It identified the tasks/activities carried out by the interviewer in his/her job. Priority was assigned by the individuals to each of their activities, on a scale of 1-3 (1 = primary job role and cannot be delegated, 2 = primary job role but can be delegated, 3 = outside the job role, administrative). Then, the duration and frequency of carrying out the tasks were captured. The timeframe for these tasks and activities was daily, weekly, monthly, quarterly or within other frequencies if deemed appropriate. Although there was, of course, day-to-day

Sites	Duration of data collection	Interviews	Workshop participants
Site 1 (pump manufacturing)	Two weeks	OM Four CLs One cell manager 20 TLs General manager (operations development) Senior manufacturing engineer Operators	Two CLs One cell manager Five TLs
Site 2 (pump manufacturing)	One week	OM Three CLs Seven TLs Senior manufacturing engineer Operators	OM Three CLs Seven TLs
Site 3 (pump re-manufacturing)	One week	OM Cell manager Four TLs Receiving and dispatch manager Order processing manager Engineering manager	OM Cell manager Four TLs Receiving and dispatch manager Engineering manager
Site 4 (semiconductors)	One week	OM Three cell managers One CL One TL Two supervisors Two cell support engineers Engineer manager	OM Three cell managers One CL One TL Two supervisors

Table III.
Overview of data collection for AS-IS capture

variation, the average task durations over the relevant timeframe were captured. Finally, the purpose and benefits of completing the activities were captured.

Each interviewer group consisted of one primary interviewer and the remaining two group members acted as note takers and observers to ensure unbiased consistency and reliability of the findings. The average duration of an interview was one hour. The fundamental advantage of the semi-structured interview was the uniformity of data capture. This ensured visibility and transparency enabling comparative analysis between the sites, as well as allowing the interviewee freedom to explore areas via conversation.

- *Diaries.* To enable the interviewer to ask more focused questions about specific tasks and also to obtain an overview of the frequency of each activity, some of the workforce provided diaries and notebooks ranging from weekly to yearly records. This proved an effective methodology for data triangulation, hence ensuring consistency in those activities being reported and potentially identifying gaps in recalling information (Robson, 2002).
- *Walkabouts and work shadowing.* To provide context to the interviews, walkabouts were undertaken in the cells. Work shadowing was conducted to confirm the reported timescales of activities, and to reveal any activities that the interviewee might have not reported. However, work shadowing arguably creates "observer-effects" which alter the behaviour of the subjects. Hence, it was not chosen as the primary method of data collection, nor did time permit for comprehensive work shadowing of every role (McDonald, 2005).
- *Workshops.* Workshops were conducted as a "round-up" after all other methods of data collection were completed and findings consolidated (Lettice *et al.*, 1995). The workshops were to validate the collected data by encouraging discussion with respect to ambiguous, missing or misleading data. For instance, every activity was displayed for each job role, divided into safety, quality, delivery, cost, communication and other categories. The sessions also clarified responsibilities and perceptions of what other job roles entail. Some workshops were conducted with only one hierarchical level present at one time. However, predominantly they consisted of all interviewees present in one session to get more interactions among the organisational levels and the interviewer group. Figure 9 is an example of a typical template used during the workshops. The centre visually represented the four waves of safety, quality, delivery and cost (including communication and other) initiatives. On the top of these waves were represented the tasks necessary for ensuring that the business continues to run. These activities cannot be assigned to a specific initiative, such as safety, quality, cost or delivery for they are more general in nature. The four corners of this template captured problems and uncertainties (top left), strengths (top right), weaknesses (bottom right) and opportunities (bottom left). Prior to the commencement of the workshops, the tasks related to the various roles in the scope, i.e. TL, CL and OM were identified from the interview questionnaires and written down on three different coloured "Post-its." These "Post-its" were then placed at appropriate places on the workshop template. This formed the structure of the workshop. During the workshop, the participants were

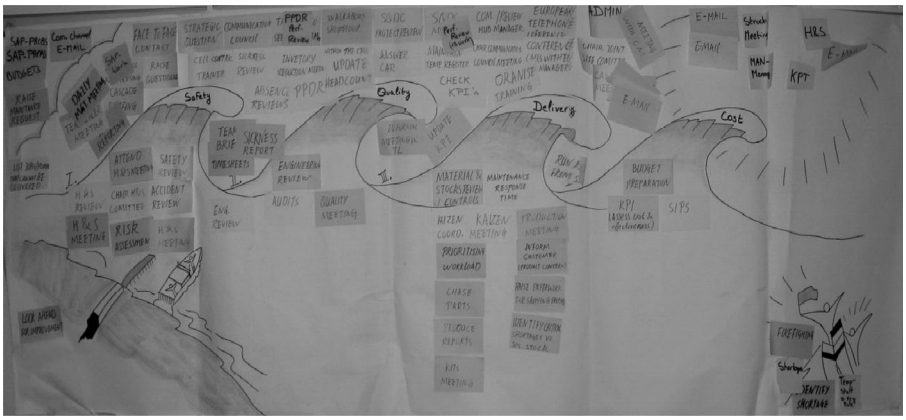


Figure 9.
Workshop template

encouraged to comment on the tasks represented on the template, related to their own role or the role of others, particularly when the tasks required the action of different hierarchical levels such as TL and CL.

Following the data collection, the raw data was structured and analysed according to a template. The template classified the type of activities for each role in the six broad areas mentioned earlier: safety, quality, cost, delivery, communication (for describing the two way dialog) and others (to allocate tasks that belong to more than one of the former categories or for activities that cannot be assigned to any of them). In addition, the following details were added for each task: priority of tasks perceived by the individual, duration of the tasks, frequency of tasks, purpose and benefit of completing the activities. This phase of data structuring involved the compilation and assimilation of both quantitative and qualitative data collected using multiple methods of data gathering (such as interviews, walkabouts and work shadowing, diaries and workshops). This enabled validating the data through triangulation (Robson, 2002).

As shown in Table IV, the activities of different roles were analysed on different time scales. A TL is typically most focused on daily activities in order to maintain the output and solve the day-to-day issues of his/her cell. In contrast, the CL is more focused on the broader management of the cell, which requires more time flexibility and therefore cannot be broken down on a daily basis. Finally, the OM acts on a still higher level (in essence strategic) which is best dealt with on a monthly basis.

Finally, the data for each role type from various sites was merged to produce an anonymous and overall perspective. The data collected was combined in order to model a holistic solution. Robustness was aided because of the generic structure

Table IV.
Time scales for activity analysis

Organisational level	*Time scale*
Team leader	Daily
Cell leader	*Weekly*
Operations manager	Monthly

through which the data was collected, together with the rigorous validation process. The operating culture and mechanisms at each site were unique; hence the terminology often varied even though there was task commonality. These variations were overcome by understanding what each task involved via interviews and workshops and assigning the common activities under uniform headings. Those tasks that were not common to all sites were separately preserved with their site names for maintaining the right level of granularity.

Based on the results of the above analysis, the AS-IS matrix was populated. The resulting matrix illustrated the safety, quality, delivery, cost, communication and other activities carried out by a typical TL, CL and OM. Each of the boxes of the matrix (such as the quality activities of the TL) were further sub-divided into maintain/running and improvement activities. The key observations from this AS-IS matrix were as follows:

- The OM is responsible for strategic planning of operations management to ensure effective use of all resources within the site. He/she is responsible for achieving satisfactory quality, total cost reduction, budget constraint and continuous improvement, to meet the commercial objectives. This job includes providing opportunities for the advancement of personnel.
- The CL is in charge of his/her cell with respect to daily operations management, planning, controlling of demand and production requirements. He/she oversees the components and products of the correct quality from the cell to the customer, with an eye to continuous improvement in new product introduction, engineering processes and procedure. He/she maintains regular communication with all employees working in the cell and creates a positive cell culture.
- The TL is responsible for daily manufacturing activities to achieve quality commitments and delivery on time to customer and also team safety in an effective productive manner. A TL makes first line decisions, working in the more fixed framework established by CLs. TLs are expected to possess better inter operative skills.

Best practice capture

This stage develops the best practice matrix by identifying operations management better practice from industry and literature review. The following approach was adopted in this phase.

Data was obtained from two benchmark index studies conducted in year 2002 by Cranfield University (UK) in collaboration with the Department of Trade and Industry (DTI), UK; "Manufacturing – A Sector Study" (BenchmarkIndex (2002a) and "Quality Cost and Delivery – A Sector Study" (BenchmarkIndex, 2002b). Using these studies, small and large companies whose performance was consistently within the upper quartile on safety, quality, delivery and cost were investigated. In addition, large companies whose performance was in the upper quartile of some of safety, quality, delivery or cost were also investigated. The information obtained from these studies was complemented with an intensive review of literature to populate the best practice matrix, Appendix 1.

The resulting best practice matrix, Appendix 1, was validated through visits to three companies whose performance was consistently in the upper quartile of safety, quality, delivery and cost.

In this way, a rigorous approach was adopted to ensure that the resulting best practice matrix captures relevant activities at the right level of granularity. The use of multiple sources of information ensured the robustness and validation of results through triangulation.

Best practice reformulation

The reformulation strategy shown in Figure 5 was applied to re-structure the best practice matrix. The resulting/re-formulated best practice matrix, Appendix 2, could now be directly compared to the AS-IS matrix, shown in Appendix 3.

Proposed TO-BE

As shown in Figure 6, the AS-IS matrix (shown in Appendix 3) was compared with the best practice matrix, (shown in Appendix 1), to propose the TO-BE matrix. The strategy shown in Figure 7 for the development of the TO-BE matrix was adopted in the case study.

Figures 10 and 11, respectively, show the classification of key quality and cost activities for the three operations management roles.

Activity Comparison - Quality

Team Leader	Cell Leader	Operations Manager
Maintenance/Running activities	Maintenance/Running activities	Maintenance/Running activities
Quality audits - 3	MQR – Monthly Quality Review meeting - 3	MQR – Monthly Quality Review meeting – 3
Care sheets - 3	ISO 14001 meeting - 3	Review KPIs – 3
Review KPI's - 3	Review/update major KPI's - 3	Review overall strategy/Figures – 3
ECARS – 4	Certify and train suppliers or replace suppliers – 2a	Attend meetings to change corporate orientation to zero defects implicit in all products, processes and systems – 2a
Permits - 4	Improvement Activities	Improvement Activities
Enter scrap data and rework - 4	Cell improvement initiatives - 1	Kaizen meeting - 4
SPR – product review meeting - 3 + 2b (removed from OM)	Kaizen meeting - 1	Quality improvement initiatives – 1
TPR – Technical Product Review meeting – 3 + 2b (removed from OM)	Oversee and champion the six sigma process – 2a	Attend Kaizen event close-out – 2a
Update manufacturing /assembly instructions to include key quality measures – 2a		
Attend product / process meetings at the specification stage – 2a		
Improvement activities:		
Kaizen meeting - 1		
Create ongoing awareness of the need for quality measurement – 2a		
Enhance instructions to improve the quality of manufacturing /assembly – 2a		
Identify and communicate product quality variance to product engineers – 2a		

Activities KEY: 2a – Completely new 3 - Continue

1- Enhance 2b – Another level 4 - Diminish

Figure 10.
TO-BE matrix – classification of key quality activities

Activity Comparison - Cost

Team Leader	Cell Leader	Operations Manager
	Improvement activities	Maintenance/Running activities
	Attend cost improvement training – 2a	Authorise expenditure - 3
		Budget preparation and review - 3
		Manage manufacturing expenditure - 3
		Analyses cost savings from TQM – 2a
		Improvement activities
		Cost reduction initiatives - 1
		Initiate BPR cost reduction initiatives – 2a
		Arrange cost training for cell leaders – 2a

Activities KEY: 2a – Completely new 3 - Continue

1- Enhance 2b – Another level 4 - Diminish

Figure 11.
TO-BE matrix – classification of key cost activities

Deployable recommendations

The framework was applied to develop a set of deployable recommendations based on the proposed TO-BE. The focus of recommendations was on cost and quality. As suggested by recommendations cascade I (Figure 8), the key performance indicators of the company were compared with the best practice in the above mentioned areas. Based on this comparison, a set of high-level objectives were constructed to narrow its gap with the best practice. These high-level objectives were derived in a workshop with the OMs. These objectives are listed below:

- *Delivery.* Improve delivery performance to that of best practice companies.
- *Quality.* Create an environment of zero defects implicit in all products, processes and systems.
- *Safety.* Enhance the environment for causing zero accidents.
- *Organisational structure.* To ensure that the current organisational structure supports the achievement of operations objectives.

Recommendations cascade II (Figure 8) used the high-level objectives identified above to develop activity recommendations for each role based upon the TO-BE developed in the previous stage. The activity recommendations for the roles of OM, CL and TL as regards quality and cost are summarised below:

(1) Operations manager – quality:
   - promote a zero defect plan via a six sigma initiative;
   - review key performance indicators; and
   - provide authority to quality initiatives (e.g. attend kaizen close-out events).

(2) Operations manager – cost:
   - authorise expenditure;
   - prepare and review budgets;
   - manage manufacturing expenditure;

- analyse cost savings from TQM;
- identify cost reduction initiatives;
- initiate BPR cost reduction initiatives; and
- arrange cost training for CLs.

(3) Cell leader – quality:
- champion and oversee production quality improvement initiatives within the cell;
- organise regular six sigma meetings; and
- identify and arrange six sigma training for TLs.

(4) Cell leader – cost:
- attend cost improvement training; and
- participate in cost improvement.

(5) Team leader – quality:
- integrate quality into the manufacturing/assembly process; and
- lead regular kaizen blitz's.

(6) Team leader – cost:
- should not be directly involved in cost-related activities.

Based on the high-level objectives and the detailed level activity recommendations given above, key recommendations were developed for both operations and supporting organisational structure:

- *Key Recommendation I.* Ensure that the involvement of OMs in short-term production issues is a rare exception.
- *Key Recommendation II.* Raise the capability of cells to adopt six sigma as a way of life.
- *Key Recommendation III.* Empower the CL for total responsibility of health and safety within the cell.
- *Key Recommendation IV.* Further, investigate whether the current organisational structure supports the achievement of operational objectives.

Discussion

The above case study illustrates that the main advantages of the framework are:

- *AS-IS capture.* The framework develops an AS-IS matrix that provides a definition of the existing practices/structure in the company in the context of operations management and at the right level of granularity.
- *Best practice capture and re-formulation.* The framework re-formulates the generic best practice initiatives in such a way that the activities are captured at the right level of granularity. The resulting best practice matrix can be directly compared with the operations management AS-IS of manufacturing company.

- *Operational effectiveness through best practice adoption.* The framework presents a novel approach for developing a deployable TO-BE matrix based on the comparison of AS-IS with best practice. This promotes best practice adoption.
- *Operational standardisation and consistency.* The framework develops detailed activity recommendations for the roles of the supervisors and OMs in a manufacturing firm.
- *Operational efficiency.* The implementation of proposed standardised processes will enable better resource utilisation.
- *Flexibility.* The project will provide an updateable infrastructure for achieving and maintaining better operations management practice.

The main limitations are as follows:

- The framework does not deal with re-designing cells, teams or operations; organisational level hierarchies were assumed to be fixed.
- Behavioural studies are outside the scope of the framework.
- The framework does not recommend a fixed timetable of activities for OMs, CLs or TLs.
- There are many interacting and complex factors that achieve what can be considered as best practice (Sackett *et al.*, 2005a, b). The framework has been drawn as a "stepping stone" for manufacturing environment given its current management of operations. It is not a comprehensive consideration of all the factors contributing to best practice. For instance, there are fundamental aspects such as corporate culture, management styles and technological issues which have not been dealt with within the scope of this paper. However, the framework provides useable solutions that a manufacturing firm already operating at good operations management performance may consider implementing to further enhance its business.

Conclusions

Realisation of better cost and quality operations management practice through an enhancement in the effectiveness of the roles of the supervisors and OMs is an enabler for a manufacturing organisation to meet its corporate goals. There are numerous, widespread, diverse and often fashionable initiatives that potentially help manufacturing organisations in implementing various best practices in operations management. However, the guidance for manufacturing organisations already deploying a suite of initiatives and operating at a competitive performance level is neglected. Initiative implementation support for these organisations needs to be updateable, based on a clear definition of the existing and evolving operations management practices in the target organisation. The novel framework proposed in this paper has been developed as a response to these requirements.

This paper has proposed a framework for achieving and maintaining cost and quality operations management good practice within a manufacturing environment. The authors use a new approach for identifying the profile of current activities and integrated best practice activities for the roles of TLs, CLs and OMs within a manufacturing company. Based on a thorough comparative analysis of the current company practices with the best practices, the authors provide a recommended set of

activities for the TLs, CLs and OMs. These recommended activities are then utilised to develop a cascade of deployable recommendations. This paper has validated the framework within a high-performance complex manufacturing environment.

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Appendix 1

Table AI.
Best practice matrix

Type of activities involved	Techniques: Maintenance/running activities – TPM	TQM	JIT/Kanban	5S	Six sigma	Improvement activities – Kaizen	BPR
Team leader	*Delivery*	*Quality*	*Delivery*	*Safety*	*Quality*	*Quality*	*Other*
	Schedule planned shutdowns for improvements	Update manufacturing/assembly instructions to include key quality measures	Do preparatory checks prior to Kanban implementation	Design timetable to standardise 5S	Create ongoing awareness of the need for quality measurement	Conduct event to concentrate cell team for 3-10 day period on a production process or cell	Attend "re-designed process" training
	Schedule daily maintenance activities	Attend product/process meetings at the specification stage	Identify products and parts with stable month-to-month delivery needs	Maintain timetable to standardise 5S	Enhance instructions to improve the quality of manufacturing/assembly		Arrange "r-designed process" training for operators
	Communication	Identify education and training for quality	Designate empty Kanban area for supplier pick-up	Lead 5S activities	Identify and communicate product quality variance to product engineers		
	Undertake weekly meetings with operators	*Cost*		Attend safety meetings	*Delivery*		
	Other	Measure scrap rate			Measure, identify root cause and report delivery variance		
	Undertakes daily walk-throughs	*Other*					
	Do roadblock busting tasks on the floor	Ensure continuous functioning via walk-throughs					
	Identifies training and development						

(continued)

Table AI.

Type of activities involved	Techniques						
	Maintenance/running activities					Improvement activities	
	TPM	TQM	JIT/Kanban	5S	Six sigma	Kaizen	BPR
Cell leader	*Delivery* Undertake TPM championing	*Quality* Arrange education and training for quality	*Quality* Certify and train suppliers or replace suppliers	*Safety* Walk-throughs to ensure 5S is a way of life	*Quality* Oversee and champion the six sigma process	*Quality* Arrange event to concentrate cell team for 3-10 day period on a production process or cell	*Delivery* Analyse delivery processes
	Cost	*Cost*	*Delivery*	Organise regular meetings to ensure 5S is a way of life		Produce schedule to ensure rapid implementation of improvements	Attend meetings to improve the manufacturing delivery process
	Measures cost savings using TPM	Analyses trends in scrap rates	Plan and aid suppliers with setup reduction initiatives	*Cost*			*Cost*
	Analyse the operational efficiency of the cell	Other		Gather data of lost time due to accidents			Attend cost improvement training
	Communication	Create continuous motivation via walk-throughs					Communication
	Focus maintenance department to train operators for preventive maintenance tasks						Attend regular meetings for BPR initiative
	Undertakes monthly meetings with TL						Other
							Set-up training for TLs

(*continued*)

Table AI.

Type of activities involved	Techniques						
	Maintenance/running activities				Improvement activities		
	TPM	TQM	JIT/Kanban	5S	Six sigma	Kaizen	BPR
	Other						Perform periodically staff, (TL), qualifications reviews
	Undertakes daily walk-throughs Arranges training and development for equipment maintenance						
Operations manager		*Quality*	*Cost*	*Cost*	*Quality*	*Quality*	*Quality*
		Identify and communicate an upward moving quality target	Reviews cost versus delivery performance (with respect to inventory levels)	Analyse lost time due to accidents	Identify which processes have the highest priority for improvement	Issue statement for shop floor improvements	Attend meetings to redefine the product quality process
		Attend meetings to change corporate orientation to zero defects implicit in all products, processes and systems		*Other*		Attend Kaizen event close-out	*Delivery*
		Cost		Provide top level support for 5S technique			Attend meetings for delivery improvement initiative
		Analyses cost savings from TQM					*Cost*
		Communication					Initiate BPR cost reduction initiatives

(*continued*)

Table AI.

Type of activities involved	Techniques						
	Maintenance/running activities				Improvement activities		
	TPM	TQM	JIT/Kanban	5S	Six sigma	Kaizen	BPR
		Undertake communication activities, providing leadership and ensuring commitment from all parties					Arrange cost training for CLs
							Communication Undertake road-block busting of status quo thinking by questioning why processes are performed in a certain way Lead regular meetings for BPR initiative *Other* Set-up training for CLs Provide high-level guidance for removing barriers Perform periodically staff, (CL), qualifications reviews

Appendix 2

Table AII.
Re-arranged best practice matrix

	Activity areas Safety	Quality	Delivery	Cost	Communication	Other
Team leader	*Running*					
	Design timetable to standardise 5S	Update manufacturing/assembly instructions to include key quality measures	Schedule planned shutdowns for improvements	Measure scrap rate	Undertakes weekly meetings with operators	Undertakes daily walk-throughs
	Maintain timetable to standardise 5S	Attend product/process meetings at the specification stage	Schedule daily maintenance activities			Do roadblock busting tasks on the floor
	Lead 5S activities	Identify education and training for quality	Do preparatory checks prior to kanban implementation			Identifies training and development
	Attend safety meetings	*Improvement*	Identify products and parts with stable month-to-month delivery needs			Ensure continuous functioning via walk-throughs
		Create ongoing awareness of the need for quality measurement	Designate empty Kanban area for supplier pick-up			*Improvement*
		Enhance instructions to improve the quality of manufacturing/assembly	Measure, identify root cause and report delivery variance			Attend "re-designed process" training
		Identify and communicate product quality variance to product engineers				Arrange "re-designed process" training for operators
		Conduct event to concentrate cell team for 3-10 day period on a production process or cell				

(continued)

Table AII.

	Activity areas					
	Safety	Quality	Delivery	Cost	Communication	Other
Cell leader	*Running*					
	Walk-throughs to ensure 5S is a way of life	Arrange education and training for quality	Undertake TPM championing	Measures cost savings using TPM	Focus maintenance department to train operators for preventive maintenance tasks	Undertakes daily walk-throughs
	Organise regular meetings to ensure 5S is a way of life	Certify and train suppliers or replace suppliers	*Improvement*	Analyses trends in scrap rates	Undertakes monthly meetings	Arrange training and development for equipment maintenance
		Improvement	Plan and aid supplier with setup reduction initiatives	Gather data of lost time due to accidents	*Improvement*	Create continuous motivation via walk-throughs
		Arrange event to concentrate cell team for 3-10 day period on a production process or cell	Analyse delivery processes	Analyses the operational efficiency of the cells	Attend regular meetings for BPR initiative	*Improvement*
		Produce schedule to ensure rapid implementation of improvements	Attend meetings to improve the manufacturing delivery process	*Improvement*		Set-up training for TLs
		Attend meetings to redefine the product quality process		Attend cost improvement training		Perform periodically staff, (TL), qualifications reviews
		Oversee and champion the six sigma process				

(*continued*)

Table AII.

	Activity areas					
	Safety	Quality	Delivery	Cost	Communication	Other
Operations manager		*Running*	*Improvement*	*Running*	*Running*	*Running*
		Identify and communicate an upward moving quality target	Attend meetings for delivery improvement initiatives	Analyses cost savings from TQM	Undertake communication activities, providing leadership and ensuring commitment from all parties	Provide top level support for 5S technique
		Attend meetings to change corporate orientation to zero defects implicit in all products, processes and systems		Reviews cost versus delivery performance (with respect to inventory levels)	*Improvement*	*Improvement*
		Improvement		Analyse lost time due to accidents	Undertake road-block busting of status quo thinking by questioning why processes are performed in a certain way	Set-up training for CLs
		Identify which processes have the highest priority for improvement		*Improvement*	Lead regular meetings for BPR initiative	Provide high-level guidance for removing barriers
		Issue statement for shop floor improvements		Initiate BPR cost reduction initiatives		Perform periodically staff, (CL), qualifications reviews
		Attend Kaizen event close-out		Arrange cost training for CLs		

Appendix 3

Table AIII. AS-IS matrix

	Activity areas					
	Safety	Quality	Delivery	Cost	Communication	*Other*
Team leader	Housekeeping audits	Quality audits	Materials management		Daily management meeting	Daily project meeting
	Walkabouts Monthly H&S meeting and paperwork	Care sheets Review KPIs	Print/review SCP plan Production planning/adjust SCP plan		Phone calls Cascade briefing	Operator coaching Monthly TOPS meeting
	Fire route check Risk assignments	ECARS Permits	Demand planning Chasing shortages		E-mail Communication council	Night shift handover HR
		Enter scrap data and rework	Supplier/purchasing liaison Man management Review labour effectiveness Deal with breakdowns OEE sheet completion Raising purchase orders Measure throughput efficiency Enter build cards onto system Count WIP/PI checks Schedule adherence Process orders Machine/line maintenance			

(continued)

Table AIII.

	Activity areas					
	Safety	Quality	Delivery	Cost	Communication	*Other*
	Improvement activities	*Improvement activities*				*Improvement activities*
	Workplace organisation strategy	Kaizen meeting				Championing Kaizen Initiatives
Cell leader	*Maintenance/running activities*					
	Monthly H&S meeting	MQR – monthly quality review meeting	CDQ – cost delivery quality		Enquiries from TLs	Review staffing level
	Follow-ups	SPR – product review meeting	Demand planning		Cascade briefing	Weekly technical and operations review – TOPS
	H&S meeting	TPR – technical product review meeting	Monthly demand plan review		E-mail	Communications council
	H&S walkabouts Risk assessment review	ISO 14001 meeting Review/update major KPI's	Kits review NPI – new product review meeting		Phone calls Daily management meeting	Project process review Man management/walkabout on factory floor
	Workplace organisation review		Materials management			
			Inventory review Monthly production meeting			

(*continued*)

	Safety	Quality	Delivery	Cost	Communication	*Other*
			Weekly supply review Production planning + reviews Monthly reports of performance/deliverables			
		Improvement activities Cell improvement initiatives Kaizen meeting				*Improvement activities* Manufacturing Architecture Review
Operations manager	*Maintenance/running activities*					
	Monthly H&S meeting	MQR – monthly quality review meeting	Demand planning	Authorise expenditure	Communications council	CL liaison
	Safety planning and strategy	SPR – product review meeting	Monthly demand plan review	Budget preparation and review	Phone calls	Three monthly KPI review
		TPR – technical product review meeting	KITS review	Manage manufacturing expenditure	Cascade briefing	Man management
		Review KPIs	NPI – new product introduction meeting		E-mail	Miscellaneous meetings
		Review overall strategy/figures	Monthly production meeting			Monthly report

(continued)

Table AIII.

Table AIII.

Activity areas					
Safety	Quality	Delivery	Cost	Communication	*Other*
		Weekly operations review			Quarterly international ops. meeting Monthly TOPS meeting Liaison with global ops. director
Improvement activities					
Safety awareness/improvement initiatives	Kaizen meeting	Delivery improvement initiatives	Cost reduction initiatives		Increasing visibility of KPI's
	Quality improvement initiatives	CDQ – cost delivery quality			SQDC – supply chain ops project review
		Manufacturing architecture review meeting			Strategic planning review
					Long-term planning initiatives Drive towards self supporting cells