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Analysis and design of focused demand chains

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Abstract

The paper describes the evolution of focused demand chains over an extended period of time as a major UK lighting manufacturer has sought to remain an international player in a fast changing business environment. Analysis and design procedures make use of the concepts of Wickham Skinner and Marshall Fisher to answer the strategic questions "what facilities are required and how should they be laid out to enable the necessary focused demand chains?" and to answer the tactical question "which focused demand chain is appropriate for this product?" The case study then details how the company has been transformed from operating within a traditional supply chain to driving change via the engineering of four focused demand chains. The paper concludes with a comparison of operations enablers, customer choice, and business performance metrics covering the transition period culminating in the current focused demand chain scenario. By matching products to the appropriate value stream there is a consequential reduction in product development time of 75%; manufacturing costs reduction of up to 27%; and up to 95% reduction in delivery lead times.

JEL classification: L22; L23; L64

Keywords: Demand chain management; Classification; Case study

1. Introduction

The need for focus in manufacturing is long established (Skinner, 1974) and is defined as "the concept that simplicity, repetition, experience and homogeneity of tasks breed competence. Furthermore, each key functional area in manufacturing must have the same objective, derived from corporate strategy." In the 1990s this concept was expanded, first to cover logistics (Fuller et al., 1993) and then the entire demand chain (Fisher, 1997). This paper specifically addresses the question of how does an organisation enable focus in their demand chain? Brace (1989) explained the concept of a demand chain as "... the whole manufacturing and distribution process may be seen as a sequence of events with but one end in view: it exists to serve the ultimate consumer." This perspective can be traced back to Levitt (1960), when he emphasised the need for organisations to be customer and market orientated.

A structured methodological framework is presented to specifically aid the practitioner in the development of a focused demand chain strategy. This is tested on an in-depth case study application in a UK lighting company. As a consequence, the pragmatic and successful approach adopted by the company is codified and made transparent. The methodology may, therefore, be transferred to other companies and to other market sectors. This is a requirement laid down by Micklethwait and Wooldridge (1996) for the establishment of any new component of management theory.

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In order to overcome the averaging effects (Fuller et al., 1993), which mask both exemplars and poor practice alike, the focused methodology tailors demand chain competencies so as to best service varied marketplace environments. Our classification approach is, therefore, presented to segment products based on market demands. Hence, alternative strategies can be developed for each taxon to maximise competitive objectives.

The paper commences with an integrated framework for the development of focused demand chains. The particular product classification system utilised is a five parameter (duration of life cycle; time window for delivery; volume; variety; and variability, with the acronym DWV^3) scheme due to Christopher and Towill (2000). To provide operational benchmarks, this system has been applied to both the 1996 and 1999 lighting company products. By 1999, there were four product clusters defining the four implemented focused demand chains. Our case study then describes the implementation and operation in some detail. This includes the utilisation of core competencies in the current and future marketplace. The paper concludes with a review of the actual industrial performance improvements for each chain, together with the key enablers made possible by moving towards the focused demand chain scenario.

2. An integrated framework for the development of focused demand chains

Fig. 1 illustrates the major steps in our integrated framework for the development of focused demand chain strategies. Step one is the development of a holistic demand chain strategy. This leads from highlighting of core competencies and resources, and its primary purpose is the identification of specific markets to be targeted plus the overall corporate strategy. Hence, inputs from the marketplace in the form of key order winner and order qualifier (Hill, 1985) characteristics are used, together with information about the competitive situation in the form of knowledge of the strategies and tactics of competitors.

Once the overall demand chain strategy has been established, specific products and their related service levels are identified. These are tailored to the target markets with emphasis placed on prioritisation of service, quality, cost or lead times, thereby emphasising the all important trade-offs to be made in each focused demand chain. The next step is the critical part of the integrated framework, i.e. categorisation of demand chain types. Given the specific products and their related service criteria the DWV^3 classification variables proposed by Christopher and Towill (2000) are used to categorise the products into clusters with similar characteristics. The reasoning behind the use of the DWV^3 variables is explained in the following section. The output of this key step is a clear definition of the requirements for each demand channel, along with specific objectives to maximise competitiveness in each targeted market segment.

The specific demand chain types require earmarked facilities. This is the task of the fourth step of the framework shown in Fig. 1. The facilities need to be tailored to achieve the desired objectives, e.g. those products necessitating high service levels in the form of availability may require distribution warehouses located near to the marketplace. The penultimate step takes the facilities requirements to a more detailed level in relation to the production layouts and control mechanisms required at each level, e.g. if multiple variants are offered with short lead times then postponement is applicable (Lee and Billington, 1993). Furthermore, the use of Lean principles in the form of Kanban is applicable for reasonably stable demand (Naylor et al., 1999), but MRP control mechanisms are more appropriate for special or after-market products.

As mentioned earlier, the selection of the variables used to classify alternative demand channels lies at the heart of the methodology for the development of focused demand chains. Table 1 illustrates an in-depth review of empirically available classification approaches in the field of supply/demand chain management. Most of the classifications are based around product characteristics, especially in relation to market and customer requirements. Fuller et al. (1993) classification of logistically distinct businesses provides a great deal of insight into the need to avoid averaging effects with the consequential dangers of mismatching products to marketplace. Fisher (1997) has also been a major influence via his identification of the two extreme types of products, i.e. functional and innovative. Our preferred classification system will now be described.

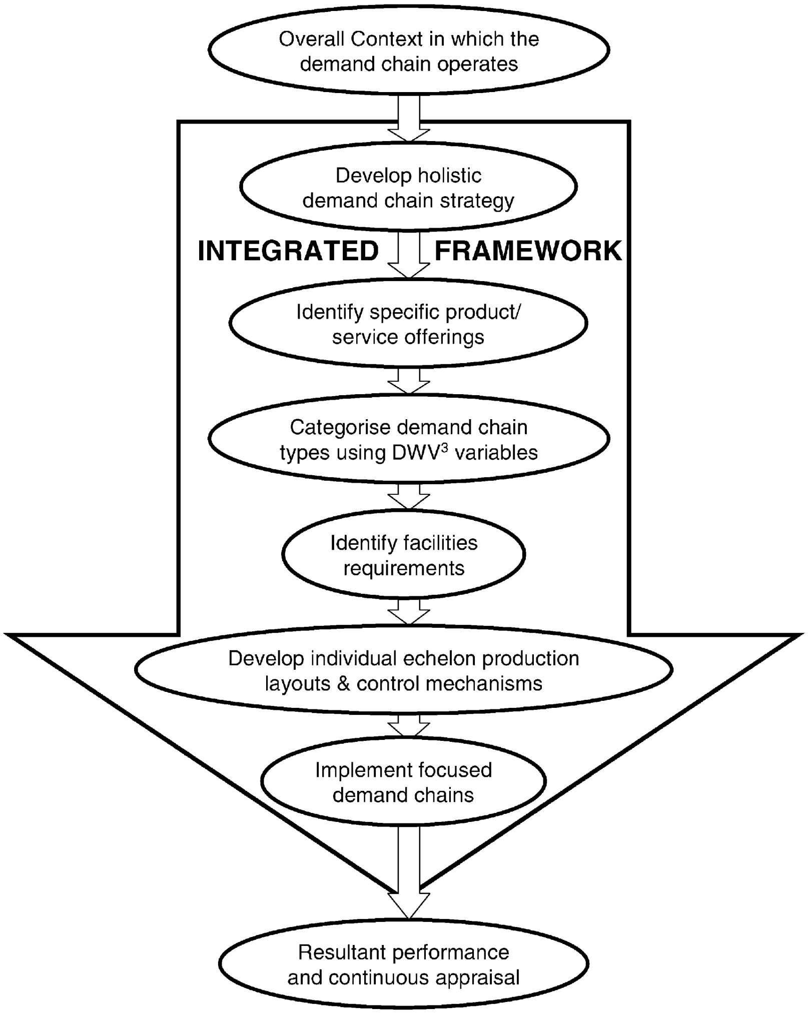

Fig. 1. Integrated framework for the development of focused demand chains.

3. Applicability of DWV^3 classification variables for demand chains

Christopher and Towill (2000) have produced a series of papers comparing the Lean and Agile Paradigms. The thrust of their work has been on establishing the extent to which these two paradigms have synergy and the extent to which they are in conflict. The purpose is to define the best "mix and match" strategy to be adopted in a given business situation. This leads to various combinations of leanness and agility, of which the best known is *leagility* (Naylor et al., 1999). In their research Christopher and Towill (2000) have been seeking a simple classification system, which would codify the selection of a value stream according to lean and agile principles. Their industrial experience plus literature review (most notably Shewchuck, 1998) led them to propose DWV^3 as such a codifer. The posteriori use of this classification system on the lighting company data is the first industrial evaluation of the new system and as such is one of the original features of this paper.

There are five key characteristics that influence decision making in the design selection of demand chain strategies. These attributes are: *duration of life cycle*; *time window for delivery*; *volume*; *variety*; and

Table 1
Classification of demand/supply chains within the literature

Authors	Classification variables	Taxa
Hoekstra and Romme (1992)	Position of de-coupling point Process constraints Product-market constraints Delivery service requirements Inventory cost considerations	Make and ship to stock Make-to-stock Assemble-to-order Make-to-order Purchase- and make-to-order
Fuller et al. (1993)	Annual sales revenue Annual unit volume Co-ordination requirements Destination volume Handling characteristics Customer order fulfilment interval	System orders Customer inventory Replenishment Rapid response Nuts and bolts Slow movers Bulk cable
Lampel and Mintzberg (1996)	Level of aggregation Level of individualisation	Pure standardisation Segmented standardisation Customised standardisation Tailored customisation Pure customisation
Fisher (1997)	Product innovation Demand volume stability Product life cycle duration Make-to-order lead time Product variety End-of-sale mark down	Functional products Innovative products
Pagh and Cooper (1998)	Product life cycle Product customisation Product variety Product value Relative delivery time Delivery frequency Uncertainty of demand Economies of scale Manufacturing and logistics	Full speculation Logistics postponement Manufacturing postponement Full postponement
Naylor et al. (1999)	Cost, quality, lead time and service level Stability of demand	Lean Agile Leagile
Lamming et al. (2000)	Product innovation Product uniqueness Product complexity	Innovative-unique and complex Innovative-unique and non-complex Functional and complex Functional and non-complex

variability (DWV[3]). Table 2 summarises the key reasons why the original authors included each of these five classification variables.

Duration and stage of product life cycle have been noted by many authors as key characteristics that require demand chains to recognise and thereby adopt tailored strategies. Hayes and Wheelwright (1979) stress the important link between the manufacturing process and product life cycles, whilst Cavinato (1987) illustrates how logistics rides the roller coaster of product life cycles. The time *window* for delivery or delivery lead time, reflects the responsiveness requirements placed on the demand chain. In combination with manufacturing and logistics lead times,

Table 2
Key reasons for the use of DWV^3 variables to classify demand chain types, adapted from Christopher and Towill (2000)

Classification variables	Some key reasons for use to classify demand chain types
Duration of life cycle	Short life cycles require rapid time to market Short life cycles require short end-to-end pipelines to enable demand to be continuously replenished during the life cycle Short life cycles require a demand chain to be able to 'fast track' product development, manufacturing and logistics to exploit ever decreasing windows of opportunity Replenishment lead times need to be matched to stage of the product life cycle, so to reduce lost sales and obsolescence risks
Time *window* for delivery	Rapid response is required to replenish fashion goods that are selling well at a particular point in time Competitive pressures are continually reducing acceptable response times, with many demand chains competing on the basis of very short windows for delivery of customised products
Volume	Products aimed at high volume mass markets allow for the lean-type production and make-to-forecast strategies to take advantage of economies of scale Lower volume markets benefit from flexibility both in production and the entire demand chain
Variety	Greater variety results in a larger number of stock keeping units because the volume is split between alternatives Continuous appraisal of the proportional breakdown between variants must be conducted during the product life cycle because those variants popular at the introductory stage may be less popular in the decline stage
Variability	Variability relates to spikiness of demand and unpredictability Spikiness drastically effects capacity utilisation and resultant production techniques Unpredictability increases the risk of obsolescence and lost sales and can be addressed via information enrichment (Mason-Jones and Towill, 1997), consultative forecasting (Fisher, 1997) and lead time reduction (Watson, 1994)

it identifies the feasible position of the de-coupling point (Hoekstra and Romme, 1992).

Volume is the third of the DWV^3 variables. Fuller et al. (1993) emphasise the attention that should be placed on key products that are both high volume and high margin because of their critical importance to an organisation. Parnaby (1993) explains the *Lucas way* by which the manufacturing processes are segmented dependent on annual volume.

Product *variety* is constantly increasing at the marketplace as demand chains attempt to compete on the basis of added value in relation to colour, form and function. Postponement is a feasible mechanism to ease these problems (Lee and Billington, 1993). However, there will always remain some additional cost associated with increased variety, either in the form of stock holding costs to cover variant demands or increased production costs caused by the flexibility requirements of postponement.

The final classification variable of the five is demand *variability* and is the most significant in the opinion of the present authors. Fisher (1997) emphasises the impact unpredictable demand can have on the chain in the form of stockouts and resultant lost sales or alternatively excessive obsolescence costs. Harrison (1997) emphasises that because of unstable original equipment manufacturers (OEM) schedules there is a need for increased lead times, buffer stocks and capacity.

4. A UK lighting company case implementation of focused demand chains

A detailed historical account of the change programme in the lighting company used as a test bed herein was written by Aitken (2000). The present paper is based on that description but uses additional material from that same industrial source as needed to substantiate the value stream classification system which is our major original contribution. The richness and utility of that contribution by Aitken (2000) has already been recognised elsewhere. For example, a version has been developed by Cranfield University as a formal management school case study. It has also been used as a demonstrator for evaluation of a proposed model for enabling change in the agile enterprise and as such appeared in an invited paper (Aitken et al., 2002). However, the emphasis therein was on the extent to which lean production, flexible response, agile supply, and organisational agility impacted on that particular company and its business strategy. As such, it is of peripheral interest to the present investigation, which is concerned with the exploitation of a product classification system to analyse and design focused demand chains.

The case information available verifies the classification approach to identification of the required focused demand chains. Our approach is centred in the lighting company via a two-phase re-engineering programme. The first phase ran from 1996 to 1998, whilst the second phase was conducted from 1999 to 2000. The first phase concentrated on developing and exploiting demand chain competencies. Then, phase 2 specifically addressed how these core skills are fully utilised in current and future marketplace environments.

Prior to 1996, the company's organisation and management of its internal and external demand chains was based on a traditional functional approach. Manufacturing managed all of its material flow on a push principle driven by MRP. Hence there was no differentiation between low and high volume products and between regular or irregular demand items. Productivity was low as manufacturing orders ranged in size from 1 to 1000. Each production order was preceded, and followed by, changeovers and downtime. All seven forms of Ohno (1988) wastes (or muda) were apparent in the internal demand chain and material conversion operations. Management of the external demand chain was at an arm's-length contractual basis (Sako, 1992). The supply base was broad as the strategy of the buying function of the company operated on the principle of 'lowest price wins'. Buyers routinely moved the source of components to a new supplier if the price was lower. So new vendors would be assessed on the basis of price and component quality only. Consequently, there was no obligation for repeat transactions if the existing supplier did not retain the lowest price.

5. Exploitation of current demand chain competencies

In order to rectify the foregoing current situation, the need for focus was identified as a potential solution. As a first step and to gain maximum impact as quickly as possible, it was realised that the existing product portfolio should be categorised and demand chains designed to maximise competitiveness in each category. In effect this is equivalent to starting in the middle of the integrated framework, illustrated in Fig. 1. The product champion in conjunction with the senior management team decided to segment the products into two groups. Fig. 2 illustrates this classification in relation to the five DWV^3 variables. The sequence of the five variables was shifted and sorted until a near perfect match was achieved between theory and practice. The two clusters are differentiated predominantly on market demand volumes and responsiveness requirements. This 1996 analysis led to the engineering of two distinct and focused demand chains based on MRP and Kanban principles, respectively.

Order winning (OW) and order qualifying (OQ) characteristics for the high and low volume product clusters used are based on Johansson et al. (1993) total value metric. Here, the key to winning in the marketplace for the high volume products is determined to be cost. Given the current resources and competencies of the demand chain, in combination with the relatively stable demand patterns, the company decided that lean principles (Womack and Jones, 1996) were most appropriate.

In the case of the low volume products, service level (or availability) is the key order winner. The unpredictable nature of the demand patterns in combination with a high ratio of product codes to annual volume meant the existing MRP strategy was most appropriate for the second focused demand chain. As a result, the low volume products continued with a push (MRP) strategy, whilst the high volume section operated a pull (Kanban) strategy. This dual MRP/Kanban approach is well established in material flow control (Parnaby, 1988).

6. Development of demand chain competencies

Once the internal demand chain had been re-engineered to operate two parallel strategies, attention was switched to the supply base. The result of these activities was a shrinkage in direct supplier numbers from 267 to less than 100. Such a move

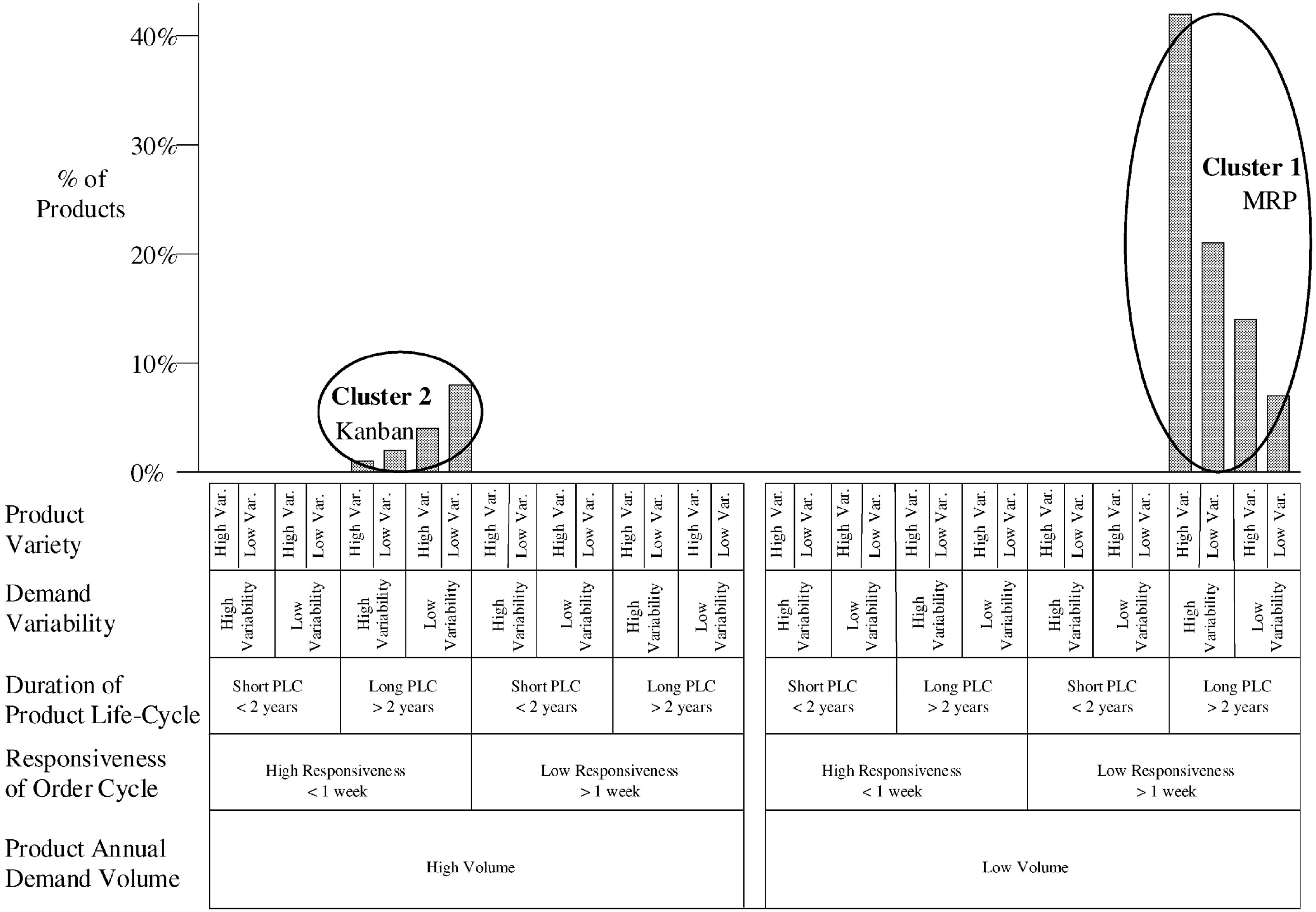

Fig. 2. The 1996 historical classification of the lighting case studies products.

Table 3
Performance improvements resulting from re-engineering phase 1 of the lighting demand chain (Aitken, 2000)

Product attributes	1995	1998	
		Low volume	High volume
Product codes	8000+	5000	850
Material flow	Push	Push	Pull
Material control	MRP	MRP	Kanban
Demand predictability	Mix of high and low	Low	High
Minimum order quantity	Pallet	Single unit	Pallet
Service offered	Made-to-order	Made-to-order	Ex-stock
Product development (months)	24	6	6
Order cycle time (weeks)	8–12	2–4	0–2
Costs (1995 index = 100)	100	85	73
Sales volume (1995 index)	100	110	125

has many benefits (Lamming, 1993) including risk reduction.

Following the segmentation of the internal demand chain and the reduction of the supply base, it became possible to simplify the ordering and communications system between "players" in the chain. The high volume operation introduced, with the assistance and agreement of its suppliers, a two-bin, Kanban material ordering system. Muda previously observed in these operations included inappropriate processing, unnecessary inventory, unnecessary motion, excess waiting time and unnecessary transportation. All were reduced following Kanban installation in this focused demand chain.

The final part of the re-engineering conducted during phase 1 involved improvements in new product introduction. Lead times for new product development in the lighting industry in 1996 were typically 18–24 months but, the time from concept to product delivery was proving costly in terms of pay-back and market leadership. Hence, suppliers within the new partnership ethos became involved at the new product design stage. Consequently, the lighting company is, therefore, becoming a fast innovator with many consequential benefits (Stalk and Hout, 1990). The performance improvements resulting from phase 1 of the re-engineering of the lighting company's demand chain are illustrated in Table 3. The major benefit was the reduction of averaging effects masking both outstanding and poor performance. The products were no longer paced by the slowest, and previously conflicting competitive objectives were now maximised for each of the two clusters of products.

These very creditable performance improvements were achieved through the efforts of both supplier and buyer alike. Integration of demand chain activities and information flows accelerated the implementation of lean practises, such as Kanban. Operational improvements followed a consistent and deliberate strategy of developing trust and openness in the relationship between supplier and buyer. Suppliers working in partnership with the company to develop improvements gained additional sales volumes, which in turn increased the interdependence of both parties to the exchange. Improvements in the relational as well as operational performance developed a virtuous circle for both parties in the exchange. In other words, the effective design and operation of business interfaces played a vital role in enabling effective change as highlighted by Towill (1997a,b) when adopting a systems approach to supply chain design.

7. Identification of the lighting company's demand channels

Phase 1 of the re-engineering programme provided the company with a firm basis for a more comprehensive overhaul of its demand chain strategies. Therefore, phase 2 was able to start at the beginning of the integrated framework illustrated in Fig. 1. This was because partial benefits already accumulating from the development of focused demand chain strategies had gained buy-in from senior management, operators and strategic demand chain partners alike.

Environmental feedback in relation to marketplace conditions and competitors strategies highlighted two

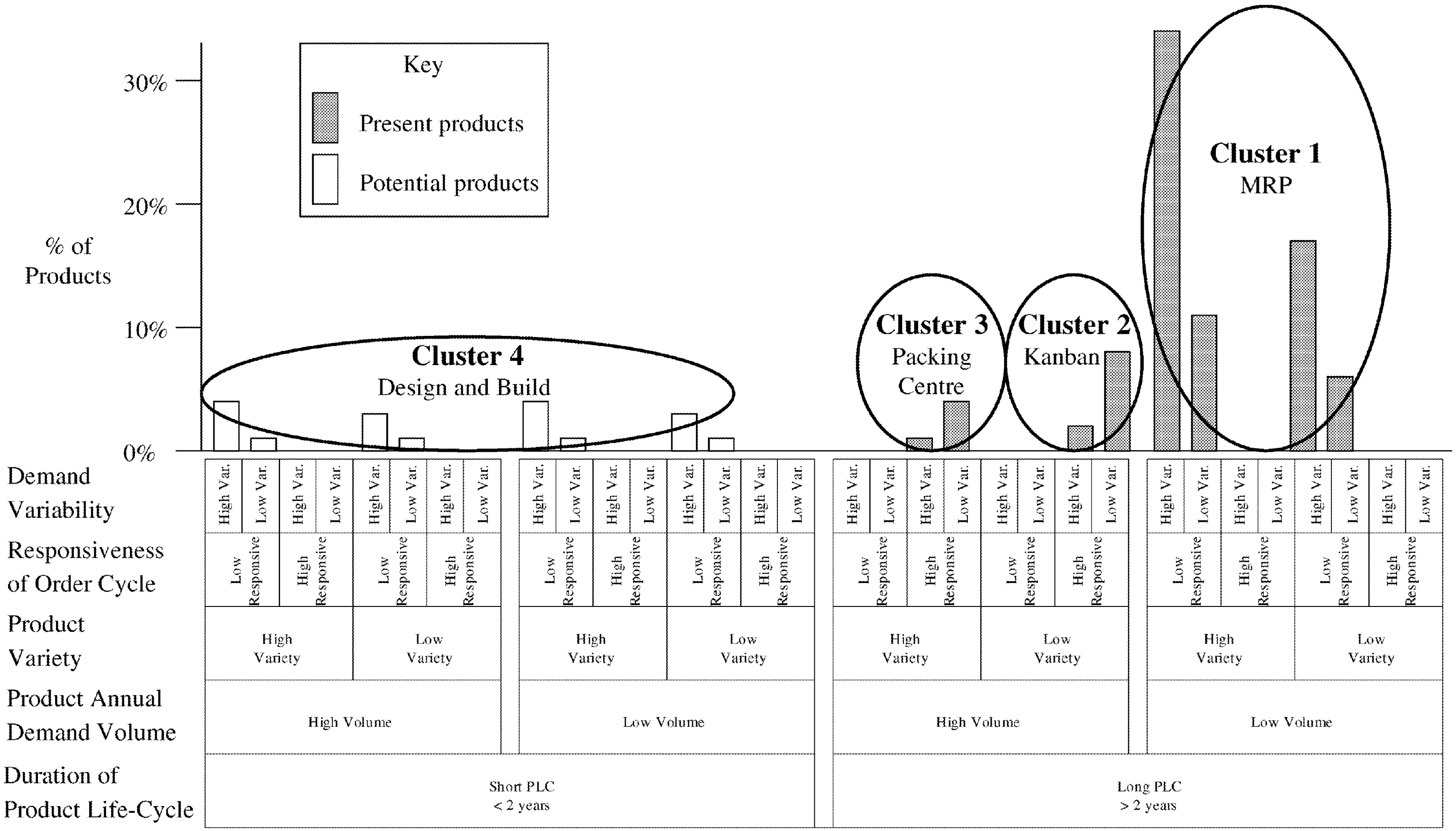

Fig. 3. The 1999 classification of the lighting case studies products.

major factors to be addressed. First, the lighting industry had become a global marketplace. This, in combination with the fact that a number of the products had become commodity in nature, meant a UK based company would struggle on the basis of price when competing with imports from low labour cost countries, such as China. Secondly, the environmental feedback factor illustrated the movement of the lighting industry towards increased demands for customised products. This, in turn necessitated working much more on a one-to-one basis.

The feedback of competencies effect was extremely buoyant. Phase 1 of the re-engineering programmes had resulted in the demand chain being able to introduce new products four times faster. The new lean demand channel was capable of responding ten times faster to specific customer orders for existing products. All these factors meant that the overall context in which the lighting demand chain operated within was in good health but must further develop to stay ahead of the competition.

To fully exploit the new competencies, the product champion in collaboration with the senior management decided to increase the number of product groups from 2 to 4. Fig. 3 is an updated version of Fig. 2, illustrating the new classification of the lighting company's products relevant to the business needs of 1999. In this instance three of the five variables are pivotal in classifying the product types. These are: duration of product life cycle, annual volume, and product variety. Cluster 1 is exactly the same as 1996, i.e. low volume and unresponsive. Clusters 2 and 3 were originally aggregated to make up cluster 2 in 1996. But this cluster of products is now split into two, based upon high and low variety. Cluster 4 comprises totally new products. These are potential customised products reflecting the new opportunities in the lighting sector.

8. Utilisation of competencies in the current and future marketplace environment

The four clusters highlighted in Fig. 4 exploit the overall context within which the lighting demand chain is currently operating. They have been segmented specifically to exploit the resources and core competencies available to the extended enterprise. Cluster 1 consists of the low volume products. This is very similar to the previous cluster 1, as of 1996. The major difference is the removal of products during their introductory stages. Hence, this cluster is more akin to automotive after-market products or "strangers" in Lucas terminology (Parnaby, 1993). The existing MRP control mechanisms are, therefore, still utilised and the resultant internal demand chain is illustrated in Fig. 4, together with the other three demand channels. The major order winner for this cluster of products remains the service level in terms of availability of small volume products. Therefore, the application of a make-to-order approach, via MRP control, with common raw material stocks and shared manufacturing resources, maximises availability within acceptable lead time, cost, and quality parameters.

Cluster 2, the high volume, low variant products are increasingly becoming commodity-like in nature and are exposed to competition from low labour cost countries. The major order winner here is cost. However, since the UK lighting company cannot compete on the basis of cost, very short lead times are the only remaining competitive avenue. This is facilitated via a lean demand channel and a make-to-stock policy, so that deliveries to specific customer orders can be made in very short lead times (1 day if required). The Kanban controls and the two-bin system operated in conjunction with the supply base maximises efficiency for these products, which have relatively predictable demand patterns. The resultant internal demand chain is once more illustrated in Fig. 4.

Despite the very short lead times offered for the commodity type products, the UK lighting company, as with many UK organisations, is in danger of being pushed out of the marketplace. To combat this the lighting company and its associated demand chain increased customer service by offering multiple variants of relatively standard products. The products utilising this strategy make up cluster 3. These are high volume, high variant products. The order winner in this instance is still cost, closely followed by availability of multiple variants. To achieve these objectives the application of postponement was seen to be optimal (Lee and Billington, 1993; van Hoek, 1998; Pagh and Cooper, 1998). This was partially due to the nature of lighting products in that they are assembled from three major sub-assemblies. Therefore, the de-coupling point has been placed at the sub-assembly

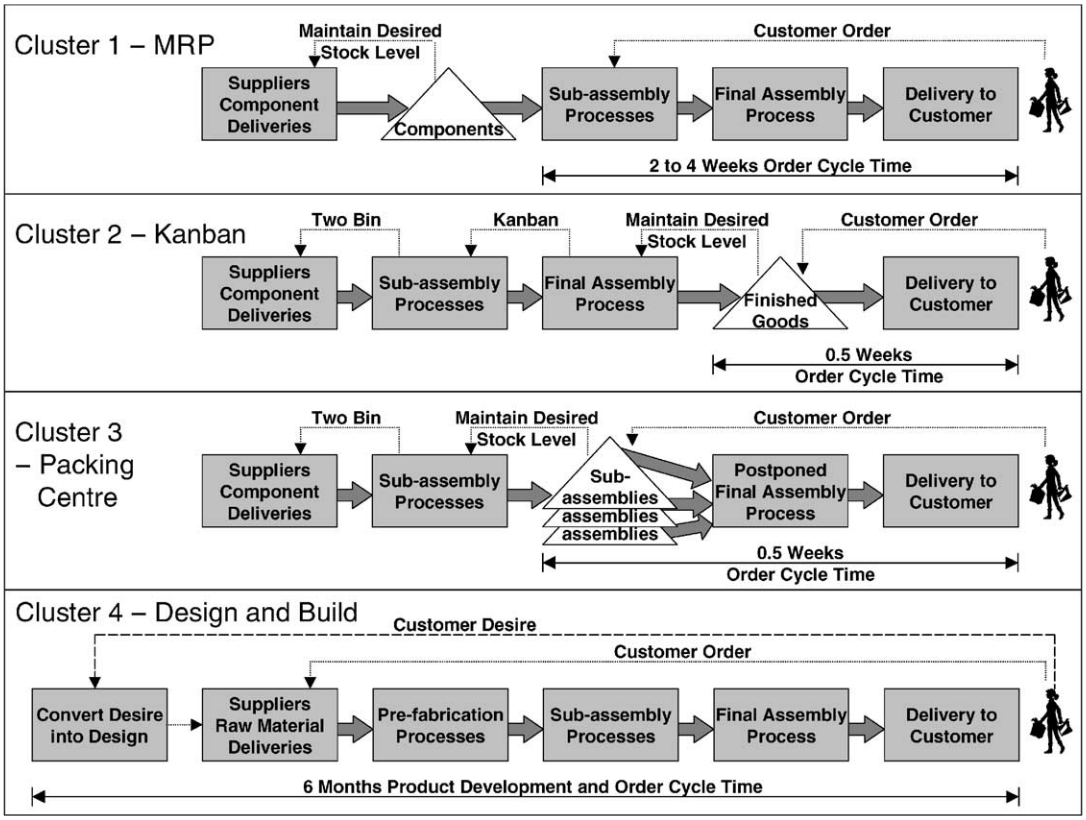

Fig. 4. Focused demand chains designed to maximise OW and OQ objectives for each of the four product clusters.

level as illustrated in Fig. 4. Prior to the de-coupling point, lean principles are applied to maintain desired stock levels as in the case of the cluster 2 products. After the de-coupling point in the final packing centre specific customer orders are assembled and dispatched, therefore, offering multiple variants cost effectively in very short order cycle times. Thus, a leagile strategy (Naylor et al., 1999) was adopted so as to obtain the best from both worlds.

In the final product cluster, four were seen as new opportunities in the marketplace in line with the increased demand of customised products. Fig. 3 illustrates these particular products as having short life cycles. In addition, those products already in their introductory stages have been included, as the duration of the life cycle remains uncertain. A completely new approach to operating the demand chain is required in this instance and has been noted as agile in nature (Aitken et al., 2002). The new design competencies developed in phase 1 of the re-engineering programme are exploited to the full via offering the market a comprehensive design-and-build strategy. Fig. 4 shows the internal demand chain for this cluster of products. It has been specifically designed to offer customised products in short development lead times as effectively and efficiently as possible, therefore, maximising the order winning objectives.

9. Dynamic appraisal of product routing based on stage of product life cycle

Phase 2 of re-engineering was completed by 2000, at which time focus had been achieved in the shape of the lighting company's four established demand chains. The resultant strategies had been implemented

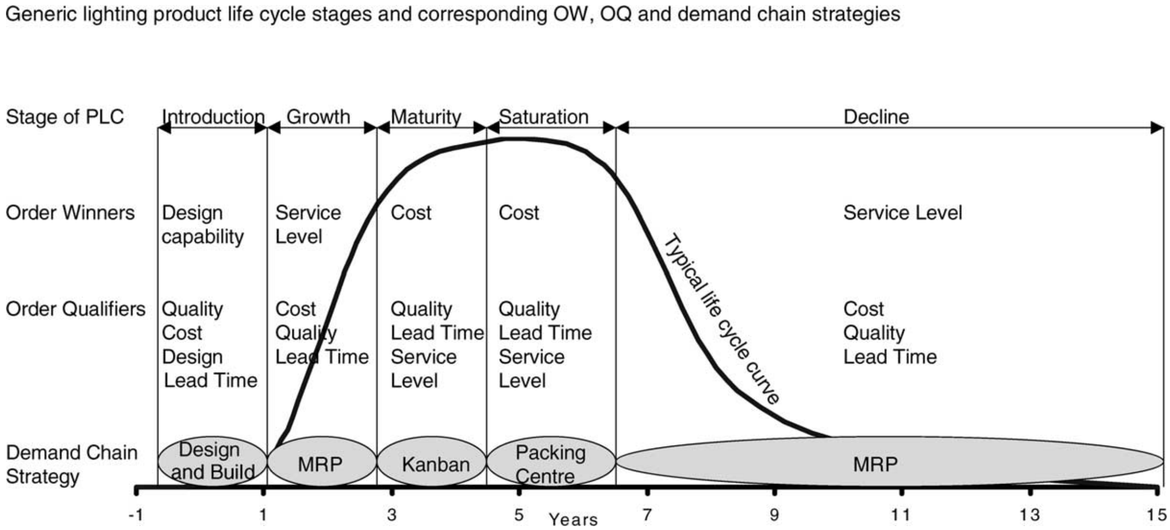

Fig. 5. Generic lighting product life cycle stages and corresponding OW, OQ and demand chain strategies.

and competitive advantage gained in each via the removal of conflicting objectives and the shaping of focused demand chains to suit particular marketplaces. However, at this point it was noted that the product routing was not static. In fact the marketplace OWs and OQs are dynamic for any specific product as it proceeds through its product life cycle. This is noted by numerous authors, including Hill (1985), Kotler (1994) and Porter (1980). Furthermore, as Hayes and Wheelwright (1984) and DuBois and Oliff (1992) have stated, the production and manufacturing processes must also dynamically adapt to best service these changing marketplace conditions. Fig. 5, therefore, traces a particular lighting industry generic product, its OW and OQs for each life cycle stage, and the resultant most applicable focused demand chain strategy.

During the introduction stage of the product life cycle, the capability of design is the key OW followed closely by the design lead time. Therefore, the design and build strategy is most applicable. Once the product has entered the marketplace and if the demand increases, then the product enters its growth stage. During this time the service level in terms of availability of a product with unpredictable demand is the key OW. As a result, the product is transferred to the MRP push based demand chain. When the product has reached its mature stage it is switched to the Kanban demand chain, so to best compete on the key OW of cost. During the saturation stage, low labour cost countries enter and compete in the marketplace, so the UK lighting company competes by offering multiple variants. In order to do so the packing centre focused demand strategy is utilised. Finally, as the demand for the product tails off and enters the decline stage of the product life cycle, it is transferred back to the MRP demand chain so as to maximise the service level for the low volume highly unpredictable product.

10. Discussion

The lighting company's case study offers a great deal of insight into the feasibility of developing focused demand chain strategies. All major process steps in the integrated framework proposed in Fig. 1 were performed by the company industrial engineers, although not necessarily in exactly the same order. The resultant four focused strategies greatly enhanced the competitiveness of the company and their demand chain partners. Table 4 illustrates the four strategies, together with some of the observed benefits from using the focused approach. Costs have been greatly reduced for three of the four channels. In the case of the design and build strategy the apparent price increase is because re-engineering has facilitated

Table 4
Resultant performance of the four demand chain strategies

Strategy name year implemented	Original MRP 1995	MRP 1998	Design and build 2000	Kanban 1998	Packing centre 2000
Enablers					
Product codes	8000+	3500	N/A	400	450
Material flow	Push	Push	Pull	Pull	Pull
Material control	MRP	MRP	Discrete orders	Kanban	Kanban
Demand predictability	Mix of high and low	Low	High	High	Medium
Minimum order quantity	Pallet	Single unit	Single unit	Pallet	Single unit
Service offered	Made-to-order	Made-to-order	Design and build-to-order	Ex-stock	Assemble-to order
Performance metrics					
Product development (months)	24	6	6	6	6
Order cycle time	8–12 weeks	2–4 weeks	1–4 weeks	0–2 days	<5 days
Costs (1995 index = 100)	100	80	150	73	80

identification of the true costs. Thus, the cross-subsidy from commodity-like products at the expense of other items, which is one of Fuller et al. (1993) averaging effects is avoided. The order cycle times have been massively reduced for all four strategies, but especially for the Kanban and packing centre strategies, which often win orders on the basis of this responsiveness. Similarly, the competitiveness of the design and build products has been greatly enhanced via the compression of the product development lead times.

The DWV^3 classification variables are generic and it is the contention of the authors that these hold for many industries and marketplaces. The simplistic clustering mechanism based on binary scales and alternating the order of the five variables is manifestly subjective. But it must be so in order to incorporate the tacit knowledge of the management team tasked with identifying the clusters of product types. The best sequencing of these during value stream analysis variables is an area of potential further research. For example, during phase 1 of re-engineering of the lighting demand chain volume is the bottom line and, therefore, as shown in Fig. 2, is the most significant variable. But during phase 2 the duration of life cycle plays a more critical role, as seen in Fig. 3. This may not be coincidental; the ranking in priority of the five variables seems dependent upon the present level of sophistication used to segment demand channels within an organisation, i.e. the extent to which the value streams are focused.

11. Conclusions

The advantages of focus have been long understood in context of manufacturing management and can be traced back to the fundamental theoretical work of Skinner (1974). Fuller et al. (1993) extended the approach to logistics, whilst Fisher's (1997) argument encompassed the whole demand chain. However, regrettably few examples exist in the literature of how to achieve this desired focus in practice. This paper has presented a structured framework for the practitioner to confidently implement focused demand chains in their own organisation. The in-depth experience and insight from the implementation by a forward looking company in the lighting industry has provided invaluable case based evidence of the validity of the approach.

The theory of focused demand chains is based on the premise that modern day marketplaces have diverse requirements for alternative products and services. No one demand chain strategy can best service all these requirements. Hence, focus is required to ensure demand chains are engineered to match customer requirements. Such focus is enabled via segmentation on the basis of each product's characteristics. Therefore, the classification variables used to segment the products lies at the heart of the methodology. This paper has reviewed the empirically available classification approaches, their key variables and resultant taxa. The classification system based on the five variables of DWV^3 has been evaluated via a case study and can be seen to have great potential in identifying focused demand channels ahead of design and implementation.

The lighting case study has provided some valuable insight into the methodology for engineering focused demand chains. Over a 4-year period the company transformed their traditional supply chain to a highly competitive market orientated focused demand chain. The results speak for themselves, via increased sales volume, decreased costs, and increased customer service levels in relation to order cycle times, product development lead times and variety. They are highly significant and point the way for further industrial application of the classification methodology based on the DWV^3 variables. Finally, the classification system enables specific results obtained in one industry to be placed in a generic context. As such it aids "transferability" between companies and between market sectors which is arguably one factor in establishing management theory.

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