



**A Conceptual understanding of Criminality and Integrity
Challenges in Food supply chains**

Journal:	<i>British Food Journal</i>
Manuscript ID	BFJ-07-2016-0314.R1
Manuscript Type:	General Review
Keywords:	Food supply chain fraud, Food supply chain crime, Food supply chain criminality

A CONCEPTUAL UNDERSTANDING OF CRIMINALITY AND INTEGRITY CHALLENGES IN FOOD SUPPLY CHAINS

ABSTRACT

Business, consumers and governmental organisations are harbouring a growing need to gain an appreciation of behaviours connected to food criminality. In order to acquire a cross-functional understanding of these thematic areas [crime & fraud] the mapping of existing research is needed. This paper contributes to the process of knowledge understanding, by systematically reviewing literature to provide an analysis of the current body of business knowledge against the thematic criterion of 'supply chain food crime' and 'supply chain food fraud'. The analysis derives themes from the literature and maps this across the 8 pillars underpinning the UK Government paper on food supply chain resilience. The paper concentrates on the metrics that contribute to 'food crime' and 'food fraud' and deviating views of academic versus non-academic literature. In concluding the paper identifies thematic areas for further research, and presents a conceptual framework of food supply chain resilience.

KEYWORDS

Food authenticity, Supply Chain Food criminality, Food crime, Food fraud

1. INTRODUCTION

Traditional supply chain risk management (SCRM) has received significant attention by both academic and practitioners, however, despite this noteworthy body of knowledge an air of indecision and trepidation across holistic business networks reside in terms the ultimate resilient supply chain (Sodhi & Tang, 2012), in part due to the challenges associated with supply chain resilience being measured as aggregate level events. This cumulative assessment of supply chain risk, limits an organisations ability to realise elements that deliver true cause and effect relationship within global supply chain operations (Bacon, 2014; Christopher and Lee, 2004; Punter, 2013). Furthermore, the intricacies of SCRM become more prevalent when applied across extended value chains, with an asserted sectoral demand increase for foodstuffs of 50% by 2030, which will lead to the 'perfect storm' of food SCRM (House of Commons International Development Committee, 2013).

Food authenticity is associated with innumerable amounts of risk, many of which are associated with traditional SCRM. However, there are elements of risk mitigation that reside within food supply chains not experienced in other sectors, such as but not limited to consumer activity, food legislation and scientific testing. It is this multi-sectoral cross functional approach that requires food supply chains to holistically collaborate in order to mitigate value chain risk, as no one element in isolation is able to mitigate over all supply chain risk (Spink & Moyer, 2011). Consequently, in order to realise cross-functional understanding of research within this field, this paper has collated and reviewed a widespread body of knowledge across the thematic areas of 'food crime' and 'food fraud', comparing and contrasting existing literature against the developing themes in practitioner presses, permitting identification of future research in this discipline.

1.1. TRADITIONAL SCRM

The significance of greater holistic supply chain focus associated to risk and resilience are supported by the European Commission and OECD (European Commission, 2014), whom expound traditional supply chain risk as being measured against key themes such as criminality, disease (epidemic), natural disasters, technological (cyber crime) and terrorist events. These fundamental thematic areas are a determinant of aggregate event-driven episodes, which cultivate ambiguity in the wider supply chain understanding of risk management. Nonetheless, Allianz (2014) undertook to understand the constructs of supply chain risk, and attempted to categorise supply chain events that comprise episodes of business risk. However, although these allocate a top level appreciation of the differing business risk, there is no correlation to sector type, node or global location permitting a better understanding of holistic value chain risk management.

In reviewing the holistic supply chain risks of criminality, there is a globally accepted rise in fraudulent activity within the business domain. 70% of globally positioned businesses have encountered some form of criminality within its supply chain, with 67% of these events involving an insider from within the organisation. This rise of criminality in a supply chain context can be identified within Europe, with 56% of businesses in 2012 reporting some form of fraudulent activity compared to 77% in 2013 (Kroll, 2014). We could surmise that perhaps this rise of fraudulent activity is attributed to better reporting,

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6 however the World Economic Forum assert that concerns remain over lack of focus pertaining to
7 resilience in a supply chain context against a continual increase in fraudulent behaviour (Bowman,
8 2014; McCarthy, 2014; World Economic Forum, 2013). Furthermore, studies have been undertaken to
9 review resilience in a business context, with FM Global (2016) citing three fundamental focus areas
10 required to improve overall business resilience; economic, quality and supply chain, and within these
11 three thematic areas greater focus is required on corruption, infrastructure and suppliers to be build
12 greater business resilience.

13 1.2. FOOD CRIMINALITY

14 In being able to bridge the gap between academic and practitioner research in appreciating the food
15 supply chain risk landscape, a distinction needs to be made between 'supply chain food crime' and
16 'supply chain food fraud'. These terms are often used in an interchangeable manner, habitually
17 misunderstood by academics and practitioner alike, with the Food Standards Agency referring to the
18 differentiation between terms as "unhelpful" and "impractical" (FSA, 2016). Further compounding the
19 complexity between 'food crime' and 'food fraud', Manning and Soon (2016) purport that at times
20 instances of food fraud may overlap or intercede with food defence and/or food quality issues.

21 Therefore, to clarify, the Food Standards Agency cite "*Food fraud is a dishonest act or omission,*
22 *relating to the sale or preparation of food, which is intended for personal gain or to cause loss to*
23 *another party"* (FSA, 2016, p.9) Furthermore, Prof. Elliott (Elliott, 2014) asserts how fraud becomes
24 organized crime when undertaken repeatedly for profitable means, at which point it falls under the
25 auspices of the Governments Serious and Organised Crime strategy (October 201337).

26 Consequently, the authors for purposes of clarity and to remove confusion in the system refer to
27 'food crime' and 'food fraud' as 'food criminality'.

28 1.3. SUPPLY CHAIN RISK MANAGEMENT AND FOOD SUPPLY CHAINS

29 Our cross-sectional analysis of the literature highlights a tendency within academia and practitioner
30 led publications to centre risk and resilience research around cumulative event-driven thematic areas,
31 that attempt to review cause and effect relationships in an aggregate manner. Recent events within
32 global food supply chains have evidenced a detachment between thematic areas of research and the
33 direction of practitioner led interest (Fig.1). This disconnect between practitioner need and academic
34 research is further supporting the aforementioned 'perfect storm' of risk and resilience within food
35 supply chains across Europe. Taking for example the UK food manufacturing sector which comprises
36 310 thousand businesses, engaging 3.8 million workers across a net worth of £96 million (European
37 Commission, 2014), any risk or resilience issue in this sector could have drastic consequences to a
38 nation's health and countries GDP. It is therefore of no surprise that DEFRA (2013) purport the need
39 for organisations to foster environments of collaborative practice, that enhance nutrition, quality and
40 safety of food stuffs, through the generation of innovative programs that leverage off of research that
41 develop tools and databases to mitigate risk in a food supply chain context. This need for innovation
42 is also supported by recent UK Government reports with both Professor Elliott and Food Standards
43 Agency supporting the need for greater collaborative sharing of information to permit holistic food
44 supply chain actors to benefit from greater food product authenticity and traceability (Elliott, 2014;
45 FSA, 2016).

46 The linkages between authenticity and traceability are highlighted by Nelleman et al (2009), asserting
47 annual global food supply chain losses of 1.3 billion tonnes, with no awareness or appreciation of
48 where this product is leaching from. Although in itself this raises questions regarding traceability in
49 the food supply chain, it further supports the need to recognise and understand that if supply chain
50 actors are unable to trace foodstuffs leaving the food chain, how are they [food supply chains] in a
51 position to identify elements coming into food supply chains (authenticity). In order to mitigate these
52 issues associated to authenticity and traceability against that of disappearing foodstuffs, Nelleman et
53 al (2009) suggest examples of legislative efforts to curb risk associated with criminality, building
54 greater resilience into food chains. However, studies by the Africa Research Bulletin (2013) have
55 discovered that over legislation of food chains cultivates a black market community, driving food
56 losses higher and exacerbating the challenges of 'invisible' and 'traceable' supply chains. This lack of
57 'traceability' creating the 'invisible supply chain' strengthens the authors views that food supply chain
58 resilience is a cross functional process and can not be mitigated by legislation alone. However, in
59 predicting food supply chain criminality it is crucial that organisations understand the causative
60 factors that influence occurrences of risk, such as criminal factions being able to circumvent existing

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scientific testing processes, and supply chain actors of complex extended food supply chains needing to navigate the differing cross border regulations in place (Manning & Soon, 2014).

In summary, the lack of consistent approach to research into food supply chains coupled to confusion with understanding the difference between 'food crime' and 'food fraud' is oppressing accountability, authenticity and traceability, thus is a significant area for academia and practitioner alike to collaboratively broach to facilitate resilient food chains. It is clear from current research that no one solution alone can mitigate risk in a food supply chain, therefore, the authors argue that it is incumbent on business, government and research communities to support and underpin the auspices of scientific testing and legislation, by bringing together a triangulated approach (Science, Legislation & Operational) to food supply chain resilience through a collaborative approach to security of supply.

2. METHODOLOGY

This research employs a systematic literature review (SLR), which affords a well defined and coordinated facilitation of research gap analysis for researchers, across areas of literature which are often contradictory and subjective in approach (Denyer & Tranfield, 2006; Tranfield et al, 2003). As such, a systematic cataloguing of current research was undertaken through an iterative method of identify, explicate and refine across research databases to ascertain the significance of reviewed research (Clark & Oxman, 2001; Tranfield et al, 2003). To ensure appropriate rigor and objectivity in the overall process, the authors conducted the analysis individually using a common framework to give validity to the research outputs, as suggested in the systematic literature review processes supported by Duriau et al (2007), Rousseau et al (2008) and Tranfield et al (2003).

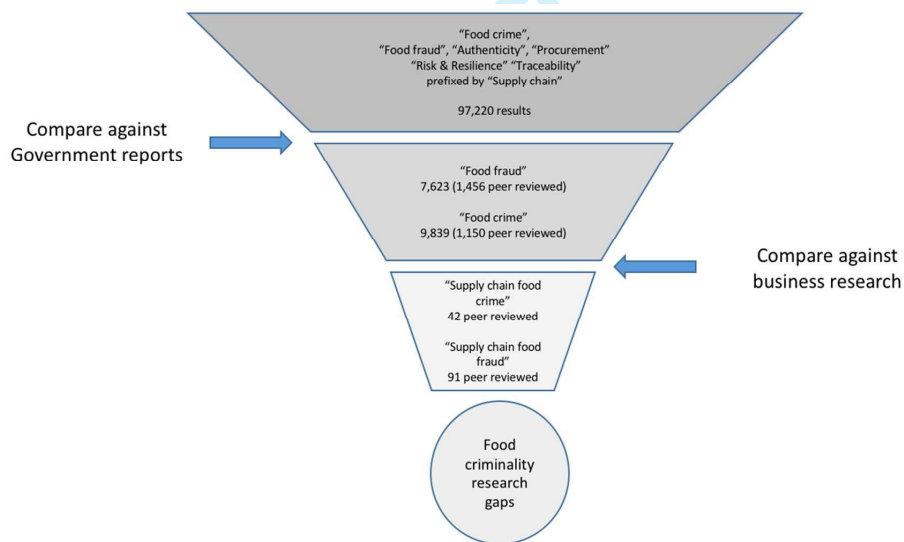


Fig.1. Systematic literature review – stage gated process

In the initial review of food supply chain risk literature and considering recent events affecting food chain actors e.g. the Horsemeat case, we identified the emerging nature of food supply chain criminality and food fraud. This created the focus for the study and a multi-stage search process (Fig.1) was adopted. This enabled an inclusive search criterion at the outset, setting the scene for the wider context of food supply chain food crime and fraud (including but not limited to academic journals, books, news presses, practitioner journals and government presses). This initial search utilised the keywords "Food crime", "Food fraud", "Authenticity", "Procurement", "Risk & Resilience" and "Traceability" all prefixed by "Supply chain", presenting 97,220 results. The researchers then re-examined this body of knowledge within the supply chain risk and resilience sector and applied a concentrated search for "food fraud" and "food crime" areas that were prevalent in the Food Standards Agency and UK Government reports (Elliott, 2014; FSA, 2016), which proffered 7,623 (1,456 peer reviewed) and 9,839 (1,150 peer reviewed) articles respectively, with a high concentration of findings pertaining to scientific approaches to food criminality.

Therefore, in order to meet the outcomes of Governmental research and gain an appreciation of cross-functional understanding (DEFRA, 2013; Elliott, 2014; FSA, 2016) the research process further examined journals to assess relevance against the field of business [supply chain], with the authors selecting a detailed review of the subject area using only the search criteria “supply chain food fraud” and “supply chain food crime” against an inclusion criteria of peer reviewed academic journals, which delivered a return of 91 and 42 respectively. The authors then applied the additional criteria against the Chartered Association of Business Schools (CABS) research catalogue due to its International acknowledgement and impact in the sector of business research, yielding 5 peer reviewed papers under the aforementioned search criteria.

The concluding phase of assessment analysed the UK Government report into Supply Chain Food criminality, particularly the eight pillars of food supply chain criminality prevention “Consumers, zero tolerance, intelligence gathering, laboratory testing, audit, government support, leadership and crisis management” (Elliott, 2014, p.15). A comparison was made of the eight pillars set against the focussed peer reviewed papers to assess relevance of existing thinking within academic and practitioner circles, to achieve an appreciation of the research gaps across thematic areas.

3. PRESENTATION OF FINDINGS

3.1. Step 1 - Holistic view of Supply chain food criminality literature

The literature on supply chain risk management adequately covers, areas such as inventory, procurement and risk, but is lacking thematic areas pertaining to food supply chain risk management (Table.2). Given the rise of food criminality and continuing demand for food, this lack of food chain risk management understanding is of concern, particularly given inventory and procurement strategies deployed across the holistic supply chain are well understood risk mitigation strategy (Sodhi & Tang, 2012).

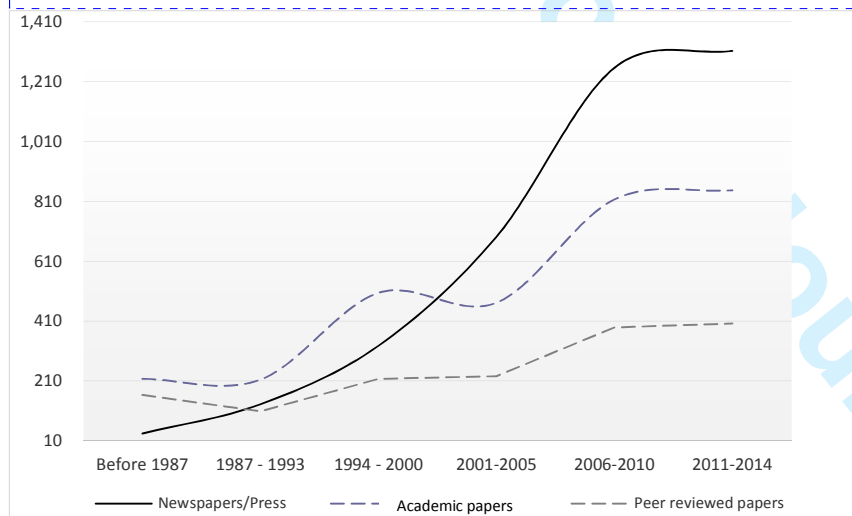


Fig.2. 'Food crime' publications [Academic & Practitioner] (Fassam & Dani, 2015)

Additionally, taking the wider view of all articles published in the area of 'food crime' and 'food fraud', due to the relatively new-found status of the topic in supply chain related research there is a distinct difference between the amount of academic articles published in comparison to those published in professional literature and newspapers. (Fig.2). There is a clear divergence amongst the two streams of publishing [industry/news & academia], albeit there was a spike in news press activity post 'horse meat 2013'. However, this still suggests a need for academia to research further into this thematic area supporting Governmental and practitioner initiatives in the areas of food criminality and create a body of knowledge to support resilient food supply chain strategies.

Topic	Count
Crime & offence	155
Social anthropology	128

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Health & wellbeing	80
Economics	73
Food & ingredients	71
Obesity	61
Food supply chains	39
Criminology	34
Diet & nutrition	33
Hostility	33

Table 1: Top 10 peer reviewed papers thematic 'Food crime'

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Despite the clear divergence between business/news presses and academic research, the existing body of academic knowledge has a high scientific concentration on the areas of public health and diet within the 'supply chain food crime' research. This literature depicts how 'public health' and 'diet' have developed as compelling thematic areas against other food supply chain challenges, and supports the view that consumers are more concerned with diet and security of supply to that of criminality (DEFRA, 2013).

Topic	Count
Logistics	10,520
Supply chain	8,321
Transportation management	6,203
Theoretical treatment	5,435
Management research	4,505
Risk management	3,622
Operations research	3,416
Demand management	3,221
Inventory control	2,622
Purchasing	1,522

Table 2: Top 10 peer reviewed papers thematic 'supply chain risk management' areas

Possibly the most surprising gap across food supply chain risk management literature when compared to SCRM sources is a lack of focus pertaining to softer management challenges and risks associated with fraudulent activity (Table.2). The Chartered Institute of Procurement and Supply suggest a requirement for greater transparency in relation to trading practices and the engagement of supply chain partners to facilitate eradication of fraudulent behaviour across holistic supply chains (CIPS, 2013). The lack of topics such as bribery, corruption and fraud in food supply chain risk management, is accordingly an area that requires addressing by academic research, allied to the aforementioned areas.

3.2. Step 2 - Focused Chartered Association of Business School data

In order to probe deeper into the two topics within the academic literature on supply chains the authors focused on the key words 'Supply chain food fraud' and 'Supply chain food crime', which complements the terminology utilised in key literature and Governmental reports (DEFRA, 2013; Elliott, 2015; Spink & Moyer, 2011). This focussed search returned ninety-one 'Supply chain food fraud' and forty-two 'Supply chain food crime', peer reviewed journal papers.

Author	Date	Methodology type
Van Dorp	2003	Qualitative case study
Manning & Soon	2014	Qualitative case study
Jamal & Shariffudin	2014	Interviews
Uriocoli, Paulraj & Naslun	2013	Semi-structure interviews
Sarpong	2014	Media case studies

Table.3 CABS Supply chain food crime & fraud methodologies

In order to align with the outputs and recommendations of the Government reports (DEFRA, 2013; Elliott, 2014; FSA, 2016) and draw parallels across research in the area of business and management, the authors utilised the Chartered Institute of Business School (CABS, 2015) listings for the literature analysis. This returned 5 papers in the areas of 'supply chain food crime' and 'supply chain food

fraud', identifying an immediate lack of peer reviewed business and management literature in the area of food supply chain risk management, and thus supports the findings in the wider supply chain first stage systematic review (step 1). The research focus and methodology across the peer reviewed CABS journal papers was principally qualitative in its approach, with a split between reviews of existent literature, case studies and semi-structured interviews (Table.3), across a mix of countries, with the preponderance of European origin (Table.4).

Author	Date	Research area
Netherlands	2003	Beef labelling: the emergence of transparency
Malaysia & UK	2014	Developing systems to control food adulteration
Malaysia & UK	2014	Perceived value and usefulness of halal labelling: The role of religion and culture
Denmark, Sweden, Switzerland & US	2013	The role of law enforcement agencies in transport security, survey with Swedish operators
Ghana	2014	Traceability and supply chain complexity: confronting the issues and concerns

Table.4. Countries of supply chain food crime & fraud CABS journals

3.3. Thematic comparison of detailed literature review

A detailed examination of peer reviewed 'food supply chain crime' and 'food supply chain fraud' CABS papers was undertaken identifying key thematic areas (Table.4), which were compared alongside existent Government research into Food supply chain resilience by Prof Elliott (Elliott, 2014) and the non-CABS food supply chain risk papers (Table.5).

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Country	Date	Title
Bowman	2014	Companies are failing to detect financial fraud in supply chains
Elliott	2014	Elliott Review into the Integrity and Assurance of Food Supply Networks – Final Report
European Commission	2015	Food fraud network report 2015
FM Global	2016	Resilience index annual report 2016
Food Today	2013	European Union action plan to tackle food fraud
Food Standards Authority	2016	Food crime annual strategic assessment
Food Safety Authority Ireland	2015	What is food fraud
Johnson	2014	Food fraud and "economically motivated adulteration" of food and food ingredients
McCarthy	2014	Has Globalization made corruption worse
National audit office	2013	Food safety and authenticity in the processed meat supply chain
NSF	2014	The 'new' phenomenon of criminal fraud in the supply chain
Which consumer report	2013	The future of food – giving consumers a say

Table.5 Key non-academic supply chain food crime and fraud related publications

The key thematic areas (Table.6) indicate an inconsistent approach to the academic literature, from both the peer reviewed CABS outputs and non-CABS literature and that of the Governments report produced by Prof. Elliott. Critical areas such as authenticity, authorities, enforcement and intelligence are heavily discussed by Prof. Elliott, however are devoid within the academic research. Nonetheless, there are thematic areas where an alignment can be identified such as business, fraud, health and information. This suggests that despite there being gaps in current academic thinking, a partial alignment does reside within existent literature within the field of business research.

	ALL journals	CABS	Elliott
adulteration	x	x	
analysis	x	x	
authenticity			x

authorities			x
business	x	x	x
consumers			x
control	x	x	
crime	x		x
data	x	x	
dna	x		
enforcement			x
fraud	x	x	x
government			x
health	x	x	x
industry			x
information	x	x	x
intelligence			x
management		x	x
method	x	x	
production	x	x	x
products	x	x	x
quality	x	x	
risk			x
safety	x	x	x
sample	x	x	x
species	x	x	
standards/systems	x	x	x
testing			x
traceability	x	x	

Table.6 Thematic areas across CABS journals, Elliott review & Non-CABS journals

4. Conceptual understanding of thematic areas

Prof. Elliott's report for the government study identified 8 pillars of food supply chain resilience. These pillars as identified are not just important as bases of resilience but are the concepts to utilise to counter food fraud and crime in the supply chain. The following section creates an understanding of the 8 concepts from the perspective of themes and information identified through the focused literature sources and wider literature.

4.1. The approach to stakeholder perception

Across the existent Chartered Association of Business Schools (CABS) and non-CABS peer reviewed journals, little focus or attention has been paid to the aspects of consumer interaction with food criminality. When reviewing available literature, there is no evidence of a connect between food supply chain criminality and consumers, which is potentially driven by retail shoppers being more concerned with price and nutrition rather than that of authenticity (DEFRA, 2013). Rarely do retail shoppers realise they have been a victim of food fraud or crime, particularly due to their busy lifestyles being far removed from understanding the authenticity and originality of their food stuffs, thus reporting levels are low, which stifle profile raising of this prolific supply chain crime (FSA, 2016). Yet, despite this lack of cohesive consumer approach to food chain criminality by academics, business and consumers, the theme of a nation's health is prevalent across all three streams (Table.6), which suggests, albeit not explicitly, the consumer is affected by food criminality, but the extent, and longer term health and wellbeing aspects are yet to be fully understood. Therefore, in order to align research to Government and practitioner activities, processes and legislation in order to mitigate food risk and underpin Prof. Elliott's eight pillars of food resilience, a greater appreciation is needed of consumer perception of food chains.

It is not just academic research that is grappling to understand the landscape of food criminality, the European Commission purports how differing perceptions of food crime and food fraud are understood across its member states, with no clear 'European' definition of the problem (European Commission, 2014). However, A. Morling, Head of the UK Food Crime Unit attempts to redress the confusion in the sector defining food fraud and crime as simply; "dishonesty relating to food production or supply, which is either complex or results in detriment to consumers, businesses or overall public interest" (FSA, 2016, p.9), supporting one view of this food supply chain resilience issue. Nonetheless, 'dishonesty' in a food supply chain sense, is quite often seen as a victimless crime, with the majority of food criminality resulting in limited health risks, with the noteworthy exception to the

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6 Chinese milk powder melamine case, Peanut Corporation of America case and Sudanese spice dyes
7 public health issues (FSA, 2016; Gossner et al, 2009; Stiborova et al, 2002).

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9 In spite of this, the authors suggest that there is a potential long term health and wellbeing aspect to
10 food criminality that is yet to be understood, predominately due to the contaminates or impurities
11 not being detected ahead of consumer consumption (Everstine et al, 2013; Moore et al, 2012;
12 Wheatley & Spink, 2013). Therefore, with consumers having 'busy' lives which impact on their
13 understanding of authenticity and a focus on pricing, coupled to a lack of true understanding over the
14 health and wellbeing aspects of food criminality, caution should be placed around relating this being a
15 'victimless crime'. The authors assert greater focus should be placed on a collaborative business,
16 government and academic approach to understanding the true extent of the food criminality and its
17 impact on consumers from a health and wellbeing perspective, coupled to the long term effects of
18 ingestion of economic motivated adulterated food stuffs.

19 **4.2. Zero tolerance - the process environment**

20 The suggestion of zero tolerance is an interesting concept, particularly when we have aforementioned
21 consumer focus based around availability and price, and the impetus of food criminality episodes not
22 being addressed by traditional food defence, quality or safety processes (Spink, 2014). However, the
23 'horse meat scandal' of 2013 hit the headlines with an identifiable spike in publishing activity (Fig.2),
24 shaking consumer confidence in the market and strengthening the need for a 'zero tolerance'
25 approach to food authenticity. Nonetheless, research in the field hasn't followed the trend in
26 developing a culture of zero tolerance, with none of the reviewed CABS journals recognizing the link
27 between consumers and food criminality (Table.5). Therefore, the authors suggest that business and
28 academia are still endeavouring to understand the auspices of 'supply chain food crime' and 'supply
29 chain food fraud', with a need for greater understanding of these two areas in order to have one view
30 of 'food supply chain resilience' and 'food chain integrity'.

31 Furthermore, food criminality whether accidental or intentional is incredibly complex, in part due to
32 the globally extending supply chains that encompass a myriad of actors, quite often within the SME
33 sector (90% SMEs in Europe) that prescribe to a compliance process rather than prevention (Spink et
34 al, 2014). This [compliance] is quite often a precursor to greater food supply chain challenges, with
35 organisations both commercial and governmental looking to legislate the risk out of supply chains and
36 build resilience through greater detection. However, this according to Spink et al (2014) can not
37 happen due to the need for entire supply chains to holistically reduce the opportunity of fraud
38 occurring, and the reduction of food criminality must become a preventative process rather than
39 reactive (European Commission, 2014), and therefore arguably require the triangulated approach of
40 business (operations), testing and legislation to be complimentary.

41 **4.3. Intelligence led approach to food chain resilience**

42 Holistic supply chains must understand that those seeking to exploit food chains for criminal and
43 financial gain, will quite often do so in a stealth like manner, making resilience building akin to
44 'fighting an invisible enemy' (Spink, 2011). In order to combat this invisible threat, Manning & Soon
45 (2014) support the auspices of intelligence gathering, an area advocated as crucial to the defence and
46 mitigation of risks in a food supply chain context (Elliott, 2014). However, the creation of a data rich
47 'shared' environment quite often comes at a cost, with commercial and government organisations
48 not seeing the return on investment, predominately due to the aforementioned lack of understanding
49 into the extent of fraudulent activities across the holistic supply chains, with each case being viewed
50 in isolation. However, the intelligence led approach to preventing criminality in a food supply chain
51 context can reduce overall costs with prosecutions and investigative processes that come about in a
52 reactive governance construct (Spink et al, 2014). In addition, Spink (2014) supports the need to bring
53 about greater detection of contaminants within adulterated food stuffs, with a need for supply chain
54 actors to understand the value that prevention brings. This 'value contribution to prevention'
55 however gives commercial organisations 'an out', offering extended retail supply chains the
56 opportunity to pass on risk to upstream partners and moving away from the '8 pillar' framework of
57 viewing food criminality as a holistic supply chain problem, rather than in isolation.

58 The current professional literature (Table.5) suggests that the UK government has adopted an
59 intelligence led approach to fighting food criminality with the creation of the Food Crime Unit (FCU)
60 which is also a step toward the 'zero tolerance' network required to bring about greater food supply
chain resilience. Nevertheless, an intelligence led approach relies on the sharing of information and

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6 with little focus on the softer aspects of this area coupled to a lack of industry specific focus and
7 trepidation over holistic supply chain resilience (Sodhi & Tang, 2012), it is not a solution that can
8 expedited. However, research within the CABS papers proffer a distinct prevalence of data,
9 information and analysis in combating food supply chain criminality (Manning & Soon, 2014; Sarpong,
10 2014). The 'big data' approach to criminality management is currently lacking within the existent
11 literature and requires a more detailed holistic supply chain view to become meaningful to
12 businesses.

13 **4.4. Scientific detection and predictive analytics**

14 There is a strong science based food detection expertise across Europe, however this is only as good
15 as the information being available, with Manning & Soon (2014) supporting that substances need to
16 be "known" in advance by the testing authority in order for the substances to be recognised as a
17 contaminant. This was experienced with the Chinese melamine scandal case, having sixty-eight
18 countries affected in a product recall process (Gossner et al, 2009). In this case the organisations were
19 able to test and instigate a recall of products, however what is not known is the extent of non-
20 recalled products, with the authors purporting that there was a potential of contaminated products
21 reaching point of sale due to a lack of data sharing across holistic food supply chains, and the
22 'unknown' element of authenticity within the food supply chain. However, there are technologies
23 available to the logistics operations to compliment the scientific testing aspects within food chains,
24 that can be exploited to give greater visibility to supply chain actors, such as but not limited to scan
25 codes, QR technology or RFID, which can pass data at each node of the supply chain or touch point
26 (Dabbene et al, 2014). It is this sharing of information along the upstream and downstream supply
27 chain actors that can through a sequenced route greatly enhance traceability processes and reduce
28 instances of food criminality (Manning & Soon, 2014; Moe, 1998). However, this relies on all supply
29 chain actors having the ability to input data, and further doing so in an honest and open manner.

30 To eradicate the challenges around spurious data input predictive tools and expertise in the sector
31 are necessary to make food chains more resilient. However, 'expertise' is fraught with risks associated
32 with 'self-confidence' driving decision based management which is based on 'overconfidence' rather
33 than statistical presentation of fact (Cassidy & Buede, 2009). According to Manning & Soon (2014) the
34 ability to predict criminality in a food supply chain has inherent limitations related to reliance on
35 historical data, which due to the changing landscape of global supply chains bear little or no relation
36 to the business processes of the future, meaning a data driven approach to predicting risks in a food
37 supply chain will not work seamlessly. There is need for more work to be undertaken to holistically
38 connect supply chains in a 'live' manner, across all actors/nodes, enabling more robust data decisions
39 to be undertaken in a 'real-time' environment, rather than historic reactive processes. Furthermore,
40 the authors support that as holistic food chains become more connected, the ability to predict
41 instances will become easier and move value chains into a more resilient state, moving away from the
42 need to rely on 'siloed' experts that may miss the event.

43 Laboratory testing and audit processes despite having clear benefits, are viewed by the commercial
44 sector as expensive and laborious with challenges around lead time and the sheer volume of
45 foodstuffs in circulation set amongst extended food chains. Therefore, business, governments and
46 academia have a role to play in expanding the scope of its business operations research from testing
47 to legislation and compliance to improve food supply chain resilience. In addition to a lack of adjoined
48 thinking with an 'operations-scientific' model of food chain resilience, there is inadequate focus and
49 understanding on the people aspects [softer side] of chain management and data analytics, and how
50 these elements intercede with the laboratory testing. Consequently, more is needed in academic
51 business research to understand the auspices of management and leadership as suggested by Prof.
52 Elliott (Elliott, 2014), reviewing how these intercede with softer threats in a supply chain, further
53 complimenting rather than eradicating a scientific approach to food chain resilience. Additionally,
54 when we design these processes in isolation quite often we end up relying on legislating the supply
55 chain into resilience, which is proven not to work such as with the 1.3 billion tonnes of food missing in
56 the food chain and creation of black markets with over legislation (African Research Bulletin, 2013;
57 Nelleman et al, 2009).

58 **4.5. Leadership and Crisis Management**

59 In order to meet the needs of the aforementioned pillars of food resilience, Prof. Elliott calls for a
60 focus on leadership, crisis management and Government support (Dani & Deep, 2010; Elliott, 2014).
These are significant areas of importance when reviewing supply chain risk and resilience, however

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6 quite often there is a lack of appreciation relating to the complexity that resides within collaboration
7 and co-opetition strategies. Arguably the predominant driver for organisations considering embracing
8 co-opetitive strategies pertain to trust. Therefore, organisations will principally be concerned about
9 anti-competitive behaviours manifesting themselves and the effect this will have on overall business
10 operation, with associated fears masking benefits that collaboration and co-opetition can deliver to
11 the wider supply chain. Therefore, more needs to be done in the arena of co-opetitive food supply
12 chain management to bring about more resilient value chains for all actors in a supply chain context,
13 including the consumer.

14 Furthermore, the auspices of sharing information and leadership are compounded by the challenges
15 associated with expert overconfidence (Anger, 2006). It is this often reactionary expert opinion that
16 drives a wedge between organisations, with conflicting opinions predominately based on one's own
17 experiences and interpersonal variations which preclude a collaborative approach being taken
18 (Manning & Soon, 2014). This challenge related to leadership and crisis management becomes even
19 more confused when reviewing how holistic supply chains operate. Quite often the leadership will
20 only be reviewing elements pertaining to their own facility rather than the wider holistic supply chain
21 (Manning & Soon, 2016). Unless food supply chains take the holistic view of food criminality and
22 mitigation strategies to the core of their operations, the criminal elements will always have a gap in
23 the chain that can be exploited.

24 In furthering this mitigation of risk in a food supply chain context, Manning & Soon (2016) support the
25 need of a proactive approach to supply chain processes and adopt food crime risk assessment tools
26 (FCRA). However, these tools are only worthy of risk mitigation if all elements of the supply chain are
27 adopting similar processes, data sharing is transparent and each actor feels engaged in the overall
28 outcomes of a resilient food supply chain. There is an argument that leadership, crisis management
29 and tools to deliver more resilient supply chains require more detailed behavioural science research
30 (Dani, 2009; Manning & Soon, 2016), particularly with 'consumers' being an area for further research
31 and 'management' being identified within the current 'supply chain food fraud' research (Table 5).

32 When reviewing traditional supply chain risk management literature, quite often organisations are
33 measured on financial risk with nothing in modern day literature to support 'food crime' or 'food
34 fraud' as requiring attention at SCRM level. More noteworthy, are the recommendations in literature
35 that service organisations need not concern themselves with SCRM than that of manufacturing
36 organisations (Blome & Schoenherr, 2011). This lack of 'service' focus on SCRM would support the
37 'silo' approach experts take, and is a potential driver behind a lack of cohesive leadership, crisis
38 management and data sharing that will arguably drive more proactive and resilient food supply
39 chains. Furthermore, leadership drove successful SCRM strategies that are constructed around
40 capacity flexibility and multiple supplier procurement strategies, again supporting the financial
41 aspects of supply chain management (Hittle & Leonard, 2011). There is little literature to support
42 leadership and crisis management in the 'supply chain food crime' or 'supply chain food fraud', with
43 more understanding required across commercial, governmental and research to draw conclusions.

44 5. RECOMMENDATIONS FOR FUTURE RESEARCH

45 There is a desperate necessity for change amid research into food supply chain risk management,
46 especially with regard to business and the under-represented area of the SME that comprise 90% of
47 the food industry sector. This is of further significance to DEFRA and the UK Government (DEFRA,
48 2013; Elliott, 2014), and their desires to encourage research that is tangible and transferable to the
49 commercial sector. However, as we can clearly note (table.6) there is a variance between practitioner
50 led and academic research. Furthermore, none of the current academic business research in the 'food
51 crime' and 'food fraud' field has considered the softer side of food criminality and its connection to
52 insider threat, procurement or external activist risks against supply chain security. Therefore, based
53 on the extensive systematic literature review and gap identification the authors have introduced a
54 food supply chain risk management (FSCRM) conceptual framework (Fig.3) to support the future of
55 research in food resilience with a specific focus on food fraud and crime '*food criminality*'. With
56 reference to the work of Prof. Elliott (Elliott, 2014) within the context of food supply chain resilience,
57 the authors purport a need for business and management research in the areas of authenticity, local
58 authority engagement, consumer focus, enforcement, Government and industry engagement,
59 intelligence gathering, risk management and testing. There are many collaborative areas across these
60 themes that will drive greater understanding and therefore resilience in the sector, and further

joining the needs for Academia, Governments and Practitioners to work together in order to meet the needs of consumers.

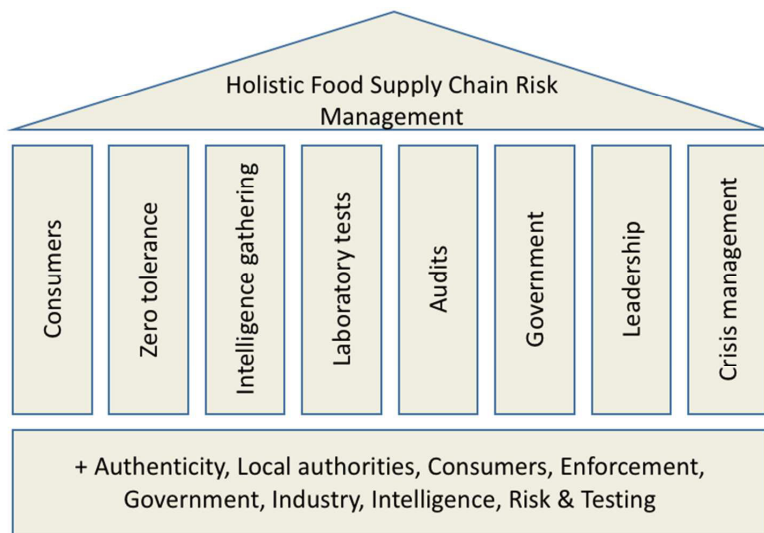


Fig.3 Conceptual framework for food supply chain risk management

Additionally, the thematic area of inventory and procurement as a way of managing and mitigating risk in a food supply chain, is devoid in current business literature. These areas are crucial in mitigating overall food chain risk and reducing criminality that is purported as an easy target [food] and support the areas of identified gap in current research (Figure.4) with authenticity, consumers, data, enforcement and intelligence (Economist, 2014). There is an inescapable need for practitioners and academics to work collaboratively, allied to the gap analysis in current literature to form a body of knowledge that supports the reduction of food criminality, fosters innovative practices and develops a culture of learning across all fields.

Traditional supply chain risk management research supports key drivers to risk mitigation pertaining to trust and unprincipled behaviour, areas that are lacking in the current food criminality body of knowledge. Despite there being a need to share data holistically across food chains, the risks of anti-competitive behaviour historically stifle collaboration and therefore necessitate a further research area to build greater resilience and reduce criminality. Furthermore, the view of the holistic supply chain and actors that add value to the enforcement and sharing of information need to be reviewed, with more research required downstream, including the customer in the reporting and decision making processes on food supply chain security.

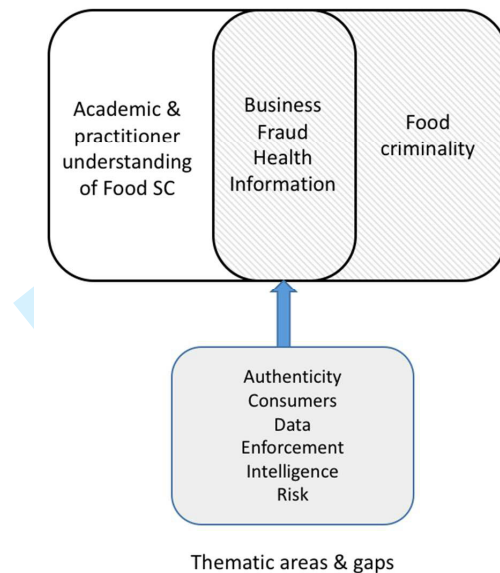


Fig.4: Key thematic areas of supply chain food criminality

Since the release of the UK Government report into food supply chain crime, little has been seen in terms of change in meeting the needs of more resilient food chains (Noble, 2014). The authors argue that this is predominately driven by a concentration on security of supply rather than authenticity issues combined with a lack of understanding to dissemination processes needed for research from both academic and practitioner, across wider food supply chain stakeholder group.

In closing, there is a disparity and confusion being caused by the varying terminologies being used within food systems (Elliott, 2014; FSA, 2016). US led research is allied to the term 'fraud' whereby Asia/European studies seem to lean more toward 'crime'. Therefore, in order to eradicate confusion, the authors support the Food Standards Agency of referring to these acts as 'food criminality' and not getting entwined with the legal terminology, and instead raise research and understanding which will arguably mitigate and reduce food authenticity issues.

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