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PLANNING FOR IS RELATED INDUSTRY TRANSFORMATION: THE CASE OF THE 3DAYCAR

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ABSTRACT

Despite their potential to reshape business radically, information systems (IS) and information technology (IT) can be key inhibitors of industry transformation. In the automotive industry, although IT is a key enabler of process transformation, the existing IT systems constitute a significant barrier to change. While there are a number of models of change barriers, few have been validated in practice. This paper adapts one model, the barriers information framework ('BIF') in order to assess the nature of barriers to change as basis for managing organizational change. The barriers to IS-related change are identified as structural, managerial, user, and technology and are cross-referenced to the key parties involved in transformation of the motor industry: dealers, vehicle manufacturers, suppliers, and logistics services. The paper finally reflects on the model and suggests extensions to it.

1. INTRODUCTION

Globalization is a pre-requisite for the automotive industry in the 21st century. Vehicle manufacturers and their supply chain partners need presence in both mature and emerging markets to spread greater volumes over their investment base. Communicating effectively both locally and globally increases the importance of information systems (IS) and information technology (IT).

The automotive industry operates complex IS. Current systems act as a major inhibitor both to time compression in the order fulfillment process and to organizational change. For example, a customer order entered into the system at a car dealership must complete five overnight updates on existing IS, involving batch processing and code conversions, before it is released into vehicle production.

The European automotive industry is facing a period of significant change, driven by poor profitability, excess finished stock and over-capacity (Womack and Jones 1996, Pemberton, 2000). Customers are more price conscious and less patient, demanding vehicles built to individual specifications and delivered in short lead-times (Williams, 2000). Vehicle manufacturers (VMs) can no longer rely on selling cars from existing stock and are shifting their business models away from mass production towards mass customization and build-to-order (BTO). This increases the importance of existing systems for efficient order execution and integrated information flow. Yet, many IS reflect the functional departments for which they were originally conceived.

'3DayCar' (3DC) is a complex project that aims to understand the current practice, relationships and technology between automotive suppliers, manufacturers (VMs), logistics, dealers and customers. It was established in 1999 as a research programme to examine the role of order-to-delivery (OTD) and the barriers to change, across the automotive supply chain. The key objective of 3DC is to develop a framework in which a vehicle can be built and delivered to customer specification in minimal lead-times, with three days OTD time as the ultimate goal.

Identification of the barriers to change is essential if they are to be incorporated into planning for the redesign of the automotive industry. This will promote a successful transition from the current 45 day OTD lead-times, production push and the erosion of profits through discounted sales, towards responsive production and customer order pull. The current state of IS is illustrated in the generic map (Figure 1). Here, operating systems (rectangular boxes) and storage systems or databases (ovals) are linked by flows of information (arrows). The solid lines represent divisions between the various players in the supply chain and the dotted lines represent the divisions between functional systems at the manufacturer. Figure 1 demonstrates that transforming IS will require a step-change in current organizational thinking, towards the concept of 'timeliness of information' (Stalk and Hout, 1990), total visibility, and real-time information flow.

Information technology is an enabler of change and a major force influencing business success. Much organizational change over the last two decades has been technology-driven. The rapid change in IT has raised managerial concern regarding the capability of firms to manage its introduction into the business environment (Kwon and Zmud 1987). However, the barriers to successful implementation are not just technical. Structural, managerial, user and technical all affect the change process (Kirveennummi et al., 1998). This paper attempts to identify barriers to IS-related change to enable better organizational planning, and then to reflect on existing models of change inhibitors. The next section considers barriers to IS-related change and the BIF model. The third section outlines the research approach and the fourth introduces the case study. The final section applies the BIF model to the cases and reflects on the findings, the usefulness and the shortcomings of the model in planning for IS-related industry change.

2. BARRIERS TO IS-RELATED CHANGE

Two approaches to organizational change involve looking at the process of change through collaboration and learning (Lewin 1972, Grantham 1993), and identifying the barriers that resist change (Beatty and Gordon 1988, Argyris 1992, Auer 1996). This paper adopts the barriers to IS-related change approach as a mechanism for planning the implementation of IS, organizational and industry changes needed to meet the aim of the 3DayCar. The model used as the basis for the analysis is the core of the barriers information framework (BIF) proposed by Kirveennummi et al., (1998). This model categorizes barriers as structural, managerial, user and technical:

Structural barriers include both the formal and non-formal barriers that affect the change process (Kwon and Zmud 1987). Formal barriers include organizational hierarchy, which can lead to varying degrees of inflexibility, resistance to change and slow reactions. Deep hierarchy indicates vertical communication and centralized decision making and such organizations often find it difficult to see the need for change. Organizational size often indicates complexity that can lead to centralization of decisions and functional specialization.

Non-formal barriers can originate from culture and values such as a closed environment and organizational inertia. If old habits continue to control activities, this can result in defensive routines such as anti-learning and over-protecting. If people protect and institutionalise these routines they can become barriers to change.

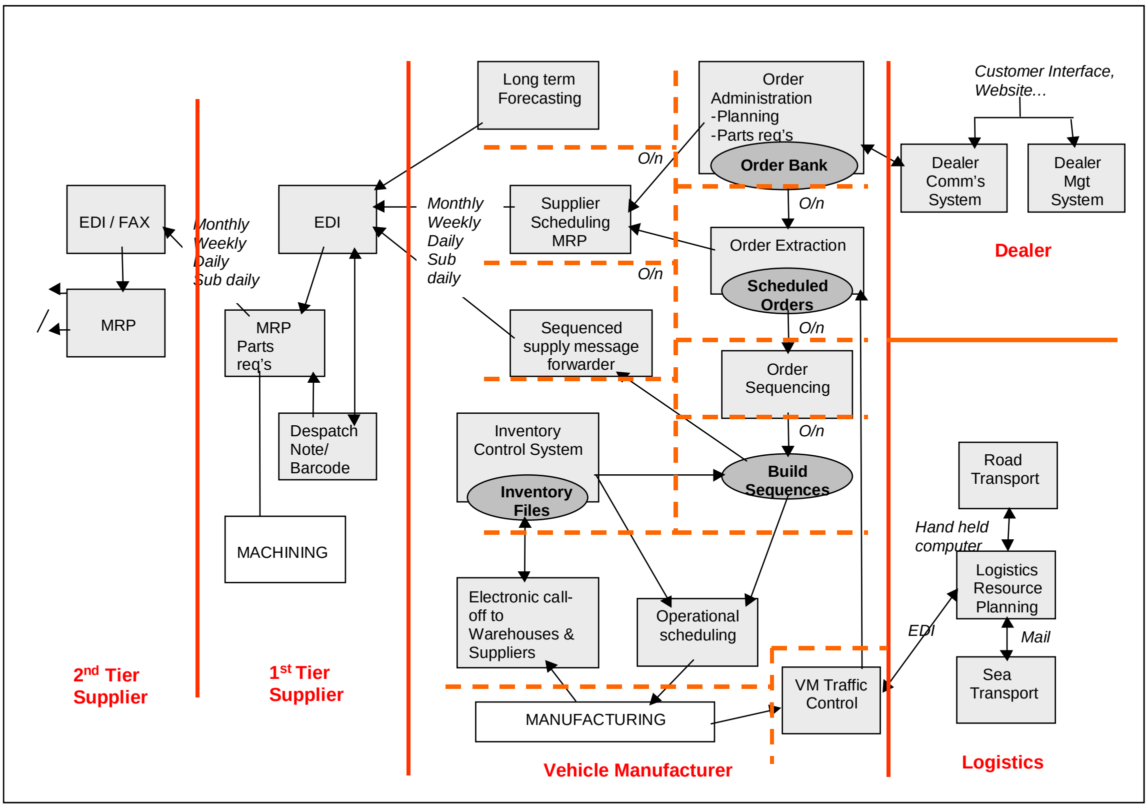

Figure 1: *Generic IT systems map of the automotive supply chain*

Managerial barriers originate from top management. This is the most powerful driving force, or hindrance, to change. During periods of change, managers must show emotional intelligence. However, there may be problems in sharing information, communication and collaboration when rearranging functional and social boundaries. Change can only be sustained through 'top level' planning and directing of the learning process.

User barriers include both internal and external factors as explanations for individual resistance or acceptance to IT (Martinko et al, 1996). Individual fears, attitudes and prejudices as well as the influence of co-workers and supervisors are all significant factors. A successful change process requires the ability to transfer the learning process into practice, motivation, imagination and creativity.

Technical barriers are studied from a practical viewpoint: to make IS fit into a specific role in the organization. New technology usually requires compatibility with existing norms and compatibility with other IS. It must be usable, function properly and reflect the appropriate quality of data. Dimensions of data quality include accuracy, completeness, consistency, reliability and timeliness.

3. RESEARCH METHOD

The 3DayCar (3DC) programme brings together researchers and industrialists from all areas of the automotive supply chain. Six research streams cover systems, organization, technology, environment, marketing, and finance. An IT sub-group co-ordinates the definition and validation of the IT requirement for 3DC and meets regularly with the technology research officer. This paper is based primarily on the findings by the technology research stream, assisted by systems and marketing.

Primary data was collected through a series of semi-structured interviews with car dealerships, vehicle manufacturers, component suppliers and logistics/carriers based around the key research question: what are the current IS barriers to delivering a 3DayCar? Fifteen meetings took place with senior managers, which included a tour of technical facilities where possible. During these meetings a ‘big picture’ was developed and discussed with management, reflecting the flow of information through the organization and the technical infrastructure used to support it. This technique was based around the ‘value stream mapping’ approach (Rother and Shook 1998). The research focused on 8 case studies, 2 from each functional area of the supply chain. Identities of individual organizations are protected. The initial results of the survey were fed back to participating sponsors via a preliminary report and presented at a 3DC conference. This allowed for reflection on the findings.

Case studies are applicable where the research question is of a ‘how’ or ‘why’ nature, where control over behavioural events is not needed, and where there is a focus on contemporary events. Yin (1994) defines a case study as an empirical enquiry *that “investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident*”. Case studies also allow reality to be captured in detail and many variables to be analyzed. From a positivist viewpoint, problems with cases include the difficulty of generalization, lack of control over variables and different interpretations by different stakeholders (Galliers 1992). The case study is an appropriate approach with a complex project like 3DayCar. The phenomenon investigated is barriers to IS-related industry transformation. The research design involves the collection of data through interviews and observation and the data analysis is conducted though application of the ‘BIF’ model.

4. CURRENT PROCESSES IN THE AUTOMOTIVE INDUSTRY

The successful integration of technology between firms involved in the same supply chain and indeed between functions in the same firm represents a continuing struggle for industry. In the automotive sector IT, the extent, and pace of current change in the external environment sets a particularly challenging task for effective design and management at operational and strategic levels. Figure 2 details the current IT barriers between dealers, VMs, suppliers and logistics.

4.1. Dealers

The lack of integration between Dealer Management Systems (DMS) and Dealer Communication Systems (DCS) causes high levels of hand keying and information duplication. Dealers operate two distinct systems. DCS is linked with the VM and provides information on vehicle availability, price, incentive and orders. DMS provides dealers with an independent database of customer details. When an order is placed, significant levels of duplication of information occurs, with identical data such as vehicle description and owner details hand keyed into both systems. In terms of changing the whole vehicle delivery process from a manual to an electronic system, much development is required, as there are still around 20 'hard copy' documents per vehicle.

The system support provided for dealers is often inadequate and not aligned with their business needs. Despite Sunday being a busy day for order enquiries, no IT system back-up is provided by VMs because the weekend is traditionally reserved for system maintenance. Hardware choices promoted by the VM can be inappropriate. For example, the DCS satellite bandwidth is too narrow to transmit all necessary information to the VM. Consequently, some dealers revert to using EDI. Due to the complexity of the process and the duplicative systems, training system administrators for the role can take up to 2 years.

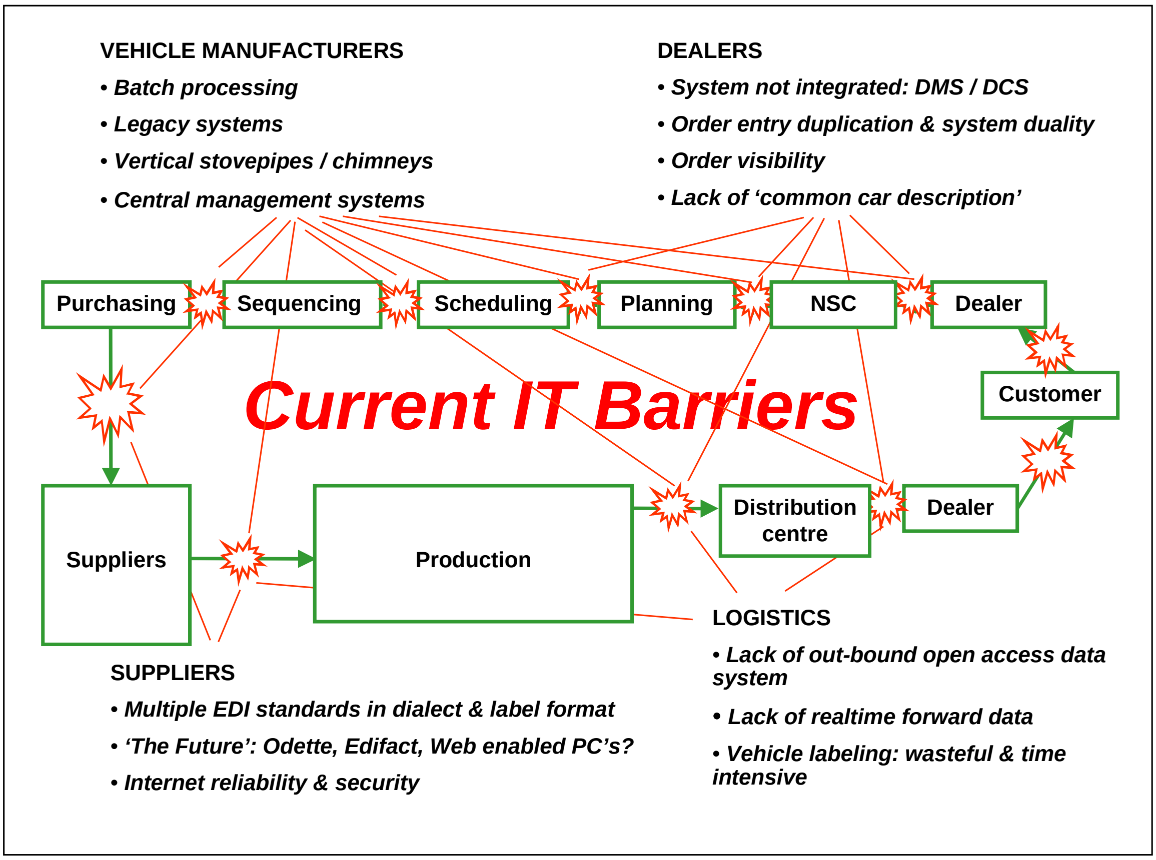

Figure 2: *Current IT barriers amongst key automotive players*

Liaison over systems designed for the dealer network does not adequately involve 'Dealer Councils'. The manager of one dealership stated that he had heard of 13 new DCS software 'improvements' currently being prepared by the VM, but had not been consulted about any during the development process. It is the opinion of dealers that 'IT Specialists' at the VM create new software without working with end-users. This extends to the use of the Internet by dealers for new car sales: their lack of involvement in the VMs going on-line makes dealers uncertain of the future and provides a gap for new entrants, particularly brokers, to enter the market.

Order visibility beyond stocks held in vehicle compounds and distribution is highly variable, but all dealers can see the UK market stock for their franchises. Once a factory order has been placed, some versions of DCS can provide data further upstream in production, but feedback can be slow. If the vehicle is in the VM pipeline, then it can take up to 48 hours for this information to be given to the dealer.

Many DCS do not give a delivery date, or have significant time delays in confirming them - a particular problem for customer-built orders. When dealers are given delivery dates on the system, these often change and are not guaranteed. To compensate for this, dealers add on extra days to the delivery date quotation to the customer. A sales director commented:

> *"We don't confirm the delivery date to the customer until the vehicle actually arrives at the showroom…so much can go wrong!"*

Customer enquiries are delayed by dealers having to use long-winded, descriptive vehicle specification details. The only exact means of identifying a vehicle currently is checking its engine-engraved VIN (vehicle identification number) number, which is considered adequate by VMs, but inadequate by dealers. Complex model variations and the lack of an electronic description standard cause delay and confusion for dealers in obtaining specific vehicle price and delivery dates. The adoption of an electronic common car description standard would simplify this process.

Significant conflict exists in vehicle retailing at present between the traditional 'territorial sales' approach encouraged by the VMs, and the 'empowered customer' approach currently adopted by new entrant IT specialists. New entrants, offering customers the facility to trawl for a quote from a number of dealers, are undermining the current system based on local sales territories.

Despite the imminent threat of losing market share to importers, the traditional boundaries between VM/dealer and dealer/dealer remain, where system ownership and resistance to sharing is obscuring the potential benefits of technological solutions. As one dealer puts it:

> *"Technology is the easy bit, 90% of our problems are process-related."*

VMs of premium vehicles have begun to incorporate configuration tools into their websites, recognizing the power of enabling customers to self-configure and price their own vehicle specifications on the Internet (eg: www.lexus.com). The interface with the end customer appears to changing as VMs begin to adopt new communication technologies and explore new business models pioneered by Dell and Cisco.

4.2. Vehicle Manufacturers

'Batch Processing' is the major IT barrier to 3DC. Large numbers of customer orders are processed prior to production at a set time every 24 hours. The current configuration of VMs' systems typically results in individual mainframe systems updating overnight, processing batches or 'buckets' of orders in time intensive cycles that adds 4-5 days to the order lead time. As information flows through the batch processing systems is largely un-sequenced, it is possible for the output of one process to miss the start of the next window, adding further time into the process.

Legacy systems were originally built for a different world of IT capability, specific tasks (not integrated) and where technology was associated with control. Systems today are still driven by in-bound logistics and push by production, rather than by order demand. Changes to the IT infrastructure have been achieved by VMs simply 'bolting on' additional systems alongside existing mainframe architecture. For example, in the 1990s, PC-based client-server architecture offered a powerful industry standard on which to base new systems. However, few of the old systems were ever fully engineered out of the business and switched off, resulting in complex, overlapping networks. Many VMs face an expensive and ongoing burden of replacement and repair of an ageing 'spaghetti' network of systems.

The research reveals that the total lead-time required to develop, pilot and 'roll-out' systems across several continents can be as much as 10 years. Once committed to an operational IT strategy, VMs have little choice but to complete them regardless of changes to the external environment that may occur.

The generic IT map (Figure 1) illustrates the stovepipe or 'chimney mentality' (Merton, 1968) of VMs. The dotted lines between the VMs' systems illustrates how systems have developed 'within' separate functions. IT tends to be designed to meet the specific objectives of the different players in the supply chain within an organisation. They are not driven by true customer order fulfilment philosophy and inhibit smooth order flow. 'Stovepipe/chimney' refers to the mentality that focuses on the requirements of specific parts of the process without considering what effects may result in other areas. This multiplies the series of batch systems operating, such that once an order has entered the system, it is often invisible to the rest of the firm and to other supply chain partners until it reaches the order sequencing or operational scheduling stage.

Central management systems are popular amongst VMs, due to ease of maintenance and the purchasing advantage gained through economies of scale. However, the time lag introduced at regional plant level, where central batch processing cannot allow for local time differences, can result in higher levels of inventory. Driven by material optimisation, systems are designed for purchasing and in-bound logistics (pull to production) aspects of supply rather than for the flexibility to respond to individual markets (pull to customer demand).

4.3. Suppliers

Suppliers perceive the major IT barrier as a lack of adherence to EDI standards by VMs in terms of protocol (language used during transmission) and format (the label layout or visual interface). Currently, EDI format changes are made by VMs up to three times a year. Suppliers already receive messages in about a dozen different formats, all of which must be converted to a common standard before they can be processed internally. This causes delay and disruption to the system, particularly in the event of a system malfunction.

Converting electronic data to 'hard-copy' documentation is a lengthy process for suppliers faced with delivering vehicle parts to depots in transit to other destinations. Typically seven duplicate copies of documentation per part is required, specifying carrier, warehouse, depots and final destination.

Each format change costs a supplier around two 'IT manager weeks' worth of labour. Considerable time is spent by suppliers with IT software consultants, where the suppliers are increasingly reluctant to build and maintain a customized system with diverse inputs from around a dozen demanding customers who seem to change their minds on a whim. Suppliers are concerned about the significant costs of IT administration caused by the undisciplined approach by VMs and the implications of adopting new technology on an unregulated, individual basis.

The arrival of the Internet has rejuvenated EDI by allowing the same data to be used in a different manner: i.e. using the existing telecom infrastructure with any customer and in real time. This represents a major opportunity for 2nd and 3rd tier suppliers, a high proportion of whom are not connected to 1st tier suppliers by EDI and rely on fax, phone or post. However, 1st tier suppliers, beginning to perceive bespoke EDI as complicated and costly, are experimenting with other 1st tiers on a joint study of business-to-business (B2B), Web-enabled e-procurement. In theory, this will allow real-time interaction, for example in notifying a customer of the precise time when a component delivery has left the site.

Despite current Internet experiments, uncertainty exists amongst European suppliers over what technology they should invest in. Suppliers have taken a rather haphazard approach to IS strategy where, according to the manufacturer they are supplying, they have adopted a mix of various systems. In the future, Web enabled PCs and membership of the relevant Internet trade exchange sites may be sufficient. However, this too will require significantly more inter-VM co-operation than exists at present, in order to achieve and maintain a universal operating standard.

There is concern among suppliers who have adopted Web-enabled systems that they do not offer sufficient reliability or security to conduct transactions between businesses. A total system failure whether caused by the Internet or otherwise, cannot be buffered by the low stock levels typically held at most plants. Suppliers also question whether the Internet is ready to support mission-critical operations, where delay in delivering a message could ultimately mean the stopping of a vehicle assembly line. Accountability would ultimately rest with the supplier. This is regenerating some support for traditional EDI and dedicated machine–to-machine links.

Thus, suppliers are awaiting further developments in Web technology before committing to a route that currently provides more flexibility, but is lacking in reliability and security. 2nd and 3rd tier suppliers question how they will ‘figure’ in the big automotive manufacturing portals like Covisint, the Internet trade exchange, whose membership currently includes Ford, General Motors, Daimler Chrysler, Renault Nissan and major suppliers. Concern is focused on whether it is the VMs, who currently hold the most power in the supply chain, that stand to benefit most. Suppliers are concerned that once they are committed to new technology, it may be used against them, to enforce unilateral price cuts.

4.4. Logistics

In-bound logistics systems for materials and components are more developed than those for out-bound vehicle distribution, but this contradicts the value of the goods carried. Despite having their own systems, the lack of contractual commitment given to outbound logistics providers promotes short-termism, which hinders long term investment and the development of new IT facilities. The key issue is poor data on projected volumes and resource planning, as part of the general quality of advance information from the VMs’ central control. Outbound logistics providers lack a universal open-access data system that is integrated into the VM system.

Lack of connectivity is the main technical obstacle, particularly in current out-bound logistics. However, wide area networks and extranets could be utilized to provide a high portability of information, ease of transfer and access, eliminate re-keying of data and time lost on updates. This could reduce the number of non-contradictory messages from VMs being exchanged with supply chain partners, a common issue for logistics providers for outbound transport.

Out-bound logistics complain of inadequate real time forward data for delivery planning. They feel that shorter lead-times are required, driven by ‘smart’, fast routing systems, meaning the end of long lead-time based load consolidation.

Logistics firms argue that there is much new technology of which VMs are not aware. While they use off-the-shelf routing and load planning software, they are eager to develop more sophisticated network planning systems that can learn from route planning. This software uses 'genetic algorithms' that claim to cut journeys through experience and recalculation.

Proactive decision making systems are required, such as suppliers taking control of replenishment, based upon a signal to build for a delivery date from order placement at the factory. Mid-journey re-routing could be used by the logistics firms to provide a ‘24 hour, 7 day environment’ that is responsive to changing requirements and takes into account fleet capacity. Capacity sharing or ‘back-loading’ amongst logistics providers is currently managed on an ad hoc basis. Logistics firms suggest that there is a need for an information sharing pool between VMs and themselves and genuine multi-franchise delivery. All players’ systems would allow limited access to each other, enabling everyone to maximize their transport through combining overall volumes and utilizing cross-docking. This could create a single logistics trading exchange, similar to Covisint. The current system needs to be reconfigured to provide instantaneous updates to route changes and to allow for greater flexibility of use by all supply chain partners. However, one manager emphasizes that before implementing change in the massive supply chain management system:

> *“It must first be more visible and open.”*

5. DISCUSSION AND CONCLUSIONS

Overall, the cases suggest an industry divided by functional barriers and lacking integration and connectivity. In order to move towards 3DC, there is a need to focus on customer-pull, rather than supply-push. Originally, this research was conceived in a purely technological context; that of eliminating batch processing and moving from IT legacy towards fully integrated systems. However, it became increasingly difficult to distinguish between product/technology and process/organization issues. It became evident that a more complex relationship exists between IT barriers and organizational change. The BIF model was chosen in order to provide a framework for exploratory analysis of the situation (Table 1).

	Dealer	Vehicle Manufacturer	Supplier	Logistics (Outbound)
Structural	Poor visibility of orders throughout the network. Geographical territories and an unwillingness to share information between dealerships.	IT Legacy: new systems 'bolted on' to existing architecture, old systems not switched off. Existing IT solidifies the formal aspects of organizational structure.	Traditional 'tiered' structure of 1st, 2nd & 3rd suppliers and 'power distance' is preventing collaborative decisions.	Lack of direct planning between VMs and outbound logistics.
Managerial	Inadequate system support for dealers by VMs. Wish to maintain the dealer network	Technology associated with 'control'. Central management systems popular: ease of maintenance & EOS. Rooted in production push rather than customer pull.	Lack of adherence to EDI standards by VMs: formats changing up to 3 times a year. Concern about B2B portals and exclusion of 2nd 3rd tier suppliers (Covisint)	Lack of contractual commitment by VMs.
User	Distrustful of the current order delivery system. A feeling of 'dealers v VMs'.	Stovepipe / chimney mentality: functional & departmental attitudes. Poor business process integration.	Growing reluctance to maintain the system for demanding customers who 'change their mind on a whim'. Difficulty of translating electronic documents into paper.	Sharing of information by VMs on an ad hoc basis only.
Technical	Lack of integration: DCS & DMS. Lack of electronic description standard. DCS satellite bandwidth too narrow.	Batch processing. 10 year lead times to roll out systems worldwide.	Uncertainty over what technology to invest in for the future: EDI or the Web/XML.	Poor connectivity and integration: lack of an 'open access data system'. Poor quality of advance information and unsophisticated route planning software.

Table 1: *Barriers information framework in the automotive industry (adapted from Kirveennummi et al., 1998)*

Although the framework works well as a device for structuring understanding of the 3DayCar situation, as with any framework classification in use, it presents ambiguities. For example, structural barriers are defined as formal (organizational structure and policies) and informal (culture). There is overlap between, for example, the user barriers and the cultural aspects of structure. Futher, many of the issues will be associated with more than one type of barrier. For example, with EDI standards there is a technical issue concerning traditional EDI and dedicated computer-to-computer connections versus Internet data standards based on XML (extensible Markup Language). This technical issue also has structural implications for the industry players, as it will affect the formal communication channels between parties. If open data standards are used in business-to-business portals there are management (policy) aspects to consider, such as the exclusion of smaller suppliers through restricted markets (e.g., Covisint). This suggests that care must be taken when categorizing aspects of the situation as a single type of barrier, particularly where it perpetuates a strong divide between social and technical barriers.

The second criticism of the model is that it lacks consideration of interest and motivation, i.e. the issue of who gains and who loses as a result of industry transformation. This is because the emphasis of the framework is inward-looking, being more applicable within an organization implementing a system with few external dependencies. One approach to the analysis of the industry would be to conduct an analysis using stakeholder salience theory (Mitchell et al., 1997) in order to understand the power, legitimacy, and urgency of the 3DayCar for the various parties. Preliminary analysis suggests that second and third tier suppliers are 'dependent' stakeholders – they have legitimacy and urgency but do not have power. VMs appear to have legitimacy and power, i.e., they are dominant, but do not have a sufficient sense of urgency.

Third, although the model addresses organization structure, it does not consider the wider context of industry structure. This is especially important in a networked industry when participants cannot plan or develop systems without consideration of their impacts on other players. The barriers framework is less useful when considering the industry as a whole, which is more than the sum of its dealer, VMs, suppliers, and logistics parts.

In conclusion, this research demonstrates that IS and IT are essential to 3DayCar and industry transformation, but the barriers are considerable. The BIF model is a good structuring tool that provides insight into 3DayCar by classifying the IS-related industry barriers by category and industry player, providing valuable input to planning for change. The model reveals that it is the vehicle manufacturers who control the order-to-delivery process and have significant influence over other key players. The research identifies three shortcomings of the BIF approach: the potential for misclassification, a lack of concern for motives, interests, and power, and the insular nature of the model. Extensions to the model were suggested. For example, approaches such as stakeholder salience theory may help to overcome the second of these problems, and the third may be addressed by multiple uses of the model for each value chain player, while the first problem is one inherent in any classificatory scheme. However, recognition of this latter problem helps mitigate its effects.

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