Article

Building strategic resilience in food supply chain

Manning, Louise and Soon, Jan Mei

Manning, Louise and Soon, Jan Mei ORCID: 0000-0003-0488-1434 (2016) Building strategic resilience in food supply chain. British Food Journal, 118 (6). pp. 1477-1493. ISSN 0007-070X

Building strategic resilience in the food supply chains

Journal:	*British Food Journal*
Manuscript ID	BFJ-10-2015-0350.R2
Manuscript Type:	Research Paper
Keywords:	Benchmarking, indicators, Stakeholders, Value, performance

Abstract

Purpose: The aim of this paper is to consider the concept of strategic business resilience in order to postulate innovative mechanisms to drive business performance in the food supply chain.

Design: The research included a literature review and the development of a resilience model that can be adopted in the food supply chain at both a strategic and an operational level.

Findings: Conflict of interest exist for organisations that are seeking to strategically and effectively manage the pluralistic nature of internal and external supply chain risks. The model derived in this research can be used in the food supply chain to drive supply chain agility, organisational stability and longevity, and as a result continuous improvement.

Originality/value – This research is of academic value and of value to policy makers and practitioners in the food supply chain.

Keywords benchmarking, performance, indicators, stakeholders, value

1. Introduction

Implicit in the definition of resilience is the requirement for flexibility and adaptability as well as the capacity to absorb market and environmental shocks and still maintain a fully functioning food supply chain (Folke, 2006). Factors that influence food supply chains include: natural disasters, technological accidents, infectious diseases, terrorism, and food safety incidents (Leat and Revoredo-Giha, 2013), food fraud and wider food crime and market and pricing strategies. Factors that affect supply chain resilience can be *internal* i.e. within the supply chain network or *external* factors often outside the control of the organisations involved. These factors can be categorised as: p*rocesses* such as transport, communication and infrastructure; c*ontrols* including protocols, policies, procedures, systems

and assumptions; and *demand and supply* related issues such as the fear of, or actual disturbances to, the multi-directional flow of materials, product, finance and information (Christopher and Peck, 2004). Driving a business strategy focused primarily on cost reduction without sufficient regard for the risks that this strategy creates will make the food supply chain more brittle (Viswanadham and Kameshwaran, 2013; Waters, 2007). Food supply chain brittleness is centred on factors such as low financial margins, low profitability and low resource stocks i.e. a lean management approach that can combine in multiple ways with social factors (e.g. consumer trust and brand loyalty) and factors such as weather vulnerability that affects quality or yield, price volatility or natural variation. The degree of financial brittleness in a particular food supply chain will depend on the level of profitability, liquidity, the ability to meet loan repayments and continue to implement capital investment plans that underpin business growth. Ultimately, lower operating margins reduce financial flexibility and create a more brittle supply chain that is vulnerable to major risks such as animal disease, volatility in commodity markets and an increasing cost of legal and/or social compliance.

Conversely, food supply chain agility is determined by the level of financial return, efficiency, innovation, resource management and the ability to have alternative sourcing mechanisms in place for key ingredients, organisational responsiveness and underpinning product quality that consistently meets customer requirements. For resilience to be assured in the food supply chain brittle structural aspects need to be effectively managed and where possible agility enhanced. Thus, it can be questioned whether the single concept of social-ecological food supply chain resilience is normative (Keessen *et al.* 2013) or if there are multiple meanings for what it is for an organisation, a discrete supply chain or indeed the whole global food system to be deemed as being resilient. There is heterodoxy in the vocabulary surrounding the meanings of resilience (Table 1) from it being the opposite of vulnerability (Folke, 2006: Levina and Tirpak, 2006) to the ability to return to a stable state

i.e. business as usual (Morecroft et al. 2012; Holling et al. 1996; Pimm, 1991) through to the capacity for change, growth, and renewal. Folke (2006:259) suggests that resilience needs to embrace "*the opportunities that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories*".

Take in Table 1

Five drivers identified by Foresight (2011) that will propel change in global food supply chains are: global population increase; change in the size and nature of per capita demand for food especially for meat and fish; climate change; competition for key resources (land, water and energy); and changes in values and ethical stances of consumers. Folke (2006) determines three concept of resilience: engineering resilience, ecological and socio-ecological resilience and this has been adapted to the food supply chain (Table 2). Engineering resilience is a transactional concept where the focal point for management is task-orientated and is one of recovery, constancy, and continuity. Ecological resilience considers the ability to withstand business shock requiring aspects of management such as persistence and robustness whilst socio-ecological resilience reflects transformational aspects of management that encompass learning, innovation and dynamic development. This self-organising process is in essence the equilibrium that is derived from reorganising, evolving and adapting as an organisation to the wider socio-economic environment that it operates in. Buffer capacity (also a key characteristic of ecological resilience) is the ability for an organisation or a supply chain to withstand shock and remain as a fully functioning business. Examples of how buffer capacity can be built is the use of buffer material and product stocks, or analysis of required skillsets for the organisation and a programme of capacity building in individuals through training and development. Thus, food supply chain resilience can be described and organisational goals can be developed either transactionally using financial, quantitative metrics or qualitatively in

terms of the ecological or holistic properties of resilience interfacing with what would generally be considered to be elements of an organisation's corporate social responsibility (CSR) strategy. However, organisations are increasingly expected to review their ethical performance in relation to stakeholders' expectations, identify how improvements could be made and then communicate these deliberations back to their stakeholders in order to deliver continued value (Manning *et al.* 2006; Manning, 2015). The whole process of value creation in food supply chains is realised through multi-organisational involvement and building mutual benefit (Caiazza and Volpe, 2012). Further they argue that a value chain is in fact an economic and social reality involving a set of actors and activities that interact and work together to satisfy the needs of specific markets. This definition supports the socio-economic view of strategic resilience (Caiazza et al. 2014; Caiazza and Volpe, 2012).

Whilst exploitation of natural resources could be considered as a key element of a global multinational corporation's (MNC) model of operation, this can create ecologically defined market failures in resource rich developing nations especially as a result of soil and groundwater depletion, reduction in forested areas etc. (Stigliz, 2006). An organisation can seek to offset the environmental impact of these activities by a variety of means e.g. reducing waste, using emissions or outputs from one process as inputs into another, offsetting emissions by developing other sequestering activities. However, this stratagem focuses on mitigation of current practice rather than innovating and adapting the whole process to embed long term organisational resilience. Organisational ability to adapt to change can stall if there are high levels of complexity in terms of products, processes and intra- and inter-organisational structures (Power, 2005). Therefore, organisational resilience is to be the ability to reinvent dynamically business models and associated corporate strategies as circumstances change (Hamel and Välikangas, 2003). Ultimately, resilience must be embedded strategically and within the operating system, driving agility, an ability to be

adaptive and deliver solutions especially with regard to emerging or re-emerging risks. The aim of this paper is to consider the concept of strategic business resilience in order to postulate innovative mechanisms to drive business performance in the food supply chain.

2. Strategic and operational resilience

Resilience is in part "the ability of an organisation to approach crisis situations as a potentially positive experience, and to utilise an enhanced ability to change as the economic, physical, political and social situation demands" (McManus, 2008:26). Strategic resilience is not about responding to a single crisis or rebounding from a setback, it encompasses anticipating and reacting to secular trends that can permanently impair the earning power of the core business (Hamel and Välikangas, 2003). Alternatively it has been suggested that strategic resilience "results when the organisation gains the capability to quickly convert threatening surprises into opportunities and to identify unique opportunities and act effectively before their competition" (Välikangas and Romme 2012:45). Further Välikangas and Romme (2012) differentiate between operational resilience and strategic resilience where the former is recovery focused e.g. after experiencing a crisis and tenacity in the face of threat i.e. reactive management and the latter is renewal focused in terms of changing without the driver of a crisis i.e. proactive management. The research has considered the concept of strategic and operational business resilience and postulated that innovative mechanisms need to be developed in order to embed resilience and drive performance and continuous improvement in the food supply chain.

Development of risk management strategies is a core executive process. Shareholders will place specific emphasis on ensuring the inherent risk to their financial investment is addressed in the strategic planning processes undertaken by senior management executives and executive boards. Indeed definition of organisational risk and the means for its control forms part of an executive annual report. A formulated approach has been described (Mintzberg,

1978) where *internal risk*s associated with the organisation itself should be easier to quantify and thus mitigate than *external* risk (national or global social, political or economic forces) especially where there is a strong organisational operating system in place. Management can alleviate the effect of such risks by developing a risk register and then having contingency or disaster recovery strategies in place, but such a formulated, executive approach may still not react quickly enough to a sudden supply chain "shock" or an emergent, previously unknown risk. Strategic change is often by its nature ad hoc and irregular, never steady and results from the interaction of periods of continuity, change, flux and inertia (Mintzberg, 1978).

Ensuring resilience in a wider business environment that is evolving rapidly requires two kinds of strategy firstly *intended strategy* i.e. what was planned and, secondly what is *realised strategy* i.e. what happened in practice. This emergent strategy is actually, what is exhibited by the organisation (Figure 1).

Take in Figure 1

Business continuity management (BCM) is the management process that identifies an organisation's exposure to internal and external threats and as a result synthesizes hard and soft assets to provide effective prevention and recovery for the organisation i.e. operational resilience, whilst maintaining competitive advantage and value system integrity namely strategic resilience (Elliott *et al.* 2002). Operational BCM should be driven by an interactive rather than a purely reactive or proactive strategy and during contingency planning consideration should be given to ensure that plans developed in isolation can be actualised whether they are needed or not (Elliott *et al.* 2002; Mintzberg, 1978). The scope of contingency plans in the food supply chain can include factors such as natural disaster, climate variation, flood, fire, crop failure, yield reduction, animal disease outbreak, and failure of product to meet minimum quality specifications. Product recall, foodborne disease outbreak, supply chain failure (bankruptcy or financial failure of supply chain partners,

logistical failure), food crime, threat or supply chain sabotage, and disruption to services e.g. internet, electricity, waste disposal, water, and distribution networks as with the historic incident of volcanic ash preventing movement of air freighted food should also be considered. Transactional consideration of engineering resilience in the context of BCM reflects the time to return to a stable state following shock, or perturbation, i.e. how quickly supply can be resumed (Folke, 2006; Morecroft *et al.* 2012), but this is limited in terms of the socio-ecological resilience requirements of creating supply chain value. This latter, self-organising, approach drives the interplay between supply chain disturbance, reorganising, sustaining and developing i.e. continuous improvement through enhancing adaptive capacity. In this context, the focal point for management is facilitating transformability, learning, and innovation rather than recovery or constancy. This requires fully integrated feedback systems and cross-chain dynamic interactions between organisations (Table 2). In order to develop an appropriate business continuity plan (BCP) that ensures strategic and operational resilience, consideration must be given to the environment in which the BCP will operate, and to the degree of turbulence in terms of the rate of change that is externally or internally driven. Therefore, the strategy must be flexible, and include the ability to deliver a set of value-based aspirations. Organisations need to consider resilience as being well beyond a BCP and develop strategies that, as Mintzberg (1978) describes, are not just formulaic but allow for an iterative approach to maintaining resilience. This requires management focus not to be purely on the organisational process and the architectural framework of policies, protocols and systems (system measures as defined by Tangen, 2005) but go further to consider how performance measures can be developed that will inform and lead strategy.

In determining risk, there are a number of factors that can be considered including marketing and pricing strategies, food safety incidents, food fraud and food crime, infections livestock diseases, technological and infrastructure risks and national and localised natural disasters or

accidents (see Figure 2). These will have an impact on strategic resilience in terms of both market and technology turbulence. Market turbulence is determined as the change in the composition of customers and their preferences whereas technological turbulence refers to the amount and unpredictability of change in production or service technologies (Slater and Narver (1994) cited by Terawatanavong et al. 2011). Market and technology turbulence can have both a push dynamic (from the challenges at primary production in terms of natural resource availability, livestock disease outbreak, weather and seasonal impacts, influence of ability to freely distribute product) through to a pull dynamic by the consumer. Primary level food production is subject to a number of potential "shocks" that can cause poor yields or crop failure either on an acute level in a single year or have chronic effects over a number of years, even decades. These factors can often have more influence in terms of supply and demand dynamics than ongoing technological research work in continuously developing the genetic potential of the crop to yield (Ray *et al.* 2012). Due to multiplier factors, poor feed crop yield and low product quality at primary production level impacts on further stages in the food supply chain e.g. the escalating effect, in terms of net efficiency, of poor feed quality and then lower feed conversion rate in the animals the feed is provided for. In food supply chains accumulative weak performance will influence food availability, and affordability for the world's increasingly urban population with an aggregation of marginal losses, rather than marginal gains. The aggregation of marginal gains theory is that multiple, seemingly miniscule, improvements throughout any given process, can collectively achieve a far superior output (Durrand *et al.* 2014; Eisen *et al.* 2014; Hill, 2014; Smith *et al.* 2014). Conversely the aggregation of marginal losses theory is worthy of consideration in the wider context of resilience and supply chain performance.

Assurance of strategic and operational resilience requires the integrated engagement of supply chain actors at all stage of food production, distribution and information exchange in order to

limit vulnerability, external and internal risks. Threat Assessment Critical Control Point (TACCP) is described in PAS 96 (2014:3) as the "*systematic management of risks through the process of assessment of threats, identification of vulnerabilities, and implementation of controls to raw materials, packaging, finished products, processes, premises, distribution networks and business systems by a knowledgeable and trusted team with the authority to implement changes to procedures*". Thus, an appropriate and well-integrated TACCP plan is just one element of a wider strategic resilience risk assessment that can be undertaken from primary production through to the consumer. In order to drive a quantitative approach to strategic resilience risk assessment, an architecture of analysis needs to be clearly defined, although the architecture must be agile enough to accommodate sudden and unexpected supply shocks in the event that they occur. Ultimately, corporate goals should be formulated and these need to cascade into specific, relevant and time bound measures. These measures can be strategic and influence the whole supply chain e.g. a supply chain level approach to reducing waste or be operationally based measures that define performance at a single supply chain stage. These corporate goals will as a result have influence either as a whole chain actor or as a single stage actor. Interest in CSR benchmarking for demonstrating social and environmental performance has promoted the development of supply chain guidelines and codes of practice (Manning and Baines, 2004). Benchmarking as an activity can then monitor the degree of integration between different measures and the actual organisational and/or supply chain performance that is realised. The use of methods to construct and to assess measureable socio-ecological indicators has been proposed (Mitchell *et al.* 1995; Hansen 1996; Bockstaller *et al.* 1997; Rigby *et al.* 2001; Hak *et al.* 2012). This approach suggests that quantitative measures can be used to drive what for many are deemed qualitative social aspirations and when the use of qualitative and semi-quantitative measures is open to interpretation. Bell and Morse (2003) stated that supply chain performance indicators must be

specific (outcome bound); *quantitative* (measureable): *usable* (of practical value); *available* (data easily collated); *cost-effective* (not expensive to collect); and *sensitive* (demonstrate changes in circumstances). This does not preclude the use of qualitative indicators, but by their nature, qualitative indications do not drive business performance and continuous improvement in the same way as quantitative indicators. Bourlakis et al. (2014) differentiate between four categories of socio-ecological supply chain indicators (efficiency, flexibility, responsiveness and product quality). In Table 3, the work of Bourlakis *et al.* 2014 has been adapted for the four factors with consideration of economic, environmental and social characteristics that they can quantify. Consideration of this work highlights that a resilience indicator framework could be developed that can be used at a strategic level or an operational level to provide socio-economic organisational and supply chain measures that define business goals and objectives which are measureable i.e. quantitative.

Take in Table 3

Benchmarking is the means by which targets, priorities and operations are established that will lead to competitive advantage (Oakland, 1993). Lau et al. (2005) characterise benchmarking as the systematic comparison of elements of performance in a company against those best practices of relevant companies, and then obtaining information that will help the observing company to identify and implement improvement. In order for benchmarking to be effective, it requires a measured consideration of whether the process will be implemented either at a strategic management level or at an operational, activity or enterprise level, or both. To reflect on this in another way, the benchmarking approach to developing resilience can be designed to underpin BCM strategies, long term strategic aims and objectives at the supply chain, or product category scale, as well as operationally drive the implementation of a CSR strategy or simply provide baseline data and then drive improvement. Synthesizing the

literature reviewed in this study as Hamel and Välikangas (2003) propose strategic resilience is not about simply responding to a single crisis or rebounding from a setback. Strategic resilience considers, anticipates and mitigates pressures, and drivers that influence the socio-economic environment in which the business operates. The factors considered are strategic leadership, strategic decision-making, supply chain dynamics, value based dynamics and the use of performance indicators in the context of external and internal influences and at the executive, organisational and individual level (Table 4).

Take in Table 4

Building on Table 4 and utilising the so-called 3Rs (ready-respond-recover) approach to resilience proposed by Ponomarov and Holcomb (2009) a 3Rs strategic resilience risk assessment framework for the food supply chain has been developed (Figure 2). This framework via consideration of internal organisational and external supply chain risks, and the ability of an individual organisation or a food supply chain to ready, respond and recover. Six examples of risk are illustrated in the framework, although this is not an exhaustive list, namely natural disasters, technological accident and infrastructure threats, infection or disease, food fraud and wider food crime, food safety incidents, outbreaks and product recalls and marketing and pricing strategies. The strategic resilience risk assessment framework identifies industry risk assessment tools that are already utilised to determine risk, TACCP with regard to food fraud and wider food crime and hazard analysis critical control point (HACCP) which is an approach used to consider food safety risk and its mitigation.

Take in Figure 2

Supply chain relationships depend on the abilities of the individual organisations in the food supply chain to individually and collectively act efficiently, flexibly, in order to be agile,

responsive and meet the complicated customer specifications for their products and services each time. This requires a hierarchy of strategic resilience aims and objectives and an architecture of analysis to be built around the supply chain metrics that are developed

Take in Figure 3.

In the context of a generic food supply chain, a conceptual resilience indicator framework (Figure 3) has been proposed using the secondary processing stage as an example. Similar strategic resilience indicator frameworks can be developed for other stages of the food supply chain, bespoke to particular products, processes or scenarios. The framework also includes a range of indicators that can be used as part of a supply chain monitoring process to create value for the organisation itself improving its strategic and operational resilience and provide value for a range of stakeholders. These stakeholders include shareholders who may reflect on their being less financial risk and a greater underpinning of brand value, insurance companies who are requested to provide insurance against risks such as product recalls, stock rejection, etc. and supply chain partners, community groups and consumers who may each define supply chain value in their own distinct ways. The use of a strategic resilience indicator framework can provide opportunity for an organisation to address internal and external risk and mitigate such risk wherever possible. This approach is of value to practitioners in the food supply chain in order to reduce risk. Risk is determined at many levels in an organisation from executive risk registers in corporate documents to the development of BCM protocols and the use of TACCP and HACCP at an operational level as described in the paper. The resilience assessment tools explored in this research can assist practitioners to consider a more integrated approach to managing risk and developing strategic resilience management programmes.

6. Conclusion

The aim of this paper is to consider the concept of strategic business resilience in order to postulate innovative mechanisms to drive business performance in the food supply chain. A 3Rs (ready, respond and recovery) business resilience risk assessment framework and an associated resilience indicator framework has been developed to enable organisations in the food supply chain to determine and improve their strategic resilience in terms of both internal organisational and external supply chain risk factors. This incorporates the five strategic resilience factors (values-based dynamics, supply chain dynamics, strategic decision-making, strategic leadership, and use of performance indicators) into the 3Rs strategic resilience risk assessment framework (Figure 3) to identify ways to ensure readiness through formal procedures and protocols, effective response and recovery. The strategic resilience indicator framework (Figure 4) can be use to develop and utilise performance indicators that demonstrate the degree of vulnerability within the socio-economic environment in which the organisation operates. Conflict of interest exists for organisations that are seeking to strategically and effectively manage the pluralistic nature of internal and external supply chain risks. The model derived in this research can be used in the food supply chain to drive supply chain agility, organisational stability and longevity, and as a result continuous improvement.

References

Ackoff, R.L. (1990), Strategy: Redesigning the Future, *Systems Practice,* 3 (6): 521-524

Adger, W. N. (2006), Vulnerability. *Global Environmental Change, Vol.* 16, Iss. 3, pp. 268-281.

Bell, S., and Morse S. (2003), *Measuring sustainability: learning by doing,* Earthscan Publications Ltd, London

Berkes, F., Colding, J., and Folke, C. (Eds.), (2003). Navigating Social–Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge, UK.

Bockstaller, C., Cirardin, P. and van der Werf, H.M.G. (1997), Use of agro-ecological indicators for the evaluation of farming systems. *European Journal of Agronomy,* Vol. 7, Iss. 1-3, pp. 261-270.

Bourlakis, M., Maglaras, G., Gallear, D. and Fotopoulos, C. (2014), Examining sustainability performance in the supply chain: The case of the Greek dairy sector, *Industrial Marketing Management,* Vol. 43, Iss. 1. pp. 56-66.

Caiazza R., and Volpe T., (2015), Interaction despite of diversity: Is it possible*? Journal of Management Development*, Vol.34, Iss. 6. pp. 743-750

Caiazza R., Volpe T., and Audretsch D.B., (2014), Innovation in Agro-food System: Policies, actors and activities, *Journal of Enterprising Communities: People and Places in the Global Economy*, Vol. 8, Iss.3, pp. 180–187

Caiazza R., and Volpe, T. (2012), The Global Agro-food system from past to future, *China-USA Business Review,* Vol. 11, No 7. Pp. 919-929

Christopher, M. and Peck, H. (2004), Building the resilient supply chain, *International Journal of Logistics Management,* Vol. 15, Iss. 2, pp. 1-13

Delmas, M., and Burbano, V.C. (2011), The Drivers of Greenwashing, *California Management Review*, Vol. 54, Iss. 1, pp. 64-87.

Driessen, P.P.J, and Van Rijswick, H.F.M.W. (2011), Normative aspects of climate adaptation policies. *Climate Law,* Vol. 2, Iss. 4, pp. 1–23

Durrand, J.W., Batterham, A.M. and Danjoux, G.R. (2014), Pre-habilitation (i): aggregation of marginal gains, *Anaesthesia,* Vol. 69, Iss. 5, pp. 403-406

Eisen, S., van der Poel, L., Clough, L., Musial, M., Walsh, O., and Salt, P. (2014), G183 Improving the patient pathway: aggregation of marginal gains in a secondary paediatric allergy service, *Srch Dis Child,* Vol. 99, Iss. Suppl 1. p187 doi:10.1136/archdischild-2014-306237.187

Elliott, D., Swartz, E., and Herbane, B. (2002), *Business Continuity Management. A crisis management approach,* Routledge, Oxon.

Folke, C. (2006), Resilience: the emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* Vol.16, Iss. 1, pp. 253-267.

Foresight. *The Future of Food and Farming (2011) Executive Summary*. The Government Office for Science, London.

Gunderson, L., and S. S. Light. 2006. Adaptive management and adaptive governance in the Everglades ecosystem. *Policy Sciences* Vol. 39, Iss. 4, pp. 323-334.

Gunderson, L.H., and Holling, C.S. (Eds.), (2002). Panarchy: Understanding Transformations in Human and Natural Systems. Island Press, Washington DC.

Hak, T., Kovanda, J. and Weinzettel, J. (2012,) A method to assess the relevance of sustainability indicators: Application to the indicator set of the Czech Republic's Sustainable Development Strategy. *Ecological Indicators,* Vol. 17, Iss. 1, pp. 46-57

Hamel, G., and Välikangas, L., (2003), The Quest for Resilience, *Harvard Business Review,* September 2003.

Hansen, J.W. (1996), Is agricultural sustainability a useful concept? *Agricultural Systems,* Vol. 50, Iss. 2, pp. 117-143.

Hill, J. (2014), Follow up after curative colorectal cancer resection – aggregation of marginal gains, *Colorectal Disease,* Vol 16. Iss. 8, pp. 575-576

Holling, C.S. (1996). Engineering resilience versus ecological resilience. In: Schulze, P. (Ed.), Engineering Within Ecological Constraints. National Academy Press, Washington DC, pp. 31–44.

Keessen, A. M., Hamer, J.M., Van Rijswick, H.F.M.W., and Wiering, M. (2013), The concept of resilience from a normative perspective: examples from Dutch adaptation strategies. *Ecology and Society,* Vol. 18, Iss. 2 art. 45 http://dx.doi.org/10.5751/ES-05526-180245

Lau, H.C.W., Lau, P.K.H., Fung, R.Y.K., Chan, F.T.S. and Ip, R.W.L. (2005), A virtual case benchmarking scheme for vendors' performance assessment, *Benchmarking: An International Journal*, Vol. 12, Iss. 1, pp. 61-80.

Leat, P. and Revoredo-Giha, C. (2013), Risk and resilience in agri-food supply chains: the case of the ASDA PorkLink supply chain in Scotland. *Supply Chain Management: An International Journal,* Vol. 18 , Iss. 2, pp. 219-213.

Levina, E., and Tirpak, D. (2006), *Adaptation to climate change: key terms*. Organisation for Economic Co-operation and Development, Paris, France.

Manning, L. (2015), Determining value in the food supply chain, *British Food Journal*, Vol. 117, Iss. 11, pp. 1-17

Manning, L., Baines, R.N., and Chadd, S.A. (2006), Ethical modelling of the food supply chain, *British Food Journal*, Vol. 108, Iss. 5, pp. 358-370

Manning, L., and Baines, R.N. (2004), Globalisation: A study of the poultry meat supply chain, *British Food Journal*, Vol. 106, Iss. 10/11, pp. 819–836.

McManus, S.T (2008), Organisational resilience in New Zealand, Available at: http://www.resorgs.org.nz/images/stories/pdfs/organisational%20resilience%20in%20new%20zealand.pdf [Accessed on: 29.12.15]

Mintzberg, H. (1978), Patterns in Strategy Formation, *Management Science,* Vol. 24, Iss. 9 pp. 934-948

Mitchell, G., May, A. and McDonald, A. (1995), PICABUE: a methodological framework for the development of indicators of sustainable development, *International Journal of Sustainable Development and World Ecology,* Vol. 2, Iss. 2, pp. 104-123.

Morecroft. M.D., Crick, H.Q.P., Duffield, S.J., and Macgregor, N.A. (2012), Resilience to climate change: translating principles into practice, *Journal of Applied Ecology,* Vol. 39, Iss. 1, pp. 547-551

Muthuri, J., Moon J., and Matten, D. (2006), *Employee Volunteering and the Creation of Social Capital*, Research Paper Series. International Centre for Corporate Social Responsibility No. 34-2006 - ISSN 1479-5124.

Oakland J.S. (1993), *Total Quality Management: The route to improving performance*. Butterworth-Heinemann Ltd, Oxford.

PAS 96 (2014), *Guide to protecting and defending food and drink from deliberate attack,*ISBN978 0 580 85537 5BSI Standards Limited

Pimm, S.L. (1991). *The Balance of Nature? Ecological Issues in the Conservation of Species and Communities.* University of Chicago Press, Chicago.

Ponomarov, S. Y. and Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *International Journal of Logistics Management*, Vol. 20, Iss. 1, pp. 124-143.

Power, D. (2005), Supply chain management integration and implementation: a literature review, *Supply Chain Management: An International Journal*, Vol.10, Iss. 4, pp. 252-63

Ray, D.K., Ramankutty, N., Mueller, N.D, West, P.C., and Foley, J.A. (2012), Recent patterns of crop yield growth and stagnation, *Nature Communications,* Vol. 3 (1293) Published 18.12.12 doi:10.1038/ncomms2296

Rigby. D., Woodhouse, P., Young, T. and Burton, M. (2001), Constructing a farm level indicator of sustainable agricultural practice, *Ecological Economics,* Vol. 39, Iss. 3, 463-478

Slater S.F., and Narver, J.C. (1994), Does competitive environment moderate the market orientation-performance relationship? *Journal of Marketing,* Vol. 58, No.1, pp. 46–55.

Smith, J., Meng, Z.W., Lockyer, R., Dudderidge, T., McGrath, J., Hayes, M., and Birch, B. (2014), Evolution of the Southampton Enhanced Recovery Programme for radical cystectomy and the aggregation of marginal gains, *BJU International,* Vol. 114, Iss. 3, pp. 375-383

Stigliz, J.E. (2006), *Making Globalization Work,* Allen Lane. ISBN 13 9780713999099

Tangen S. (2005), Insights from practice. Analysing the requirements of performance measurement systems, *Measuring Business Excellence*, 9 (4): 46-54

Terawatanavong, C., Whitwell, G.J., Widing, R.E., and O"Cass, A. (2011), Technological turbulence, supplier market orientation, and buyer satisfaction, *Journal of Business Research,* Vol. 64, Iss. 1, pp. 911–918

Välikangas, L.A. and Romme, G.L. (2012), Building resilience capabilities at "Big Brown Box, Inc.", *Strategy & Leadership*, Vol. 40 Iss: 4 pp. 43 - 45

Viswanadham, N., and Kameshwaran, S., (2013), *Ecosystem-Aware Global Supply Chain Management,* World Scientific Publications.

Walker, B.H., Holling, C.S., Carpenter, S.R., Kinzig, A.P., (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society*, Vol. 9, Iss. 2 5. [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art5/

Waters, D. (2007), *Supply Chain Risk management: Vulnerability and resilience in logistics,* ISBN: 9780749448547

Table 1. Meanings of resilience (Adapted from Keessen *et al.* 2013; Folke 2006 and others)

Meaning	Source:
The opposite of vulnerability.	Folke, 2006; Levina and Tirpak, 2006
A criterion to evaluate the quality of a strategy for adaptation to a stimulus e.g. climate change.	Adger, 2006; Driessen and Van Rijswick 2011
Ability of a system to adapt to change, but also the ability of a system to persist despite change.	Gunderson and Light, 2006
Ability of a system to return to its original state or move to a new, more desirable state after being disturbed.	Christopher and Peck, 2004
The time to return to a stable state following shock, or perturbation.	Morecroft *et al.* 2012; Holling 1996; Pimm 1991
Capacity for renewal, re-organisation and development.	Berkes *et al.* 2003; Gunderson and Holling, 2002
The amount of disturbance a system can take before its controls shift to another set of variables and relationships that dominate another stability region.	Folke, 2006
The capacity of a system to absorb disturbance and re-organise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks.	Walker *et al.* 2004

Table 2. Concepts of resilience (Adapted from Folke, 2006)

Resilience concepts	Characteristics	Focal point for management	Context
Engineering resilience	**Transactional**: return time, efficiency	Recovery, constancy	Stable equilibrium i.e. returning to a steady state.
Ecological resilience	**Buffer capacity**: ability to withstand shock and maintain supply chain function	Persistence, robustness	Multiple equilibria, stability at a supply chain level
Socio-ecological resilience	**Self-organising**: interplay between disturbance, reorganising, sustaining and developing i.e. developing through adaptive capacity	Transformability, learning, innovation	Integrated systems feedback, cross-chain dynamic interactions

Table 3: Resilience indicator framework with indicator categories by type and characteristic (Adapted from Bourlakis *et al.* 2014)

Indicator	Characteristic		
	Economic	**Environmental**	**Social**
Efficiency	Indicators relating to costs, margins and profitability or return on capital employed.	Indicators relating to resource efficiency, waste reduction, and carbon or water footprint.	Indicators relating to worker welfare and management of human capital e.g. staff turnover, productivity per person.
Flexibility	Indicators relating to the capability to provide individual service to customers e.g. differentiated stock keeping units (SKU), meeting changes in order levels or timings, minimising storage costs.	Indicators relating to environmental flexibility include the ability to irrigate crops if rainfall is insufficient, to change what type of forage is produced on the farm in the event of inclement weather.	Indicators relating to worker training and degree of flexibility e.g. multiple skills so can undertake more than one task. Degree of permanent versus contract staff if the fruit crop is late, orders are reduced from the retailer.
Responsiveness	Indicators relating to customer service, distribution and delivery costs.	Indicators relating to growing of new varieties adapted to climate variation, growing varieties that can tolerate more salt, less rainfall in a given region.	Indicators relating to animal welfare or labour standards e.g. reactivity to livestock mortality, livestock lameness, or health challenges. Responses to worker welfare issues.
Product quality	Indicators relating to compliance with product specifications e.g. carcase quality, intrinsic characteristics of fresh produce.	Indicators relating to environmental performance e.g. shelf-life, biodegradable or less environmentally intensive packaging.	Indicators relating to extrinsic production standards e.g. reduced stocking density, extensive production methods and consideration of worker conditions e.g. Fair Trade.

Table 4. Strategic resilience factors (Adapted from Caiazza and Volpe, 2015; Caiazza et al. 2014; Bourlakis et al. 2014; Delmas and Burbano, 2011; Muthuri et al. 2006; Elliott et al. 2002; Ackoff 1990; Mintzberg 1978)

Factors	External influences	Internal influences	
	Executive level	Organisational level	Individual level
Values based dynamics	Pressure from • Non-market actors (legislation, regulators and regulatory environment and non- governmental organisations); • Market actors (consumers, investors and competitors); • New challenges; • Historic legacies; • Community groups	Pressure from: • Organisational structure; • Organisational culture and sub-cultures; • Effectiveness of intra-firm communication; • Degree of organisational inertia; • New organisational challenges; and • Historic legacies.	Psychological and cognitive pressure include: • Narrow decision framing; • Hyperbolic intertemporal discounting; and • Optimistic bias. This could be due to the use of inaccurate or incomplete information on which decisions are based.
Supply chain dynamics	Pressure from: • Demand/supply dynamics; • Externally driven processes such as transport, communication and infrastructure; and • Externally driven controls including supply chain protocols, policies, procedures, systems and assumptions.	Pressure from: • Internally driven processes including communication and infrastructure; and • Internally driven controls including protocols, policies, procedures, and systems.	Pressure from: • Internally driven processes operating at the individual level including communication and infrastructure; and • Internally driven controls operating at the individual level including protocols, policies, procedures, and systems.
Strategic leadership	Drives: • Leadership at Executive level through stakeholder expectations; • Organisational operating system (external drivers); and • Change management (at executive level).	Drives: • Leadership at managerial level; • Organisational operating system (internal drivers); and • Change management at managerial level	Drives: • Leadership at personal level; • Organisational operating system (internal drivers); and • Change management at a personal level.
Decision making leadership	Drives: • Normative decisions (values and impact and decisions that create value); • Policies and principles (rules and formulation of values for the organisation and in turn product and service value; • Strategic decisions (focus on growth and issues that have an overarching organisational impact); and • Tactical, operational decisions (focus on efficiency and cost) or those issues reported annually to shareholders.	Drives: • Normative decisions (cultural and internal values); • Policies and principles (internal); • Strategic decisions (internally focused issues that have an organisational impact); • Tactical, operational decisions (focus on efficiency and cost); and • Tactical planning (operational, short-term goals)	Drives: • Normative decisions (cultural and internal values); • Policies and principles (internal); • Strategic decisions (internally focused issues that have an organisational impact); • Tactical operational decisions (focus on personal efficiency) ; and • Tactical planning (personal, short-term goals).
Use of performance indicators	• Externally driven from the need for regulatory compliance or market pressures to improve productivity through developing measures to drive efficiency, flexibility, responsiveness and product quality.	• Internally driven from the need for regulatory compliance or market pressures to improve operational productivity through developing measures to drive efficiency, flexibility, responsiveness and product quality.	• Internally driven from the need for regulatory compliance or market pressures to improve personal productivity through developing measures to drive efficiency, flexibility, responsiveness and product quality.

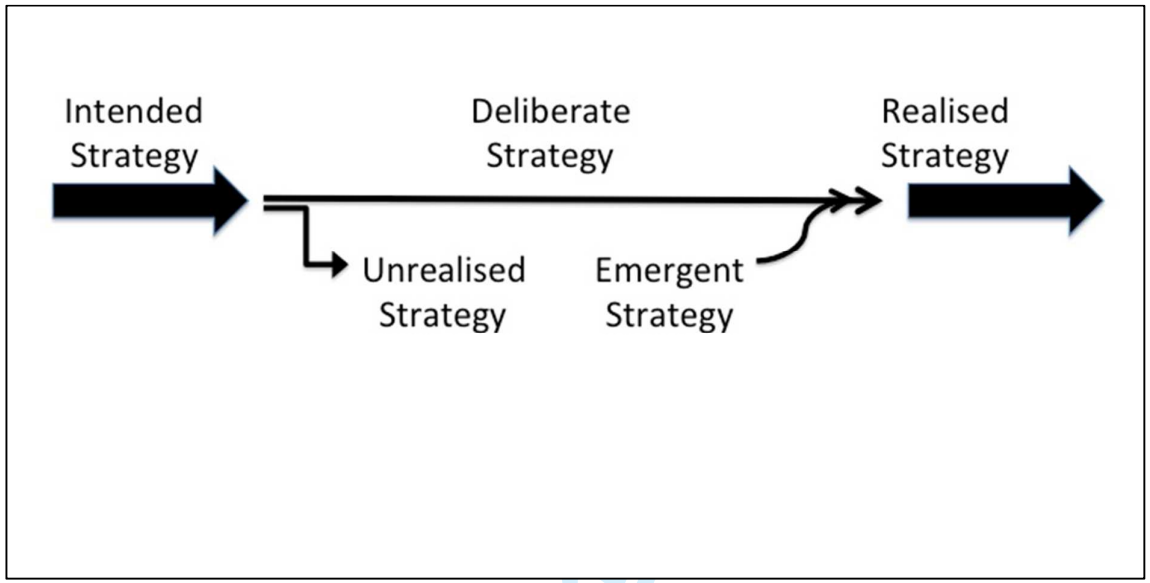
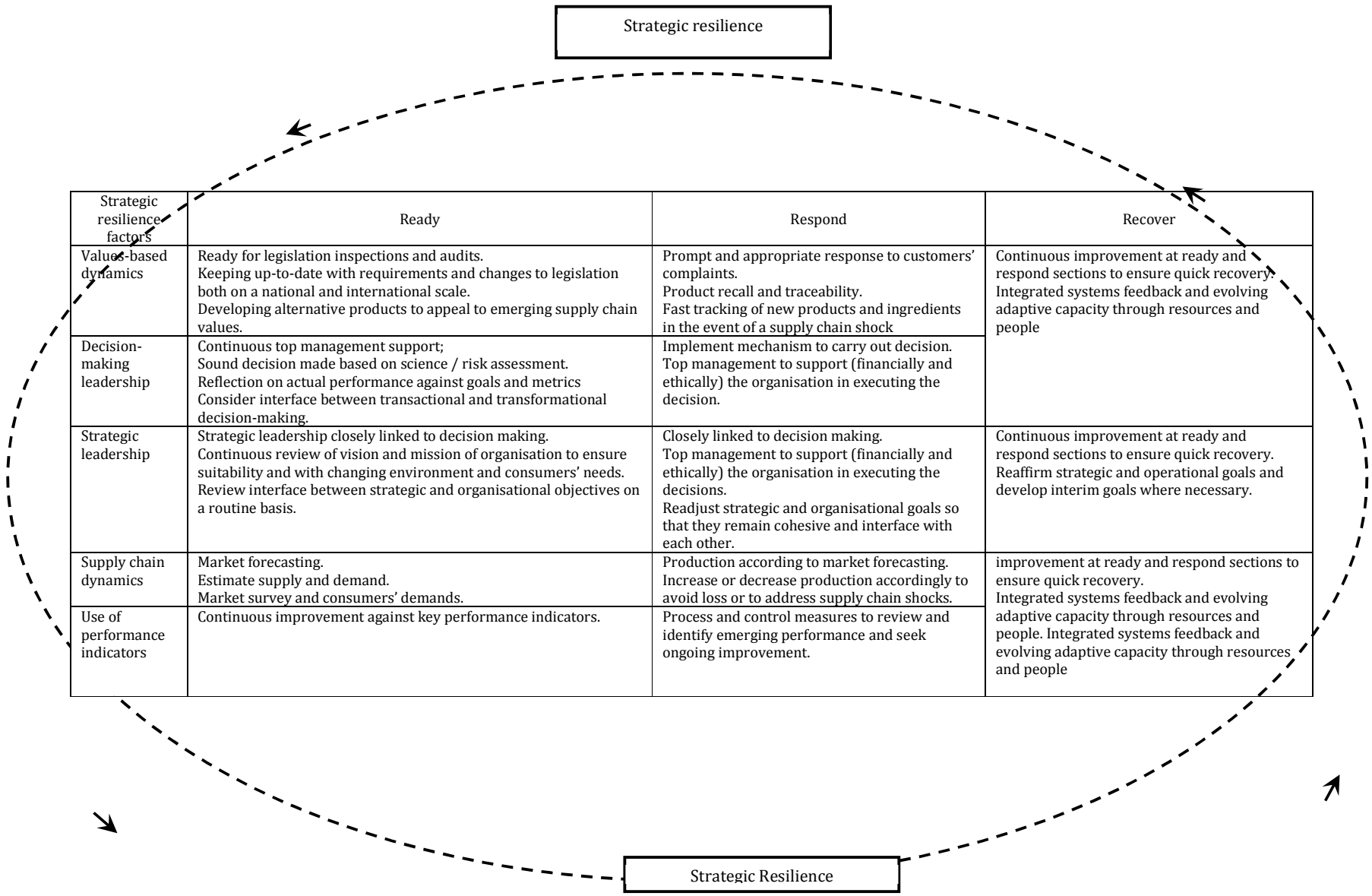


Figure 1. Types of Strategies (Mintzberg, 1978)

External supply chain risks	Internal organisational risks	Ready	Respond	Recover
Natural global disasters affecting suppliers / neighbouring countries e.g. crop failure, drought, war etc.	Natural local disasters e.g. flood, snowstorm, fire etc.	Alternative approved ingredient and service suppliers, appropriate stock levels of key ingredients; weather forecasting, alternative approved packing, processing or storage facilities.	BCM plan in place. Crisis response management team take action according to agreed protocols; introduction of new production plans to avoid productivity loss and minimise disruption.	Continuous improvement at ready and respond sections to ensure quick recovery or change product mix so that continuity can be maintained. Review efficacy of strategies and procedures employed and update as necessary. Develop new protocols, adaption strategies, training programmes as required.
Technological accidents and infrastructure threats (e.g. accidents occurring at suppliers' farms / processing plant, transportation, communication breakdown, loss of data, technical knowledge).	Technological accidents in own processing plant, loss of data, technical knowledge, communication between organisational centres.	Alternative approved ingredient and service suppliers, appropriate stock levels of key ingredients; Predetermined agreement for other organisations even competitors to contract pack product until problem is addressed, clean-up and respond standard operating procedures (SOPs), alternative transport and distribution procedures in place, information back-up, recovery and retrieval procedures developed and ready to implement.	BCM plan in place. Crisis response management team take action according to agreed protocols; Clean-up / repair technological accidents and approval protocols for production to recommence; reduce production of particular products and alternative supply mechanisms put in place to avoid productivity loss. Implement information recovery and retrieval procedures.	
Infectious animal diseases (diseases affecting importing / exporting countries, competitors) e.g. avian influenza, swine fever, foot and mouth.	Infectious diseases (diseases affecting suppliers' farms) e.g. avian influenza, swine fever, foot and mouth.	Infectious disease continuity plans developed and annually tested, emergency procedures developed and tested. Predetermined agreement for alternative suppliers and markets so supply could be diverted to source from other regions or suppliers.	BCM plan in place. Crisis response management team take action according to agreed protocols; Source from different suppliers/ countries if disease outbreak is identified. Implement alternative food products if possible to ensure markets are not lost to competitors. Work with regulatory requirements in terms of movement restrictions etc. until lifted.	
Food fraud and wider food crime incl. terrorism, boycott.	Food fraud and food crime including food tampering, substitution adulteration.	Undertake TACCP assessment and develop response plan. Consider wider potential for food crime associated with products sold e.g. with high value foods, ethnic or specific culture foods. Identify "at-risk" products that require specific monitoring. Horizon scan for emerging and re-emerging food crime hazards. Review security procedures on a routine basis. Develop a plan for alternative suppliers. Implement employee screening and training programmes.	BCM plan in place. Crisis response management team take action according to agreed protocols; Implement controls identified within TACCP Plan or equivalent. Isolate product and implement product withdrawal or recall. Source from different suppliers, investigate reason behind food tampering and include law enforcement agencies where required.	
Food safety incidents / outbreaks / product recall.	Food safety incidents / outbreaks/ contamination from own processing plant.	Undertake food safety risk assessment including HACCP assessment and develop response plan. Determine risk to vulnerable groups. Develop traceability and product recall and withdrawal procedures and test these procedures on a routine basis. Horizon scan for emerging and re-emerging food safety hazards.	BCM plan in place. Crisis response management team take action according to agreed protocols; Implement controls identified within HACCP Plan or equivalent. Isolate product and implement product withdrawal or recall. Source from different suppliers, investigate reason behind food safety incident and include regulatory and law enforcement agencies where required. Undertake sampling and laboratory testing.	
Market and pricing strategies.	Market and pricing, economic crisis.	Financial budgeting and planning including financial contingency plans such as agreed extension to overdraft. Horizontal collaboration to ensure market and price security (Leat and Revoredo-Giha, 2013).	Modify products to address constraints where possible. Market / promote alternative products to address fluctuating food prices/ availability.	

Figure 2. 3Rs (ready, respond and recovery) strategic resilience risk assessment framework for food supply chain



Strategic resilience factors	Ready	Respond	Recover
Values-based dynamics	Ready for legislation inspections and audits. Keeping up-to-date with requirements and changes to legislation both on a national and international scale. Developing alternative products to appeal to emerging supply chain values.	Prompt and appropriate response to customers' complaints. Product recall and traceability. Fast tracking of new products and ingredients in the event of a supply chain shock	Continuous improvement at ready and respond sections to ensure quick recovery. Integrated systems feedback and evolving adaptive capacity through resources and people
Decision-making leadership	Continuous top management support; Sound decision made based on science / risk assessment. Reflection on actual performance against goals and metrics Consider interface between transactional and transformational decision-making.	Implement mechanism to carry out decision. Top management to support (financially and ethically) the organisation in executing the decision.	
Strategic leadership	Strategic leadership closely linked to decision making. Continuous review of vision and mission of organisation to ensure suitability and with changing environment and consumers' needs. Review interface between strategic and organisational objectives on a routine basis.	Closely linked to decision making. Top management to support (financially and ethically) the organisation in executing the decisions. Readjust strategic and organisational goals so that they remain cohesive and interface with each other.	Continuous improvement at ready and respond sections to ensure quick recovery. Reaffirm strategic and operational goals and develop interim goals where necessary.
Supply chain dynamics	Market forecasting. Estimate supply and demand. Market survey and consumers' demands.	Production according to market forecasting. Increase or decrease production accordingly to avoid loss or to address supply chain shocks.	improvement at ready and respond sections to ensure quick recovery. Integrated systems feedback and evolving adaptive capacity through resources and people. Integrated systems feedback and evolving adaptive capacity through resources and people
Use of performance indicators	Continuous improvement against key performance indicators.	Process and control measures to review and identify emerging performance and seek ongoing improvement.	

Figure 3. Strategic Resilience Indicator Framework incorporating values, decision-making, strategic, supply and performance factors into the 3Rs