

# Profiling the resiliency and sustainability of UK manufacturing companies

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## Abstract

**Purpose** – The purpose of this paper is to identify the tools, methods and models that UK manufacturing companies adopt and apply in order to achieve resiliency and economic sustainability. The results of this work can assist in developing the foundations for defining a new joint resiliency/sustainability paradigm to assist industry.

**Design/methodology/approach** – Through a detailed, triangulated secondary data analysis and industry survey, the authors initially identify and then analyse the key resiliency and sustainability characteristics surrounding manufacturing operations. This paper initially reviews key literatures around resiliency and sustainability models and frameworks and subsequently draws out their key features and weaknesses. The work then details the research survey undertaken in to manufacturing companies aimed at identifying the resiliency/sustainability approaches that are adopted in companies. A sample of 72 manufacturing companies are used in the survey and from which the results are based.

**Findings** – Through analysing the fundamental business data of sales and manufacturing costs for 72 manufacturing companies, the authors cluster the companies in to four key manufacturing profiles. The work then shows through a more detailed analysis of the profiles that companies which are sustainable and more resilient in nature are, better engaged and connected to the development and application of resiliency and sustainability models. It was found that companies who seem to struggle in achieving economic sustainability or lack the ability to bounce back from various set-backs either do not employ such models or at best apply tools and techniques in an ad hoc manner.

**Research limitations/implications** – The paper provides key insights in to the adoption of tools, techniques and models surrounding the achievement of resiliency and sustainability in manufacturing companies. In so doing, the paper offers a new view on these issues and with the profiling exercise undertaken, companies will be able to identify their position in relation to the survey companies. This can be of benefit to the wider industrial and academic community. The development of a qualitative assessment around a relatively small sample size has its obvious limitations and it is crucial that further work with a range of companies in the area of manufacturing sustainability is key to developing (and also validating) a comprehensive set of resiliency and sustainability characteristics.

**Practical implications** – The paper highlights the issues surrounding existing academic resiliency/sustainability models and through the industry survey, it provides further information on where UK manufacturing companies are on adopting specific resiliency/sustainability models. The work suggests that the resiliency/sustainability landscape of UK manufacturing companies is much more complex and that a single strategic approach towards achieving improved manufacturing performance is somewhat dated and ineffective.

**Originality/value** – The development of a set of resiliency/sustainability profiles including the identification of the specific tools and techniques adopted by industry is aimed at tackling directly

the issues of improving company performance and is considered by the authors as one of a kind. The results of the survey provide essential information on the resiliency/sustainability landscape of UK manufacturing companies.

Keywords Sustainability, Lean, Agile manufacturing, Resiliency

Paper type Research paper

## 1. Introduction

Manufacturing companies are now operating in less secure and more complex environments. This in turn focuses their business and manufacturing facilities to cater for a wider range of demands in order to remain competitive (Paiva *et al.*, 2012). Lower cost products that are manufactured by responsive and flexible production processes are now essential in order for a company to capture new markets and to become more resilient and sustainable (Pham *et al.*, 2008).

There is currently a wide range of literature available regarding business resiliency, Fiskel (2006) on enterprise resiliency, Carvalho *et al.* (2011) on business resiliency and, supply chain resiliency outlined by the work of Berman (2009) and Ponomarov and Holcomb (2009). Similarly, much work exists in all forms of Sustainability including Elkington's (1994) work on the Triple Bottom line, the Institute for Sustainability's (2011) focus on economic issues around this area and, Flumerfelt *et al.* (2012) work on lean and agile capabilities in creating sustainable manufacturing companies.

However, there seems to be very little literature available which identifies manufacturing industry's engagement in the application and implementation of manufacturing resiliency and sustainability models, tools and techniques. Furthermore, little specific information exists around what specific tools, techniques and models look like and, how they are applied by manufacturing organisations in order to achieve sustainable and resilient organisations.

This paper will aim to plug the gap in knowledge relating to the level of application of resiliency and sustainability methods and techniques in industry. This paper will start by undertaking a comprehensive secondary research review on the applicability of existing academic models around resiliency and sustainability before showing the results of an industry survey in to 72 manufacturing companies which outline the typical tools and techniques that are applied. From here the paper closes by highlighting the gaps that exist between theory and practice and suggests ways in which the gap can be closed.

## 2. Review of resilience and sustainability models/frameworks

The development of both resilience and sustainability has led to the generation of many frameworks and models aimed at guiding companies towards improved business performance. Christopher and Peck (2004) state that resiliency means the ability of a company to be able to return to its original state or, to move towards a new more desirable state after being disturbed. Therefore, this suggests that manufacturers need to become more flexible and innovative in the products and processes it develops, thus mitigating the risk induced by poor or outdated products (Khan *et al.*, 2012). Ates and Bititci (2011) propose that in order to create the responsiveness required to become resilient, companies need to develop effective change management strategies and practices in order to deal with the need to move to more desired states. Bhattacharya *et al.* (2013) extend the theoretical development of supply chain resiliency by introducing a mechanism to reduce the impact of supply chain network (SCN) failure in the event of an "excursion" which could potentially shut an SCN down for a considerable period. This approach, thus allowing an SCN to weather the situation at hand, become more resistant and resilient in nature. Likewise, economic/environmental

sustainability suggests that companies need to produce products using less resource with a key focus on waste reduction (Pham and Thomas, 2012). This therefore suggests that a dual strategic approach needs to be employed so that a company can become both resilient and sustainable.

In terms of operational sustainability and resilience, key literatures suggest the integration of the traditional strategic manufacturing requirements of Lean and Agility with other business functions such as marketing (Adamides and Voutsina, 2006) as well as developing and integrating ICT, communication and manufacturing technologies and developing product innovation in order to achieve a more competitive manufacturing environment (Pham *et al.*, 2008). The integration of Lean and Agility into a sustainable and resilient manufacturing improvement strategy is key and, if implemented correctly, can lead to increased manufacturing capacity, lower unit costs and greater responsiveness (Christopher and Towill, 2000). It is possible for a company to be successful in adopting and implementing cost reduction strategies (often mistaken as Lean) and still fail as a business due to the lack of growth opportunities created (Ferdows and Thurnheer, 2011). Others argue that resilience and sustainability need to co-exist in an organisation and that just having one or the other is insufficient for long-term success (Burnard and Bhamra, 2011). Table I of this paper outlines the key resiliency and sustainability models and identifies the characteristics of such models.

In an attempt to achieve improved manufacturing resilience, academics and industrialists alike have developed a number of frameworks and models aimed at guiding companies towards improved manufacturing performance. Ismail *et al.* (2011) outline an approach that builds on the premise that manufacturing supply chain resilience occurs as a result of the implementation of both operational and strategic capabilities. The framework they propose is based on their earlier work in the area of manufacturing agility implementation, and involves the integration of operational agility tools with tools and approaches that are strategic in nature.

Table I summarises the key features of a number of manufacturing resiliency and sustainability frameworks and models proposed by researchers and highlights their limitations. The key features highlighted in the resiliency and sustainability frameworks/models are then extracted and shown in Table II. The features of resiliency and sustainability shown in Table II are subsequently used to construct an audit tool. This tool is then used to undertake 72 manufacturing audits with manufacturing companies (outlined later in this text) in an attempt to develop an understanding of the typical tools, techniques and methods employed in implementing sustainability and resiliency strategies in to companies. The key findings from the review of frameworks/models shown in Table V.

Few frameworks have been developed as a result of industry collaboration and survey development. Most are developed from secondary academic literature. Furthermore, the frameworks and models are focused upon the application of a single paradigm approach towards achieving supply chain resiliency/sustainability (i.e. application or Six Sigma, Lean, etc.) rather than the creation of an integrated model that effectively integrates the key elements of a number of key strategies in to one framework/model. Furthermore, the frameworks reviewed had developed a high-level systems-based development that lacked an operational perspective towards implementing a dual strategic/operational-level approach. Also, they frequently ignored the discussion on how companies can operationalise the frameworks/models. Also, few models focused on the application of tools and techniques of resilience at an operational level with little focus on integration with strategic objectives of the business.

Author	Methodology applied	Key themes highlighted	Focus of model/framework
<i>Resiliency</i> Kumar <i>et al.</i> (2011)	Six Sigma framework for SMEs developed through a triangulated research methodology	Development of Six Sigma Model and framework for manufacturing SMEs aimed at improving company resilience	Limited in scope. Focus on Six Sigma implementation to achieve resiliency
Burnard and Bhamra (2011)	Model built upon analysis of existing secondary literature in to resilience	Resilience enables companies to become sustainable through being able to respond effectively to threats and to mitigate them effectively	Focus is on organisational resilience and focuses upon strategic sustainability
Demmer <i>et al.</i> (2011)	Through a case study approach the authors identify the key antecedents of resilience in large companies and defines metrics for SMEs	Defines 7 key antecedents of resilience in large companies and defines metrics for SMEs towards developing a resilience model for SMEs	Focused primarily on strategic business issues. SME metrics based around development of networks, scanning landscapes, etc.
Gunasekaran <i>et al.</i> (2011)	Comprehensive literature review that defines the features of resilient SMEs. Framework is tested using primary research findings	An SME framework is developed that focuses upon resilience and competitiveness	Framework identifies key issues such as technology, supply chain integration, organisational behaviour, quality and marketing as being key issues in developing resilient SMEs
Ismail <i>et al.</i> (2011)	Uses a mixture of primary data (KTPs, etc.) alongside secondary information on resilience to define new model	Framework identifies the need to align strategic agility issues such as quality, cost, flexibility, service (QCDFS), etc. to correct business improvement tools to ensure a robust and responsive organisation	Describes a practical “top-down” strategic framework to assist manufacturing SMEs to develop a degree of resilience when operating in turbulent business environments
Khan <i>et al.</i> (2012)	An in-depth case study methodology was developed to uncover the strategies undertaken by a fashion retailing company to create a competitive advantage through its management of the product design/supply chain alignment	The study develops a framework that looks in particular at integrating product design and the supply chain to enable the company to develop resilient and responsive supply chains	Supply chain-oriented work that outlines a strategic rather than an operational framework that focuses upon resilience only
Pettit <i>et al.</i> (2010)	Analysis of extant literature and refined through a focus group methodology, the authors produce a conceptual framework to highlight key resiliency issues	The work highlights that supply chain resilience can be assessed in terms of two dimensions: vulnerabilities and capabilities. The Zone of Resilience is defined as the desired balance between vulnerabilities and capabilities, where it is proposed that firms will be the most profitable in the long term	The work identifies seven vulnerability factors composed of 40 specific attributes and 14 capability factors from 71 attributes that facilitate the measurement of resilience. The paper highlights the managerial implications of such an approach
<i>Manufacturing sustainability</i> Garbie (2013)	Through secondary data analysis the author highlights a framework highlighting key manufacturing sustainability themes from the literature review	The framework proposed highlights the key sustainability and resiliency issues of: systems reconfigurability, business flexibility, manufacturing strategy and new product development	The strategic framework is developed from secondary data analysis and then mathematically developed using hypothetical data

(continued)

Table 1.  
Review of  
manufacturing  
resiliency and  
sustainability  
frameworks and  
models

Author	Methodology applied	Key themes highlighted	Focus of model/framework
Pham and Thomas (2012)	Review of secondary data and the development of three SME case studies to test proposed framework	Fit Manufacturing Framework is proposed that interlinks the concepts lean, agility and sustainability to achieve resiliency	A strategic sustainability framework is proposed but no operational model is developed
Ferdows and Thurnheer (2011)	The paper examines the process of design, launch, and management of a fitness programme in 42 factories of the Hydro Aluminum Extrusion Group on five continents between 1986 and 2001. The design was based on the "Sandcone Model" proposed by Ferdows and DeMeyer but the sequence of capabilities was modified to improve safety, reduce process variability, codify and share tacit production know-how, improve responsiveness, and improve labour and machine efficiency	A fitness regimen provides a roadmap for improving core capabilities in a factory. It is different from building leanness. Fitness helps the factory become leaner, but the opposite is not always true. A factory can become too lean but never too fit	A strategic model is proposed that outlines four key measures namely: improve safety; reduce process variability; codify and share tacit production know-how; improve responsiveness; improve labour and machine efficiency
Paiva <i>et al.</i> (2012)	A survey was undertaken in to 78 Brazilian companies and 130 Spanish companies and a cross-country comparison undertaken. The constructs were empirically confirmed in both country samples, attesting to measurement invariance. The proposed model was tested in both samples and analysed the differences between them	The authors propose a Knowledge Management Framework that is developed from surveying a large sample of manufacturing companies. The model outlines the critical issue of knowledge management and how it has an essential role in reducing systems uncertainty and improving production efficiency thus contributing to developing a sustainable manufacturing organisation	Outlines the interconnections between knowledge creation, knowledge management and manufacturing strategy formulation The model is strategic and focuses upon testing the validity of the model rather than offering an operational perspective. The work does highlight the key role that KM has in achieving manufacturing sustainability

Table I.

The key findings from the literature review was that little had been done in defining and creating an operational approach towards achieving manufacturing resiliency and sustainability. Also, most models were conceptual in nature and were not implemented in practice. This therefore leads the authors to consider to what extent that resiliency and sustainability practices are currently employed in UK manufacturing companies? Therefore, the research question posed in this work is:

*RQ1.* To what extent are resiliency and manufacturing sustainability models/frameworks being used in UK manufacturing companies?

The secondary research phase has highlighted gaps in the model/framework structures of existing academic models (Table I). However, Table II shows the key features of both resiliency and sustainability that has been drawn from the key models and frameworks. In order to gain a greater understanding as to whether UK manufacturing companies employ resiliency and sustainability models in their entirety or, whether they adopt specific tools and techniques in a more ad hoc manner, the next stage of this work will show the details of a primary data study in to 72 manufacturing companies. Its aim is to provide robust primary data from which

<i>Resiliency</i>		
Kumar <i>et al.</i> (2011)	Six Sigma as a key resilience driver	
Gunasekaran <i>et al.</i> (2011), Adamides and Voutsina (2006), Pettit <i>et al.</i> (2010)	Technology, supply chain integration, quality, marketing and organisational behaviours	
Ismail <i>et al.</i> (2011), Bhamra <i>et al.</i> (2011), Pettit <i>et al.</i> (2010)	Using key measures of performance to measure resiliency – QCDFS	
	Leadership and direction setting	
	The need for operational models aimed at achieving manufacturing supply chain resiliency	
Evans <i>et al.</i> (1995)	Systems reconfigurability, supply chain reengineering	
Garbie (2013)	Agility, business flexibility, manufacturing strategy and new product development	
Ates and Bititci (2011), Pettit <i>et al.</i> (2010)	Effective change management practices and strategies as an enabler to achieve resiliency	
<i>Sustainability</i>		
Ferdows and Thurnheer (2011)	Improved safety; reduce process variability; codify and share tacit production know-how; improve responsiveness; improve labour and machine efficiency	
Pham <i>et al.</i> (2011), Achanga <i>et al.</i> (2006)	Leanness	
Ismail <i>et al.</i> (2011)	Leadership and direction setting	
Pham <i>et al.</i> (2011), Ferdows and Thurnheer (2011)	Fit manufacture	
Paiva <i>et al.</i> (2012), Ambrosini and Bowman (2001)	Knowledge management and the knowledge-based view	Table II. A review of the key features of resiliency and sustainability
Khan <i>et al.</i> (2012)	New product development and reduced time to market of new product introduction	

to develop findings and postulate theories. It will be the key features that are identified in Table II which will form the basis for the survey in to which tools and techniques UK manufacturing companies employ, in order to move towards greater resiliency and sustainability.

### 3. Research methodology

A two stage research methodology was constructed in an attempt to obtain a systematic chain of information and research data so as to allow for further synthesis and analysis. The research methodology applied in this work is adapted from the work of Kumar *et al.* (2011) (see Figure 1) and was employed in this work since it offered an effective method of robustly undertaking a systematic approach to research analysis. It uses a triangulation approach in which journal article data is combined with primary data obtained through questionnaires, observations, semi-structured interviews and two focus groups conducted with production managers to develop a coherent operational production management framework. An initial large-scale screening survey was undertaken in order to identify the appropriate companies who could provide value inputs into this work.

#### 3.1 Rationale for the survey

In order to answer the research question of to what extent are resiliency and sustainability models used by manufacturing companies, the authors undertook a study of 72 manufacturing companies to identify to what extent companies actually employed resiliency and sustainability models, tools and techniques or, whether an

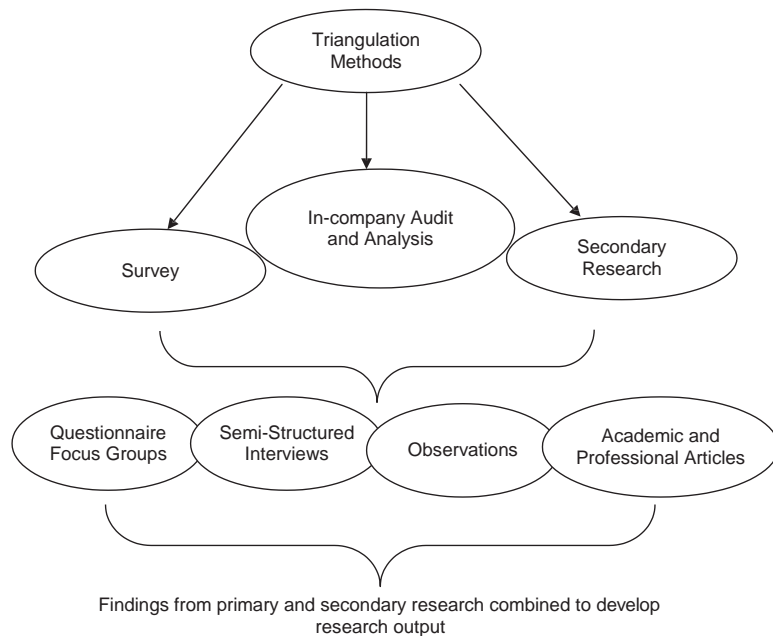


Figure 1.  
Research  
methodology applied  
to this research  
programme

**Source:** Adapted from Kumar *et al.* (2011)

ad hoc “browse and select” approach to employing specific tools and techniques was used. The survey involved detailed business reviews of each company over a three-year period (2009-2012). In stage 2 of the survey, each company was visited by a researcher where the manufacturing operations, business processes and financial profiles were analysed. The survey included a mix of both large and small manufacturing companies and its aim was to:

- (1) identify the resiliency and sustainability strategies, tools and techniques being employed in the companies; and
- (2) to identify whether the resiliency/sustainability models actually achieve improved business performance in the companies surveyed.

Stage 1 of the survey included identifying suitable companies and then issuing 120 questionnaires to those companies. In total, 93 manufacturing companies returned a completed questionnaire (details of the questionnaire are shown later). The research team subsequently analysed the questionnaires and identified 72 companies that they felt were able to provide valued inputs in to the programme and, who agreed to undertake the second stage of the survey. The manufacturing companies were identified from their UK Standard Industry Classification codes (SICs) and a range of manufacturing sectors were targeted. Companies who were SMEs were identified against the appropriate definition for SME categorisation at the time of the survey (turnover, number of employees, ownership profiles, etc.). Table III shows the number of companies assessed per industrial sector. The table also shows the number of companies by size, which fall into each industrial sector area.

Following the stage 1 “screening questionnaire”, a stage 2 survey was undertaken. Triangulation of the survey data was achieved through direct observation at the company as well as interviews with the production managers/directors of the 72 organisations selected for further analysis. Further details of both survey stages are now given.

The stage 1 questionnaire was designed to capture specific company performance data whilst allowing a section for open answers by the respondents in order to extract the widest range of information and opinion from each company. The primary aim for the questionnaire was to capture financial and strategic-level data in order for the team to identify suitable companies for the in depth “Stage 2” audit survey.

The stage 1 questionnaire captured the following data:

*Financial data turnover:* materials and labour costs, growth profile, operating costs, investment in processing technology, major investments over the past five years.

*Company profile:* number of employees, direct and indirect staffing ratios.

The questionnaire also captured the following information:

*Business type:* growth profile, customer base, relationships with customers, types of products manufactured, methods of production employed, labour skills and knowledge base.

*Attitude to technology:* types of technology currently employed, future plans for investing in new technologies, previous experiences in implementing new technology, benefits of employing production technology, worker and management skills requirements.

*Attitude to developing business:* aspirations to grow and develop company, future company growth strategy (new market sectors to be penetrated, new technologies required to meet anticipated growth, etc.), current and future workforce development strategy, succession planning and impact of this on company.

*Operational processes:* what is the production management style structure and approach? How effective were the production operations? What problems are faced by production managers? Future strategies and demands.

*Production systems management:* how are production systems developed and managed? What types of Business Process Improvement (BPI) strategies/methods are employed? How effective are they? In what sequence were the BPI strategies employed?

*Drivers and stimulators for resilience and sustainability:* did the recession create a demand to achieve resiliency and sustainability? Did the customer base drive for a strategic change? Does the need to achieve manufacturing resiliency and sustainability conflict with the other internal pressures going on the company at the time? If so, what were they and how were they overcome?

Once the 93 completed questionnaires were obtained, the research team undertook a sifting and analysis exercise to identify the most appropriate companies to undertake the stage 2 audit. Companies who did not employ basic cost accounting methodologies

Type	Size of SME (no employed)	Industrial sectors				Construction manufacture
		Aerospace	Automotive	Medical and pharm	Electronics	
Micro	1-50	5	6	3	5	3
Small	51-150	6	2	5	7	3
Medium	150-250	2	5	2	2	3
Large	Large	6	2	3	1	1
	Totals	19	15	13	15	10

Table III.  
The number of  
companies assessed  
by industrial  
sector and  
company size (based  
on staff employed)



or who did not apply business improvement strategies on a regular basis were discarded. This process identified 72 companies that the research team would take forward to second stage audit. Each company was then visited by a researcher rather than rely purely upon questionnaire feedback since it was felt that this approach would reduce the opportunity for the respondents to undertake a “tick box” survey and hence hopefully ensure that the information collected would represent a more realistic representation of the company’s operations and issues. This approach also allowed for interview and observation thus achieving a more robust triangulated approach.

Prior to visiting the companies, the research team developed a company audit tool in which they identified a range of; attitudes, practices, tools, techniques and systems that they would expect to see being employed in companies if they were seen as being resilient and sustainable. The audit tool was primarily developed from the key features identified in Tables I and II of this paper. Table IV outlines the audit tool employed.

The audit tool enabled the researchers to identify quickly the tools, techniques and systems that were employed by the companies and also, to assess the level of implementation and expertise contained within the companies. The researchers assessed the company’s manufacturing and business processes spending up to two days per company directly observing at first hand the typical manufacturing and business operations, discussing and interviewing key players and agents within the company, etc. This allowed the researcher to contextualise the responses of the staff in relation to observations made during the observations of company operations.

	Employed				Effectiveness/extent of implementation		
Feature	Yes	No	New	Developing	Developed/ embedding	Established/ embedding	Extensive/expert/ embedded
<i>Resiliency</i>							
SC							
reconfigurability							
Six Sigma							
Agility							
Technology							
integration							
Supply chain							
integration							
Quality							
management							
<i>Sustainability</i>							
Lean							
Fit manufacture							
New product							
dev'/PLM							
<i>Attitudes and behaviours</i>							
Behaviours/ attitudes							
Training							
Knowledge							
management							
Leadership							

Table IV.  
Outline audit  
tool of key  
sustainability and  
resilience features

The survey information was collated by the authors and subsequently analysed. The initial survey data involved the analysis of each company's financial situation in order to identify their current overall financial profile. Analysis of each company's sales turnover was plotted against the operational costs using three-year trend data from each company where applicable. The rationale for employing this approach was to ensure that a company's most basic business performance was exposed. In selecting sales vs operational costs, other financial incentives are stripped out of the analysis which could make the company seem more sustainable than what is actually is (government grants, parent company grants, etc.). The information was initially taken from the firm's Inland Revenue end of financial year report and then discussed with the company regarding any additional incentives and grants that may have been used. Using the three-year financial reporting data, the information was then extrapolated for a further three years in order to identify the likely performance profiles of the companies if they continued on their existing trajectory.

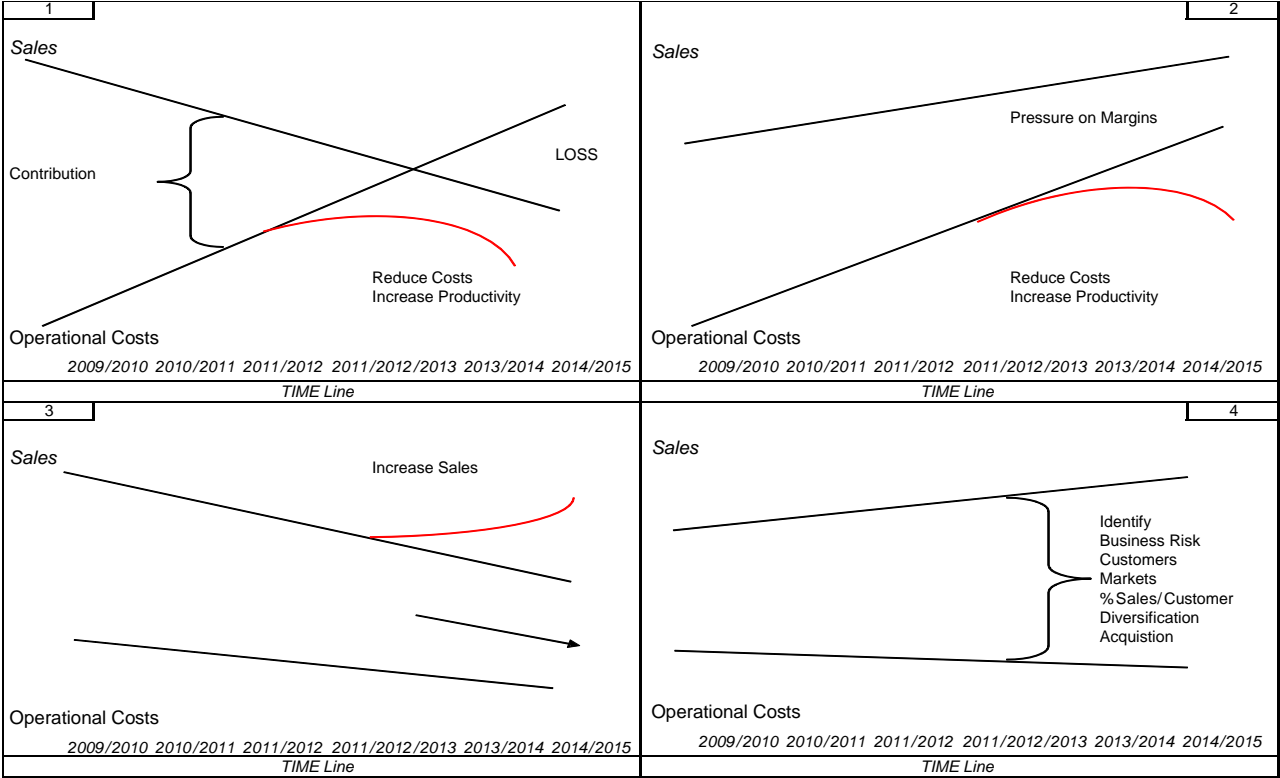
Taking the 2008 global crisis as the key disturbance factor for the companies, each company was assessed on its ability to adapt and grow following this disturbance/disruption. Each financial profile is shown in Figure 2 and discussed further in the next section. Table V shows maps the tools and techniques that were employed in each company.

### *3.2 Company profiling*

*Profile 1 – potential business failure.* In total, 12 per cent of companies surveyed were assigned to this category (two micro, three small, one large). Here the profile shows that in general, the company sales profile was in decline whilst operational costs were steadily increasing to a point where the companies were now no longer in a sustainable situation with operational costs outstripping the income returned from its product lines. It was observed that these companies had a limited strategic outlook and were unable to identify the product lines which were returning profit against those which were losing the company money. In general, these companies had no real focus on waste and cost reduction and were unable to develop new products to offset increased operational costs. These companies tended to employ little or no resiliency or sustainability strategies in order to remain competitive. When analysing the typical business improvement strategies employed, companies in this profile only applied simplistic Lean-based techniques and employed virtually no resiliency based techniques (see Table V). A small number of branch-plant companies fell in to this category where there was limited opportunity to show added value through new product introduction since they were manufacturing only plants.

*Profile 2 – trajectory towards business failure.* These companies followed similar characteristics to the profile 1 companies but their cost trajectory suggested that they were moving towards business failure unless action was taken immediately to affect change and halt the decline. Again, the companies had limited opportunity to develop new products and sales were driven often by products that the companies had little or no authority to change or where new product development and introduction was seen as being cost prohibitive. Also, in some companies, there was limited opportunity for companies to increase sales revenue through seeking new customers since they operated in closed supply chain systems such as automotive and electronic industries. Pressure on the businesses to reduce margins on a yearly basis had put the companies on a trajectory towards failure although the operational costs had changed very little over the three years. In total, 33 per cent of companies fell in to this category (three micro, six small,

Figure 2.  
Categorisation of  
manufacturing  
companies in to  
one of four  
business scenarios



Feature	Employed		Effectiveness/extent of implementation				
	Yes	No	New	Developing	Developed/ embedding	Established/ embedding	Extensive/expert/ embedded
SC reconfigurability	◆ △			■		◇	
Six Sigma	◆ △			■		◇	
Agility	◆ △			■		◇	
Technology integration	◆ △				■		◇
Supply chain integration	◆ △						■ ◇
Quality management						◆ ■ △	◇
Lean			◆ △			■	◇
Fit manufacture	◆ △			■ ◇			
Product/process dev'/PLM						◆ △	■ ◇
Leadership						◆ △	■ ◇
Behaviours/attitudes				◆	△		■ ◇
Training			◆ △		■		◇
Knowledge management			◆	△		■	◇

Notes: n % 72. Profile 1 ◆; Profile 2 △; Profile 3 ■; Profile 4 ◇

Table V.  
Sustainability/  
resiliency profiles  
for companies

four med, two large). In these cases, as with profile 1 companies these companies had little or no understanding of what resiliency strategies (see Table V) and had limited but improved understanding of the sustainability strategies to employ in order to remain competitive. There was limited implementation of sustainability techniques.

*Profile 3 – opportunities for business growth.* Companies who fell in to this category had experience of applying various waste reduction and cost down strategies and there was clear success in being able to drive down operational costs in order to ensure that the companies achieved greater efficiency of their internal business processes. However, the trend towards lost sales either through an ageing product or from loss of contracts or diminishing product sales, etc. meant that the companies could sustain themselves in the short terms but lacked the sales growth to make them financially sound in the future. In total, 36 per cent of companies fell in to this category (five micro, eight small, four med, eight large). These companies showed a greater propensity towards the application of lean thinking and other business improvement type programmes rather than being driven towards making their businesses resistant to external disturbances. Analysis of the typical business improvement strategies employed (Table V) saw a more balanced picture of resilience and sustainability implementation. Still, more implementation of sustainability techniques were seen but more work was observed around technology and supply chain integration.

*Profile 4 – the sustainable and resilient organisation.* These companies had been successful in being able to continually drive down operational costs whilst ensuring sales volumes continued to rise whilst building robust and integrated processes that would be able to respond to disturbances and disruptions in their business. It was clear in these cases that the companies mitigated business risk by developing a highly

sophisticated diverse product lines with a multi-client product portfolio. Operational systems were focused on waste reduction strategies and project management of each product line was highly disciplined and sophisticated. In total, 19 per cent of companies fell in to this category (12 micro, six small, six med, two large). These companies showed an integrated approach to the application of resiliency or sustainability strategies and were able to demonstrate that in making the company resilient, the companies were indeed sustainable also. The resiliency and sustainability approaches are analysed further in the next section.

### *3.3 Analysis of the results*

An interesting aspect of the results obtained from the survey was that micro-SMEs were performing much better than anticipated with over 50 per cent of them falling in to the sustainable/resilient profile (profile 4). Only 9 per cent of micro-SMEs were in profile 1. Therefore, the often cited impediments of; lack of skill, knowledge and financial capacity had little effect on their ability to become economically sustainable and resilient. Contrary to the view initially held by the research team, it was also identified that over 90 per cent of companies classified as profile 4 were successful SMEs rather than large manufacturing companies. These companies had developed a diverse customer portfolio which enabled them to either switch volumes when product sales dropped or create capacity for them to seek new markets in order to maintain profitability. These companies had a detailed understanding of each process and had pro-active manufacturing teams capable of squeezing out small but important improvements in manufacturing efficiency which could then be passed on to their customers through reduced product cost. Company leadership was a significant issue on profile 4 companies. In all cases the companies possessed highly motivated leaders in all areas of the company (production/operations, supply chain, marketing, etc.) who had an inherent understanding of what the company needed to do and how it could move forward to capture future markets. These companies had invested heavily in new and advanced technologies and had seamlessly connected their communication and ICT systems to their customer bases.

Leading on from the previous observation, some 85 per cent of large companies were profiled as either 1, 2 or 3. However, most of the large companies included branch-plant companies (accounting for nine out of the 13 large companies surveyed). These companies had limited or no opportunity to affect product sales thus rendering them only capable of reducing operational costs through innovative waste and cost reduction strategies. Following interviews with managers and engineers in these companies, many highlighted the difficulty in being empowered to develop innovative waste reduction strategies since their parent companies would not allow radical changes in their operational systems to occur. Opportunities for growth hinged on new product development by their parent companies which often occurred outside the UK and so the manufacturing plants could only affect improvement through developing innovation in their operational systems. Company directors operating in profiles 2 and 3 situations also highlighted that political forces were influential in awarding contracts (relative closeness to customer, exchange rates, incentives and grants) and hence maintaining a company's level of resilience could only be partially influenced by innovative cost down strategies and approaches.

The purpose of the survey therefore was to develop a comprehensive profiling of whether manufacturing companies effectively operated and developed resiliency and sustainability strategies and if so, to highlight the relative performance of these

companies against those companies who did not employ resiliency/sustainability strategies. The results were significant and conclusive and showed expectedly that companies who were employing resiliency and sustainability strategies were outperforming the companies who were not and were achieving resiliency and sustainability through the adoption of such strategies. A summary of the feedback obtained from the company audits is shown.

Companies located in profile 4 stated that since the economic downturn, they had successfully diversified their product range and customer base significantly in an attempt to spread risk and improve their chances of remaining sustainable. By shifting both their product and customer base, the companies had become more resilient in that it had taken steps to mitigate their risks. This shift, however, had been taken at some cost to the companies. In each case the profile 4 companies stated that they had each undertaken a detailed analysis of their core competencies and it was through this analysis they were able to identify new product lines and customers. Core competency (meaning the core capabilities and abilities of the company – what they were expert at) of the company and knowledge management was key to becoming more resilient.

Aligned with core competency development was the need for new and advanced manufacturing technologies to enable the companies to meet new customer requirements. New product lines often necessitates new and more advanced manufacturing technologies which also had to be paired with staff competency and knowledge profiles.

Due to the increased diversity of their product/process portfolio, the resulting manufacturing function has become more fragmented where the need to manage multiple product lines/customer portfolios and a resulting larger SCNs has become common. This meant that the management teams had to become much more strategic and systems oriented in their approach towards managing the production environment but were still required to be sufficiently shop floor focused to drive change and meet targets.

In total, 81 per cent of companies surveyed were locked in to a “cost down” view of production management. This meant that these companies did not seek to become resilient organisations since the cost and associated risks were considered too great for the company to take. Most companies in profiles 1, 2 and 3 thought that the application of lean and agility strategies were suitable to create a sustainable business and as such lacked the critical ingredient, that of resilience to be able to make a difference to company prospects. In some branch-plant companies, production managers were often restricted in changing anything fundamentally to the product and/or process by their parent company (sourcing local products, reducing cycle times by applying new methods of production, etc.) and as such they were reduced to simple and less cost effective business improvement techniques. It is also worth noting here that many managers in these firms lacked the key leadership qualities to drive business change and make true business sustainability a reality.

Effective Product Lifecycle Management aligned to an effective New Product Development and Implementation programme was seen as a critical issue for most companies in profile 4. The diverse nature of their product portfolio often meant that products would be at various stages of their product lifecycles and it was seen as imperative that production managers knew exactly where each product was on its lifecycle so that appropriate tools and techniques could be adopted in order to optimise its performance. In managing the lifecycle position of each product it is possible to individualise the production support systems that surround that product in order to achieve optimal performance.

Production managers often cited the issue that the application of Lean, Six Sigma and other process improvement programmes were often run as separate change management programmes and as such, the programmes did not integrate effectively with the production management work being undertaken in the company. This often led to a disjointed programme of operations and conflict often arose within the companies due to competing demands of achieving business improvement change whilst ensuring that production is managed effectively. Management teams stated a need for greater integration of such approaches with the production management function and also with the wider understanding of the need for a company to be sustainable and “fit for purpose”.

It was observed that profile 4 companies did not develop a single business improvement strategy but integrated a number of key tools and techniques in to a system that best suited their company. A “one size fits all” approach to improving both resilience and sustainability of an organisation was seen as counter-productive as was the need to tag every project as either a “Lean” or “Six Sigma” project. Profile 4 companies in the main, did not use the Lean or Six Sigma slogans in their business improvement strategies since they felt it generated the wrong attitudes and behaviours within their teams.

When questioned on the value and success of Lean, Agility and other business process initiatives, over 80 per cent of managers and directors stated that a more specific production management approach was needed that included the need for specific tools and techniques to be applied in a systematic way whilst ensuring long-term strategic vision is maintained for each product line within the company. There was a need to simultaneously reduce the costs of production whilst increasing sales output through the development of new and innovative products and that companies now needed to be “fit for purpose” through becoming sufficiently lean so as to be nimble (more nimble production technologies, supply chains and, flexible workforces with better competency sets) and capable of meeting a more diverse set of company demands. It was felt that Lean, Six Sigma and other approaches were used to “blitz” issues and problems but the need to remain overall, “fit for purpose” was key and was seen as a higher priority to the managers surveyed in this work.

#### 4. Conclusions

This paper has outlined the details of a study in to 72 UK manufacturing companies in which their resiliency and sustainability practices were analysed against their respective financial profiles. Four key financial profiles were identified from the study and each company was assigned to one of the four profiles. The findings of the study revealed that Category 4 companies had achieved their position due to a highly attuned production process and supply chain which aligned closely to a range of differing customers and product life cycles and that their resiliency and sustainability strategies were contributing heavily to their financial and manufacturing performance.

In profiles 2 and 3 companies it was observed that most companies employed basic, single strategy approaches such as the application of Lean, Six Sigma, etc. It can therefore be argued that these companies achieved limited manufacturing performance improvement and suggest that a multi-strategy approach to achieving manufacturing resiliency and sustainability is required in order to move them to the next level of performance.

This paper proposes therefore the implementation of a multi-strategy resilience/sustainability model as one approach within a more complex multi-strategy support

system for UK manufacturers to drive their businesses forward and to make the journey towards increased competitiveness. Such a model should aim to integrate the key antecedents of manufacturing supply chain resilience and sustainability to simultaneously integrating the key business. The industry survey can provide operational context in which to develop the model structure and identify the order and nature of the model.

The results obtained from mapping company performance against the application of various resiliency and sustainability techniques seems to support that there is a correlation that exists between the application of tools, techniques and models and the resulting levels of manufacturing performance. It was observed that companies that employed structured models to achieve resiliency and sustainability often performed better than those who employed only single business improvement paradigms (Lean, Six Sigma or Lean Six Sigma). This paper suggests that a single approach to simultaneously achieving resiliency and sustainability is not likely to yield the results needed. However, a large number of Category 1 and 2 companies “picked off” specific tools and techniques in very much an ad-hoc manner rather than employing a systematic and more holistic approach to achieving resiliency and sustainability. In this case, companies reported that they were achieving limited levels of performance improvement although most agreed that a more holistic approach to achieving both aims would probably help.

This paper offers a new view on the application of resiliency and sustainability frameworks in UK manufacturing businesses that can be of benefit to the wider industrial and academic community. The development of a qualitative assessment round a relatively small sample size has its obvious limitations and it is crucial that further work with a wider range of manufacturing companies is key to developing (and also validating) a comprehensive set of resiliency and sustainability characteristics. On particular, further analysis of the 26 profile 4 companies needs to be undertaken in order to identify the typical tools and techniques adopted by the company in order to achieve manufacturing resilience.

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#### Further reading

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