



*Citation for published version:*

Roehrich, JK, Parry, GC & Graves, AP 2011, 'Implementing build-to-order strategies: Enablers and barriers in the European automotive industry', *International Journal of Automotive Technology and Management*, vol. 11, no. 3, pp. 221-235. <https://doi.org/10.1504/IJATM.2011.040869>

*DOI:*

[10.1504/IJATM.2011.040869](https://doi.org/10.1504/IJATM.2011.040869)

*Publication date:*

2011

*Document Version*

Peer reviewed version

[Link to publication](#)

## University of Bath

### Alternative formats

If you require this document in an alternative format, please contact:  
[openaccess@bath.ac.uk](mailto:openaccess@bath.ac.uk)

#### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

#### Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

**'Implementing Build-to-Order Strategies: Enablers and Barriers in the European Automotive Industry'**

**Introduction**

The automotive mass production model which has been adopted for the best part of the last century is clearly no longer viable in business environments typified by turbulence and flux (Holweg, 2008). There is a growing need for integrated supply chains that can build and deliver to confirmed customer orders (Parry and Graves, 2008; Sharif et al., 2007). However, 'the mass customisation paradigm' (Pine, 1993) is proving difficult to operationalise, even at local levels. A build-to-order (BTO) strategy reflects the idea that value-adding activities such as assembly and manufacturing are triggered by customer orders rather than forecasts (Salvador et al., 2007). By performing these value-adding activities only in response to confirmed customer order, firms would be able to avoid, or at least minimise, the risks inherent in utilising forecasting driven manufacture, where uncertain events lead to high levels of excess inventory and poor customer service (Gunasekaran and Ngai, 2005). Prior research highlights that while build-to-order strategies have been implemented in the personal computer sector (Gunasekaran and Ngai, 2005 and 2009), increasingly complex manufacturing operations, such as found within the automotive sector, have been slower in adopting these strategies (Holweg and Pil, 2004).

The increasing significance of a BTO strategy results from two developments (Reichhart and Holweg 2007): (i) the number of product variants, and hence stock holding requirement, has been increasing across most industries, and (ii) time has become a factor in competitiveness as customers are increasingly reluctant to accept long lead-times for products and services. A build-to-order strategy is seen as offering the automotive industry an opportunity to both develop a more sustainable future (Stone and Brauer, 2008), but requires innovation and collaboration throughout the automotive enterprise and rapid and more cost effective new product development. The European automotive industry has long been faced with overcapacity (Wells, and Rawlinson, 1994), driven by a business model that requires up to 250,000 unit sales per annum, or 80% utilisation of a factory capable of 300,000 units per annum just to break even (Orsato and Wells, 2007a). Environmental concerns put further pressure on the industry to reduce waste and pollution, whilst at the same time increasing pressure on economic performance (Orsato and Wells, 2007b). New manufacturing systems

must therefore improve flexibility, responsiveness and quality in order to deliver greater profitability and return on capital employed.

Issues of BTO implementation have not been discussed holistically and at length and further research is needed to fill existing knowledge gaps (Gunasekaran and Ngai, 2005). This paper aims to add to the limited research base, seeking to add to the understanding to the potential obstacles and enablers in managing the BTO transition. In this context, the study examines a number of important factors which need to be considered in managing the European car industry during its potential transition to the new paradigm of building cars to customer. In addition, the paper considers the challenges facing the automotive industry in terms of three linked and corresponding factors: the social, economic and environmental challenges facing the industry.

The paper is organised into five sections. Section 2 locates the paper in the literature on BTO in the European automotive market. The following section considers the research's methodological considerations and section 4 then presents the empirical findings. In section 5, the research findings are discussed and the paper concludes with implications for future research and recommendation for practitioners.

## **Conceptual Background**

The conceptual background introduces the European automotive industry, explains the concept of build-to-order and the drivers and barriers for BTO transition.

### *The European Automotive Industry*

By the late 1990's both US and European vehicle manufacturers had closed the performance gap on the leading Japanese producers through adopting lean production (Parry and Graves, 2008). However, it was evident that focus had been placed upon assembly plant productivity at the expense of delivering cars that customers wished to purchase. Within the UK a collaborative research programme was formed, funded by the UK Government together with leading industrial partners, in order to develop an organisational and process framework within which a customers' need for a vehicle could be fulfilled from order placement to delivery in 3 days. Whilst 3 days was set as a desirable target for vehicle delivery as, at the time, it was unclear how long the process took. Research data showed that, largely a result of lean efforts, physical production was taking only 1.4 days, but order to delivery time was, at best 40 days (see Table 1). Indicative findings from the research

highlighted a need to focus on product strategies and body structures, assembly and improved communication from customer through the supply chain.

*<Insert Table 1 about here>*

As one of Europe's major industries, automotive production employs 2.2 million people directly and it has been estimated that 10.3 million people are employed in related sectors (ACEA, 2008). The over-capacity of European automotive industries is not spread evenly across plants, original equipment manufacturers (OEMs) or geographically across regions. Threatened plant closures and production shut downs on the scale witnessed during the financial crisis beginning in late 2008 to reduce capacity has a significant, adverse and enduring effect on brand diversity, the local populations and ultimately gross domestic product (BBC News, 2009; Reuters, 2009; Ryall, 2009; Thompson, 2009). Relocating production towards low wage economies may provide short term cost reduction through lower wage bills, but raw materials are bought and priced on a global market. The approach may prove to be short sighted as it will almost certainly decimate production in the domestic markets of central Europe. To protect the European economy, new approaches that allow costs to be controlled whilst maintaining the domestic markets are urgently required (Holweg and Pil, 2004; Stone et al., 2008). Transferring to more sustainable methods of vehicle production involves tackling some difficult challenges that require political, economic, social, environmental, technological and legislative changes.

Major vehicle manufacturers have managed to increase product complexity and reduce lifecycle time as they strive to develop and manufacture a larger number of variants within shorter time-to-market cycles (Scavarda et al, 2009; Schaffer and Schleich, 2008; Schleich et al., 2007). However, the failure to develop a robust business model led to the shutdowns of early 2009, but the industry's ability to continuously innovate may again provide its own salvation. 'Lean production' was documented by researchers who set out to understand the best practice underpinning the productivity gap between Japan and other automotive manufacturers (Womack et al., 1990). Through rigorous application of lean thinking, Western automotive companies have now significantly reduced the productivity gap identified by Womack et al. (Merlis et al., 2001), but have not yet delivered on its heralded promise of zero inventory or just-in-time approach to customer orders. Short lead times give competitive advantage to those who understand and meet market needs (Bower and Hout, 1988; Stalk, 1988). By holding tens of billions of dollars worth of stock in finished goods, automotive companies are able to rapidly meet demand. European manufactures are holding approximately two months new vehicle stock (Brauer and Seidel, 2008; Miemczyk and

Holweg, 2002; Stone et al., 2006). Reported US stock figures ranged from an average of 25 days for BMW, 85 days for GM and 35 days for Toyota between 2006 and 2007 (Automotive News, 2006; 2007). Whilst this capital intensive approach enables car manufacturers to seek a good match to the purchaser's requirement from their stock, they are compromised by their own business model as the large variety of product options they market means that customers have highly specified requirements and they frequently cannot be found an exact match. The sales staff then negotiates discounts, eroding the manufacturer's profits as a result of failing to meet the customer's request (Holweg and Pil, 2001).

Despite the current high cost of capital borrowing, the mass-production business model still pervades, with global overcapacity and rising stock levels coupled with low profitability. Build-to-order is only delivered to a small percentage of customers at the vehicle purchasing interface where both customers and financial performance indicators show it is desirable. Globally, manufacturers have yet to implement an automotive enterprise system that is responsive enough to rapidly meet a significant volume of customer demand.

#### *The Build-to-Order Concept*

Build-to-order refers to a demand driven production approach where a product is scheduled and built in response to a confirmed order received for it from a final customer (Holweg and Pil, 2004; Parry and Graves, 2008). A key aspect of BTO supply chains is the ability to respond to requests for manufactured products on demand, negating the need to accurately forecast customer demand in advance. A BTO strategy is attractive when forecasting is difficult, such as when the markets served by a firm are turbulent (Anderson, 2004). In contrast, build to stock (BTS) is the dominant approach used across the automotive supply chain and refers to products that are built before a final purchaser has been identified, with production volume driven by forecasts (Parry and Graves, 2008). It is this approach that has been employed to deliver rapid customer gratification. The expense lies mainly in terms of stock, but also transportation as finished goods are rarely where they are required.

A BTO system does not mean that all suppliers in the supply chain would produce goods to confirmed final customer order. It may not prove economically viable for a manufacturer of washers or small fixings to employ BTO. While small high volume, low value components should be built to a supplier order, effectively BTS, larger and higher value components or systems should be BTO (Mandel, 2008). The challenge for supply chain professionals is to identify correctly which suppliers should adopt the BTO and for which the BTS concept is appropriate. The point in the supply chain when this change occurs is called the 'decoupling

point', a point that the majority of automotive supply chains currently lack due to the dominance of BTS (Toth et al., 2008).

#### *Drivers for Build-to-Order*

Various drivers for the implementation of the BTO concept can be identified ranging from economical to sustainable to financial. The current tightening of lending, leading to an increased cost of capital and subsequent pressure on the BTS model has already been discussed. However, there are additional pressures which would support a move to BTO.

An important factor driving change in the automotive industry today is the competitive pressure that exists to reduce development and manufacturing cycle times and costs and to identify and improve value for the customer (Graves, 1987). New manufacturing systems must therefore improve flexibility, responsiveness and quality in order to deliver greater profitability and return on capital employed. The extant business model has led car customers to expect ever increasing choice which has directly lead to a proliferation in the diversity of models and ranges available on the market, complete with the latest developments in technology (Schaffer and Schleich, 2008). New ranges of vehicles require extremely flexible and on-demand manufacturing processes that are capable of evolution and change.

Another serious consideration for the industry is sustainability and the reduction of its 'carbon footprint' by product simplification and reduction in the number of movements each part or sub-assembly makes (Seidel and Huth, 2008). A common method, adopted by OEMs to optimise supply, reducing the complexity they face and rationalise supply routes is to rely on third party Logistic Service Providers (LSP's). However, there is a limit to which LSPs can stretch the efficiency potential. Road networks are becoming less cost effective as a means of reaching the market and greater pressure is being put on ocean carriers to move products around the globe as the relocation of production sites to low cost economies adds greater pressure on container capacity (Thelen, 2007).

#### *Resistance to Change*

Resistance to changes is a key barrier to successful implementation of new initiatives (Drew, 1994). Within the supply base, small and medium sized companies must move beyond traditional technical excellence or operational flexibility to meet the changing needs of their customers (Cagliano et al., 2001). In addition, relationships with suppliers have been considered key to success (Selto et al., 1995). Relationships must be carefully specified as collaboration and co-development is required for BTO product innovation (Howard and Squire, 2007). Hanson et al. (1994) argue that companies capable of forming learning

relationships with other companies move most rapidly to adopt new working practices, highlighting the importance of supply chain learning (SCL). However, supply chain management programmes frequently do not incorporate this learning element (Bessant et al., 2003). Investment is required in firm's ability to value, assimilate and commercialise external knowledge (Cohen and Levinthal, 1990). Successful collaboration between and amongst supply chain participants may help to overcome these barriers (Sharif et al., 2007).

In summary, there is a vast disconnected academic literature on transition and change across different disciplines (Leseure et al., 2004). The challenge facing the automotive industry if it is to transition to a BTO model is significant and research focusing on the factors that shape the decisions on BTO strategy implementation would be highly relevant (Salvador et al., 2007).

### **Research method**

The empirical findings reported in this study draw upon the pan-European research project, Intelligent Logistics for Innovative Product Technologies (ILIPT). This programme was initiated following the completion of the UK 3DayCar project comprised of leading academics and consultants. The aim of the 3DayCar programme was to satisfy UK customer requirements by producing a car that the 'customer wanted, when they wanted it'. The European Union (EU) and European automotive industry jointly recognised both the importance of continued automotive manufacturing to Europe and the failure of the current business model and so established the ILIPT project to develop and study the feasibility of a BTO business model for the European automotive sector. Recognising the European scale, it was agreed to set a challenging target for this model of only 5 days from confirmed customer order to delivery. To meet this new '5 Day Car' target the necessary improvements in productivity would require a radical restructuring across a broad spectrum of activities, as well as a possible revolutionary change with regard to its technological capacity.

The underlying objective of this research study was one of exploration that will lead to the development of an implementation framework highlighting barriers and enablers for the BTO transition. The data collection phase involved capturing the views of European industry executives at twenty-two ILIPT dissemination events held throughout Europe during 2007 and 2008. A detailed overview of the build-to-order concept was presented to assembled audiences of automotive executives and decision makers able to drive BTO implementation. From over 100 participants presented with questionnaires at the events, usable responses were provided by fifty-five executives from automotive producers and suppliers including

OEMs such as BMW, Audi, Daimler, and Volkswagen along with suppliers including Siemens, Hella, Robert Bosch, Iveco Magirus Dräxlmaier HIB, Alcan Singen, ZF Lemförder and LSP Ferrostaal. We obtained 30 responses from OEM employees and 25 from supplier employees. The respondents were categorised into two groups: (i) individuals from multiple levels of the organisational hierarchy such as executives, middle managers, and directors, and (ii) individuals from different functional areas such as research and development, operational and strategic management. It should be noted that the majority (more than 80%) of the responses represent senior managers which at least 5 years experiences in the automobile industry.

A structured questionnaire made available in both English and German language was used to collect data along with researchers writing down key points raised following presentations at dissemination events. Results collected in German were subsequently translated into English. The questionnaire consisted of 20 questions structured across areas such as current BTO practice at OEM and supplier level, barriers of BTO implementation ranging from cost to structural complexity, and the importance of company size and inter-organisational relationships. Our extensive primary data set was then collated with secondary data sources such as company reports, business strategy documents, industry trade reports and newsletters to strengthen the research validity (Yin, 2003). During the data analysis process, findings were structured and displayed in summary tables. A summary report was sent out to key informants to check data reliability and accuracy. To further enhance validity results and analyses were extensively discussed by the research team, an external researcher and then presented and discussed by a review panel of automotive experts as part of the ILIPT project EU commission review process. This process informed the structure of the findings and discussion sections.

## **Findings**

The following section highlights the empirical findings of our data collection phase concerning the implementation of BTO concepts in the European Automotive Industry.

### *The BTO Concept*

Respondents across OEM and supplier firms suggested that in order to drive process efficiency in a BTO system, the majority (~80%) of cars should be built to customer order. Respondents from the OEM side argued that the remainder of production capacity could be used to load-level, smoothing demand for production capacity, and producing vehicles where variety is much reduced, for instance in the fleet markets. Two thirds of respondents believed that the build-to-order concept is the most promising opportunity for the European

automotive industry, delivering benefits, among others, leading to lower stock levels and cost reductions. Interviewees across different managerial functions and from OEM and suppliers argued that the automotive industry in Europe is not capable of building a short lead time vehicle under current conditions. While acknowledging the need and importance of the BTO concept for car manufacturers, OEM and supplier interviewees asserted that order-to-delivery must be achieved by transforming the whole supply enterprise and late configuration of finished products alone would not prove to be sufficient. Nearly all (92%) of the interviewees stressed the point that successful implementation of a BTO system would require OEMs' entire systems to be radically changed, representing a challenging and potentially costly barrier to overcome. A similar picture was drawn for key suppliers who would in turn need to change their systems in order to fully support OEMs in their transition to BTO.

#### *Barriers to Build-to-Order Transition*

While our primary and secondary data sets suggest that most European manufacturers have already undertaken some form of implementation trials based on BTO concepts and mainly OEM interviewees regularly referred to examples of good practice in implementing BTO concepts, a myriad of barriers were identified hindering the BTO implementation process. The majority of supplier interviewees stated that the increasing costs of re-training personnel, restructuring administration and adjusting existing facilities were barriers for a successful BTO transition. Respondents from OEMs also identified barriers that currently exist in implementing BTO ranging from structural complexity (organisational and product), the need to spend extensive funds upfront, a lack of reliable information available on BTO transition programmes and their benefits, a lack of process synchronisation across the various companies involved, and a long planning horizon. For instance, organisational and product complexity calls for intensive work to be invested in process mapping of every affected operation and subsequent process redesigns. Moreover, our empirical work suggests that the size of a company influences its ability to adopt new practices. The majority of respondents (70%) suggested that large companies were considered to be less able to adopt new practices. Having access to sufficient resources, and allowing an appropriate timeframe to be made available for the implementation was described as crucial factors to facilitate a successful implementation of BTO concepts. A lack for resources ranging from financial to human to firm capabilities was mainly stated by respondents from the supplier side. Both OEM and supplier respondents mentioned that upfront and continuous training including familiarisation of principles, concepts and technicalities for all project team members is vital to BTO implementation success.

#### *Drivers for Build-to-Order Transition*

In order for companies to be able to adopt and deliver a successful transition to BTO, respondents identified and described various factors that a company needed to have in place. These ranged from employees having confidence in the final process to the need for additional internal and external experts to guide the implementation process. Respondents from the OEM side argued for the development of an appropriate incentive scheme which would help drive adoption and implementation of change within a firm and across the supply chain. Moreover, OEM respondents draw out the critical factor in driving a successful BTO transition as establishing the involvement of the company's key suppliers. OEMs, in partnership with key suppliers, would need to drive and stimulate a successful transition to BTO as identified by the majority of our respondents. OEM interviewees stated that build-to-order implementation would be slower and less successful without supplier engagement and involvement as a BTO strategy calls for a holistic approach to supply chain reconfiguration.

Respondents across different managerial positions argued that build-to-order concepts require both continuous senior management support and the need for operational managers to drive implementation. Thus, a shared vision among all key internal and external stakeholders about the benefits and importance of BTO concepts is needed and crucial for implementing BTO. Overall, the external firm environment was seen by the majority of interviewees as a key driver for the implementation of BTO. Thus, respondents argued that the industry might eventually reach a point of crisis. The reaction would be a forced adoption of BTO concepts in order to reduce costs and to stay competitive. Similarly, some OEM respondents argued that a new entrant building a business based on a build-to-order model could act as a catalyst for change by threatening incumbents' profit and market shares and again forcing the BTO transition. While mainly OEM respondents suggested that customers might be the key source of demand for the adoption of a build-to-order system, supplier side respondents argued that change may also be driven by investment banks. Banks were considered key stakeholders in the automotive industry, hence seeing BTO as a driver for cost reduction, providing them with greater returns on their investment.

## **Discussion**

The BTO concept is concerned with value-adding activities such as assembly and manufacturing which are triggered by customer orders rather than forecasts (Salvador et al., 2007). Supporting previous findings, our empirical data confirms that firms adopting a BTO strategy are able to minimise or even avoid the risks inherent in manufacturing output based on systems for forecasting uncertain events, which lead to increased levels of inventory, increased cost and poor service (Gunasekaran and Ngai, 2005). Nowadays, customers are expecting a wide range of choices, leading to a sharp increase in the diversity of car models

and ranges offered (Schaffer and Schleich, 2008). Respondents emphasised that the key factor to act as an impetus for change is the competitive pressure for incumbents to reduce development and manufacturing cycle times, thus leading to cost savings. This view is supported by proponents of the BTO concept who argue that resulting lead time reductions will help to provide sustainable competitive advantage to companies capable of deploying a BTO strategy (Bower and Hout, 1988). However, our data also shows that while the need for BTO implementation is omnipresent, the mass-production business model still pervades, with global overcapacity and rising stock levels coupled with low profitability.

Our empirical findings into BTO strategy deployment support the study by Howard and Squire (2007) arguing that supplier relationships must be carefully specified as collaboration and co-development is required for a transformation to a BTO strategy. However, while interviewees emphasised that working closely with key partners is vital for successfully implementing BTO concepts, it will also bring about significant challenges. Whilst OEMs must lead the change, findings suggest they are least able to change themselves. Our empirical work also confirms that small and medium sized companies must move beyond traditional technical excellence or operational flexibility to meet the changing needs of their customer companies (Cagliano et al., 2001) to facilitate a successful transition.

The empirical data illustrates that considering the immense scale of change required for a transition to BTO, senior and operational managers may lack experience in the necessary BTO processes and practices. Companies need to gain experience through trials based on BTO concepts and management need to receive appropriate training before the implementation programme can be realised. This finding is supported by prior research arguing for continuous training to drive and support change (Ahire and Ravichandran, 2001; McLachlin, 1997). Respondents emphasised the development of firm-specific experience in BTO concepts and practices will facilitate firms to customise their transition, taking into consideration the firm's specific context and experience. Our research shows that there is no single best solution for implementing BTO and firms need to adopt contingent implementation strategies taking into consideration the internal and external firm environment. However, the majority of respondents stated that reliable information and evaluation regarding existing good practice is limited, hindering a smooth transition to BTO strategies.

The extensive empirical data set collected shows that BTO transitions require complex changes that go beyond the boundaries of an individual firm and impact the whole supply chain. Thus, respondents argued that careful planning is needed to ensure that resources

are available and interdependencies between stakeholders are considered. Our data highlights the need for setting clear planning objectives to facilitate the successful BTO transition. This finding supports Davies and Kochhar's (1999) study showing that a lack of clear planning results in poor implementation during major benchmarking programmes. Respondents across different managerial positions stated that a lack of resources can hinder the successful implementation of BTO strategies. While interviewees stated that the availability of financial resources needs to be secured upfront, mainly interviewees from suppliers raised concerns regarding a lack of trained personnel and the need to restructure internal processes. Empirical work also suggests that a lack of resources is not necessarily affected by size of the firm, but is correlated to the complexity and "interconnectedness" of the firm's operations.

Based on the primary and secondary data sets collected and the extensive analyses, the guiding framework for BTO strategy implementation is shown in Figure 1, outlining key drivers and barriers. The framework highlights the organisational, structural and financial barriers in implementing a BTO strategy. In addition, organisational, economical, sustainability and financial drivers to build-to-order strategy implementation are shown in Figure 1.

*<Insert Figure 1 about here>*

## **Conclusions and Implications**

The build-to-order concept has been emerging as a major operation strategy for improving organisational competitiveness. This study's conceptual background serves, in combination with the empirical data, as a comprehensive base for understanding and developing a framework for BTO. The build-to-order approach outlined allows automotive firms to be fully sustainable (Elkington, 1994; Brauer, 2008). This research study explores some of the challenges and opportunities a firm may face when implementing a BTO strategy.

As with many business transformation strategies the effective implementation of a BTO strategy is dependent upon a number of fundamental factors relating to organisational, cultural and inter-organisational relationship perspectives. The research has highlighted the importance of training industry leaders and the workforce in BTO principles and practices, establishing clear planning and objective settings, enhancing supply chain learning, and aligning key stakeholders across the supply chain. Our empirical findings show that BTO change processes need to be initiated by OEMs, who were also perceived as least able to

adapt themselves. However, the transition processes will be the responsibility of the whole supply chain, requiring innovation and flexibility from suppliers.

The BTO strategy requires innovation within product development, with new products utilising extensive modularity to reduce costs whilst increasing potential variety. Establishing and maintaining inter-organisational collaboration will deliver product to customers within a timescale acceptable to the market. This will be achieved through innovative logistics and intelligent integration of suppliers. While build-to-order strategies offer the automotive industry an opportunity to eliminate overcapacity, its implementation will be a long and emerging process.

#### *Practical Implications*

Managers in the automotive industry charged with implementing a BTO strategy need to consider various enabling and hindering factors. These factors include organisational behaviour, communication and inter-organisational openness, resource availability and allocation, and budget considerations. The findings suggest that the key drivers for implementation may come, not from internal recognition of the benefits, but from external drivers that threaten the existence of the incumbents and force a transition to BTO. Indeed, it may be that a further crisis is required to empower managers to overcome the significant barriers recognised. Whilst many recognise the benefits of the new paradigm they have not yet been able to make a case to justify the significant cost and effort that is required to implement BTO across the automotive enterprise.

#### *Research Limitations and Future Research Implications*

This study was based on a limited set of individual responses from OEM and supplier firms. Additionally, the empirical data collected represents a static analysis of data at a certain point in time in the automotive industry. Future research should investigate BTO strategy implementation both longitudinally in the automotive industry and across other sectors. This will allow the inclusion of significant independent and contextual variables in subsequent theorising efforts leading to further development and testing of the guidance framework proposed. Finally, as the business scope of the automobile industry is international, it would be beneficial to replicate this study in other countries to capture and understand the phenomena across different cultural settings.

## References

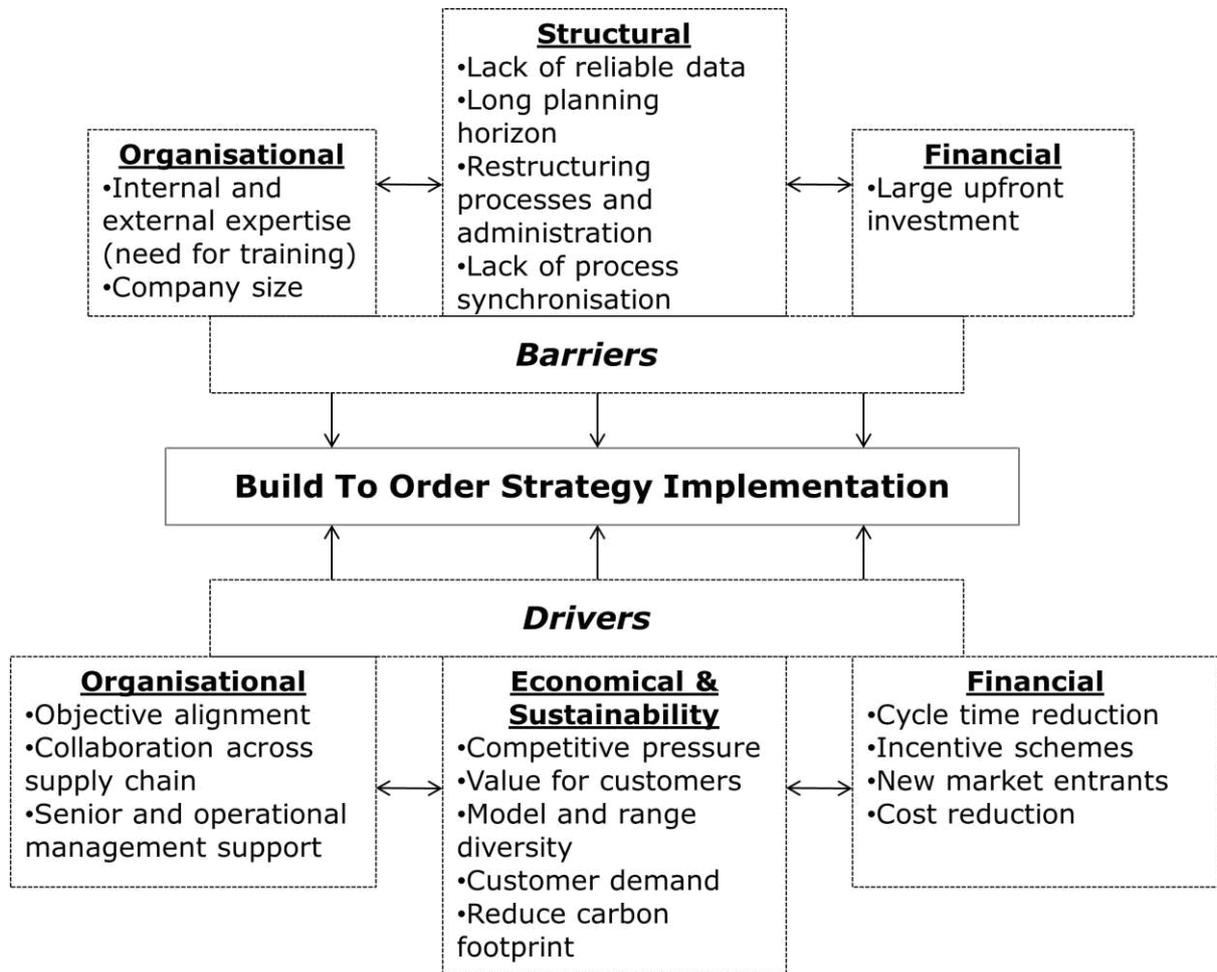
- ACEA (2008). *The Automobile pocket Guide 2008*. Obtained through the Internet: European Automobile Manufacturers Association, [http://www.acea.be/images/uploads/files/20081003\\_Pocket\\_Guide.pdf](http://www.acea.be/images/uploads/files/20081003_Pocket_Guide.pdf) [accessed 5/3/2010].
- Aichlmayr, M. (2001) 'Warehouses pick, pack and build to order', *Transportation & Distribution*, Vol. 42, No. 5, pp.87-96.
- Ahire, S.L. and Ravichandran, T. (2001) 'An innovation diffusion model of TQM implementation', *IEEE Transactions on Engineering Management*, Vol. 48, pp.445–464.
- Anderson, D.M. (2004) *Build-to-Order and Mass Customization: The Ultimate Supply Chain Management and Lean Manufacturing Strategy for Low-Cost On-Demand Production without Forecasts or Inventory*. Cambria, CA: CIM Press.
- Automotive News (2006; 2007). 'Inventory: U.S. car and light-truck inventories', Obtained through the Internet: <http://www.autonews.com/section/datacenter> [accessed 1/2/2010]
- BBC News (2009). Honda's four-month Break Begins. (1st February 2009). Obtained through the Internet: <http://news.bbc.co.uk/1/hi/business/7859863.stm> [accessed 12/3/2010].
- Bessant, J., Caffyn, S. and Gilbert, J. (1996). Learning to manage innovation. *Technology Analysis and Strategic Management*, 8, 59–70.
- Bower, J.L. and Hout, T.M. (1988) 'Fast-cycle capability for competitive advantage', *Harvard Business Review*, Vol. 66, No. 6, pp.110-118.
- Brauer, K. (2008). Decentralization in the European Automotive Industry: A Scenario-based Evaluation. *Proceedings of the 16<sup>th</sup> GERPISA Colloquium*, Turin, Italy, (June 2008). Obtained through the Internet: [http://www.gerpisa.univ-evry.fr/rencontre/16.rencontre/GERPISAJue2008/Colloquium/Papers/P\\_Brauer\\_pdf](http://www.gerpisa.univ-evry.fr/rencontre/16.rencontre/GERPISAJue2008/Colloquium/Papers/P_Brauer_pdf) [accessed 23/2/2010].
- Brauer, K. and Seidel, T. (2008) 'Network Design for Build-to-Order Automotive Production', In: Parry G., Graves A. (eds.), *Build to Order: The Road to the 5-day Car*, (pp.323-334), London: Springer. .
- Cagliano, R., Blackmon, K. and Voss, C. (2001) 'Small firms under the MICROSCOPE: international differences in production/operations management practices and performance', *Integrated Manufacturing Systems*, Vol. 12, pp.469-482.
- Cohen, W.M. and Levinthal, D. (1990) 'Absorptive capacity: a new perspective on learning and innovation', *Administrative Science Quarterly*, Vol. 35, No. 1, pp.128–152.
- Davies, A.J. and Kochhar, A.K. (1999) 'Why British companies don't do effective benchmarking', *Integrated Manufacturing Systems*, Vol. 10, pp.2–32.
- Elkington, J. (1994) 'Towards the sustainable corporation: Win-win-win business strategies for sustainable development', *California Management Review*, Vol. 36, No. 2, pp.90-100.
- Graves, A.P. (1987) 'Comparative trends in automotive research and Development', *International Motor Vehicle Programme Working Paper*, MIT, Cambridge.

- Gunasekaran, A. and Ngai, E.W.T. (2005) 'Build-to-order supply chain management: a literature review and framework for development', *Journal of Operations Management*, Vol. 23, No. 5, pp.423-451.
- Gunasekaran, A. and Ngai, E.W.T. (2009) 'Modeling and analysis of build-to-order supply chains', *European Journal of Operational Research*, Vol. 195, pp.319-334.
- Hanson, P., Voss, C., Blackmon, K. and Oak, B. (1994) *Made in Europe: A Four Nation Study*. London: IBM.
- Holweg, M. (2008) 'The Evolution of Competition in the Automotive Industry', In: Parry G., Graves A. (eds.), *Build to Order: The Road to the 5-day Car*, (pp.13-34), London: Springer.
- Holweg, M. and Pil, F.K. (2001) 'Successful build-to-order strategies start with the customer', *Sloan Management Review*, Vol. 43, No. 1, pp.73-82.
- Holweg, M. and Pil, F.K. (2004) *The Second Century: Reconnecting Customer and Value Chain through Build-to-Order; Moving beyond Mass and Lean Production in the Auto Industry*. MIT Press.
- Howard, M. and Squire, B. (2007) 'Modularization and the impact on supply relationships', *International Journal of Operations & Production Management*, Vol. 27, No. 11, pp.1192-1212.
- Howard, M., Young, K. and Graves, A. (2001) 'Towards the 3Ddaycar: vehicle design and its impact on rapid build-to-order', *International Journal of Vehicle Design*, Vol. 26, No. 5, pp.455-468.
- Kapuscinski, R., Zhang, R.Q., Carbonneau, P., Moore, R. and Reeves, B. (2004) 'Inventory decisions in Dell's supply chain', *Interfaces*, Vol. 34, No. 3, pp.191-205.
- Leseure, M., Bauer, J., Bird, K., Neely, A. and Denyer, D. (2004). *Adoption of Promising Practice: A Systematic Review of the Evidence*. Obtained through the Internet: <http://www.aimresearch.org> [accessed 12/2/2010].
- Mandel, J. (2008) 'Collaborative Execution Processes', In: Parry G., Graves A. (eds.), *Build to Order: The Road to the 5-day Car*, (pp.209-221), London: Springer.
- McLachlin, R. (1997) 'Management initiatives and just-in-time manufacturing', *Journal of Operations Management*, Vol. 15, pp.271-292.
- Merlis, S., Sylvester, M. and Newton, A. (2001) '*Lean manufacturing: the way to a better business model*' In: Dresdner Kleinwort Wasserstein Research, Industry Report, Automotive/Auto Parts: Dresdner Kleinwort Wasserstein,
- Miemczyk, J. and Holweg, M. (2002) 'Logistics in the three-day car age: Assessing the responsiveness of vehicle distribution logistics in the UK', *International Journal of Physical Distribution Management*, Vol. 32, No. 10, pp.829-850
- Orsato R.J. and Wells P. (2007a) 'U-turn: the rise and demise of the automobile industry', *Journal of Cleaner Production*, Vol. 15, No. 11/12, pp.994-1006.
- Orsato R.J. and Wells, P. (2007b) 'The automobile industry & sustainability', *Journal of Cleaner Production*, Vol. 15, No. 11/12, pp.989-993.

- Panizzolo, R. (1998) 'Managing Innovation in SMEs: A multiple Case Analysis of the Adoption and Implementation of Product and Process Design Technologies', *Small Business Economics*, Vol. 11, No. 1, pp.25-42.
- Parry, G. and Graves, A. (2008). *Build to Order: The Road to the 5-day Car*. London: Springer.
- Pine, B.J. (1993). *Mass Customisation: The New Frontier in Business*. Harvard Business School Press.
- Reichhart, A. and Holweg, M. (2007) 'Creating the customer-responsive supply chain: a reconciliation of concepts', *International Journal of Operations and Production Management*, Vol. 27, No. 11, pp.1144-1172.
- Reuters (2009). *UPDATE 2-German May Car Sales up 40 pct on Tax Steroids*. Reuters, (Wednesday Jun 3rd 2009). Obtained through the Internet: <http://www.reuters.com/article/idUSL347499620090603> [accessed 9/2/2010].
- Ryall, J. (2009). *Toyota to halt Japanese production in February and March*. *Telegraph.co.uk* (Tuesday January 6<sup>th</sup> 2009). Obtained through the Internet: <http://www.telegraph.co.uk/finance/newsbysector/transport/4139865/Toyota-to-halt-Japanese-production-in-February-and-March.html> [accessed 11/1/2010].
- Salvador, F., Rungtusanatham, M., Forza, C. And Trentin, A. (2007) 'Mix flexibility and volume flexibility in a build-to-order environment: synergies and trade-offs', *International Journal of Operations & Production Management*, Vol. 27, No. 11, pp.1173-1191.
- Scavarda, L.F., Schaffer, J., Scavarda, A.J., da Cunha Reis, A. and Schleich, H. (2009) 'Product variety: an auto industry analysis and a benchmarking study', *Benchmarking: An International Journal*, Vol. 16, No. 3, pp.387-400
- Schaeffer, J. and Schleich, H. (2008) 'Complexity Cost Management,' *In: Parry, G. and Graves, A. (eds.), Build to Order: The Road to the 5-day Car*, (pp.155-176), London: Springer.
- Schleich, H., Schaeffer, J. and Scavarda, L.F. (2007) 'Managing complexity in automotive production', *Proceedings of the 19th International Conference on Production Research*, July 29<sup>th</sup>-31<sup>st</sup> 2007, Valpariso, Chile, paper 255, Obtained through the Internet: <http://www.icpr19.cl/mswl/Papers/255.pdf> [accessed 7/04/2010]
- Seidel, T. and Huth, T. (2008) 'How the electro-mechanical value train accelerates logistics and reduces costs', *In: Parry G. and Graves A. (eds.), Build to Order: The Road to the 5-day Car*, (pp.311-322), London: Springer.
- Sharif, A.M., Irani, Z. And Lloyd, D. (2007) 'Information technology and performance management for build-to-order supply chains', *International Journal of Operations & Production Management*, Vol. 27, No. 11, pp.1235-1253.
- Selto, F.H., Renner, C.J. and Young, S.M. (1995) 'Assessing the organizational fit of a Just-in-Time manufacturing system – testing selection, interaction and systems models of contingency theory', *Accounting Organizations and Society*, Vol. 20, pp.665–684.
- Stalk, G. (1988) 'Time – the next source of competitive advantage' *Harvard Business Review*, Vol. 66, No. 4, pp.41-51.

- Stone, G., Parry G. and Graves, A. (2006) 'Transformation of the European Automotive Industry: the future of Lean', *Journal of Financial Transformation*, Vol. 18, pp.10-15.
- Stone, G., Crute, V., Graves, A. (2008) 'Managing the transition to the "5-Dave Car" in Europe', *In: Parry G. and Graves A. (eds.), Build to Order: The Road to the 5-day Car*, (pp.311-322), London: Springer.
- Stone, G., Brauer, K. (2008) 'Assessment of the Socio-economic & environmental impact potential of a European implementation of the 5DayCar', Report submitted to the European Commission, D7.7.2/D8.7.2 IST/NMP Contract No ILIPT.
- Thelen, W. (2007) 'The space race', *Automotive Logistics*, September/October, pp.38-40.
- Thompson, C. (2009). GM, Ford plunge as U.S. sales drop 41.3%. *Automotive News Europe*, (March 3<sup>rd</sup> 2009). Obtained through the Internet: <http://www.autonews.com/article/20090303/ANA05/903039928/1078/COPY01> [accessed 11/1/2010].
- Toth, M., Seidel, T. and Klingebiel, K. (2008) 'Moving Towards BTO – An Engine Case Study', *In: Parry G. and Graves A. (eds.), Build to Order: The Road to the 5-day Car*, (pp.297-310), London: Springer.
- Trommer, D. and Robertson, J. (1997) 'As 'build to order' fires up the PC business, can the supply chain stand the heat?', *Electronic Buyers' News*, Vol. 1088, pp.1-5.
- Wells, P. and Rawlinson, M. (1994) *The new European automobile industry*. London: Macmillan Press.
- Womack. J., Jones, D. and Roos, D. (1991). *The Machine That Changed the World: The Story of Lean Production*. New York: Harper Perennial.
- Yin, R.K. (2003). *Case Study Research: Design and Methods*. 3<sup>rd</sup> ed., Thousand Oaks, CA: Sage.

## Figures and Tables



**Figure 1** Drivers and barriers for build-to-order strategy implementation

<b>Function</b>	<b>Average Time (in days)</b>
Order entry Dealer-Manufacturer	3.8
Order bank	9.8
Scheduled orders	14.1
Sequenced orders held	6.0
Physical production	1.4
Loading at factory	0.9
Distribution to dealer	3.8
<b>Average delivery time</b>	<b>39.8</b>

**Table 1**      *Average delivery time for 3DayCar OEMs (adapted from Parry, G. and Graves, A. (2008). Build to Order: The Road to the 5-day Car. London: Springer, p.5).*