Socio-Economic Sustainability of Halal Food Production: An Examination of Poultry Processing in Malaysia

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Abstract:

While significant research exists in the area of sustainable food supply chains, information pertaining specifically to the Halal supply chain is limited, with very little information being available on the economic and social sustainability of Halal facilities. Through a multi-staged research methodology, this study undertakes a single company case study of a Malaysian slaughter facility. It attempts to understand the deep-rooted issues surrounding why Halal slaughterhouses struggle to maintain socio-economic sustainability even though demand for Halal food within Malaysia has increased significantly over recent years. This research contributes to the knowledge of food supply chain sustainability through exploration of the idiosyncrasies of Halal food production. It proposes and adopts a Dynamic Mapping technique that enabled the capture of internal and external process knowledge, and the simulation of what-if scenarios to determine the effect of the complex interplay of multiple systems upon the economic and social sustainability of the organization. The study finds that both external and internal issues affect the sustainability of the company. From an internal perspective, the slaughtering operation is characterized by the ritualized requirements of the Muslim faith. The slaughtering operation is the primary source of capacity constraint. Dynamic Mapping identified that with a clear lack of formalized business improvement approaches that focus on improving the bottleneck constraint, additional demand will only serve to exacerbate the situation and create a serious threat to the economic viability of the company.

1. Introduction

As the world's population grows, and the effects of food production that are detrimental to the environment are of greater concern and increasingly legislated, the difficulties surrounding the efficacy and sustainability of food supply chains has come under increasing academic attention (Acar, 2019).

Sustainability has been examined through different theoretical lenses; Krabbe (1993) for example adopts a physiocratic approach, while Sisaye (2011) uses the ecological approach. Each posits that the natural world is the primary source of all wellbeing and the ultimate recipient of all waste. Achieving a successful financial bottom line meets only one of the requirements of a more generalised term for sustainability, defined by the Brundtland Report (1987, p.15) as the Triple Bottom Line (TBL). The report defines 'sustainable development' as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". It relates to the continuity of economic, social, institutional and environmental aspects of human society, as well as the non-human environment.

Concentrating more closely on the aspects of business sustainability rather than a more holistic definition of sustainability, business sustainability is defined as "*an increase in productivity and/or reduction of consumed resources without compromising product or service quality, competitiveness, or profitability while helping to save the environment*" (The Institute for Sustainability, 2020). The duality of function outlined by this definition of sustainability requires companies to achieve business growth whilst also simultaneously reducing the consumption of resources in producing the product through *leaner* operations and producing more with less (Womack & Jones, 1996).

This paper explores the issues of sustainability that permeate Halal food production in the area of animal slaughter. The global demand for Halal foods is increasing (Sohaib & Jamil, 2017). However, this growing sector of food production has only relatively recently received detailed academic attention. A multi-layered research methodology is adopted, resulting in a single company case study into a Malaysian poultry slaughter facility. This has allowed a more detailed observation of the developmental life cycle of the company. Such case study observations are well suited to relatively new research topics, especially where the phenomena are poorly understood and characterised (McCarthy, *et al.,* 2006).

This paper applies the System Dynamics (SyD) methodology to study the Halal slaughterhouse system and combines the techniques of Process Mapping (White & Cicmil, 2016) and Systems Dynamics Modelling to form a hybrid approach for capturing and analysing the supply chain and operational dynamics of a Halal slaughterhouse. This approach enabled the exploration of the effects of both external pressures induced from consumers and governmental control of the industry, and internal process-induced operational parameters that collectively conspire to affect the case organisation's economic and social sustainability.

Firstly, the authors present a review of the literature pertaining to Halal food production, noting the prevalence of thematic and sectoral studies and highlighting the lack of research into Halal food production particularly surrounding slaughter facility operations. The methodology details a three-phase approach that results in the identification of a number of key findings that were drawn from the primary data. The authors then develop a hybrid 'System Dynamics Modelling' (SyD) approach to investigate and discuss the issues that threaten the economic sustainability of Halal slaughterhouses in Malaysia. Finally, suggestions are made for future research and practice that can lead to improved sustainability in the Halal food supply chain

2. Literature Review

Major events such as the worldwide covid 19 outbreak, BSE crisis in the UK, foot and mouth in Europe and the spread of swine fever in Western Europe show rapid geographic spread of once localised issues. With animals it has been the effective control and management of the supply chain in ensuring tracking and tracing of animal movement that has played an important role in ensuring that the spread of diseases is contained and erradicated (Van Der Vorst & Beulens, 2002; Costard *et a*l., 2013).

The ever-present threat of disease, global and economic change and potential devastating effects on the food supply chain, has resulted in significant academic study in this area. For instance, Reiner & Trcka (2003) highlighted the importance of conducting product and company-specific research. Studies have been undertaken across the globe including the United States (Nicholson *et al.*, 2011), the United

Kingdom (Ilbery & Maye, 2006), Europe (Rantavaara *et al.*, 2005; Manthou *et al.*, 2005), and Asia (Hong *et al.*, 2011), and Africa (Sanchez-Cordon *et al*., 2018).

The production of foods that are compliant with the requirements of different religions adds a further degree of complexity to the management of sustainable supply chains. For instance, the methods of slaughter, product identification and the prevention of cross-contamination are production issues that are, paradoxically, highly important to consumers yet are often impossible for them to validate (White & Samuel, 2016; Thomas et al, 2017). These constraints, along with the subtle complexities of the religious requirements (see for example, Rahman & Shaarani, 2012; Riaz & Chaudry, 2003; Shafie & Othman, 2003; Wood, 2012), mean that many producers do not fully comprehend the needs of the consumer (Regenstein et al., 2006).

These challenges have led to large-scale changes in production practices, such as the separation of halal and non-halal processing in Tanzania (Balile, 2013). Increasing awareness of sustainability issues, such as the welfare of animals, have also accompanied increased scrutiny of slaughtering practices (BBS, 2003), in particular, the ethics and religious legitimacy of stunning animals prior to slaughter (Mason, 2014; Adams, 2008; Grandin, 1996). This has resulted in the banning of Kosher & Halal methods of slaughtering in some countries (Withnall, 2014). Malaysia is unique in that the government has adopted several law Acts over the years in its effort to protect consumer interest. The Control of Supplies Act 1961 for example has allowed the Malaysian government to declare any goods (such as chicken) or food to be a controlled or to be a rationed item (Fatt *et al.*, 2010). In 2010, the Malaysian government introduced the Price Control and Anti-Profiteering Act 2010 to give permission to the Domestic Trade and Consumer Affairs Ministry to set maximum prices either for wholesale or retail goods. This Act gives freedom to the ministry to enforce price control especially during the festive seasons, where the price of controlled goods such as chicken, are monitored on weekly basis (Rahman *et al*., 2014).

While the body of literature provides clear sectoral and thematic research, evidence of the capabilities and issues surrounding food supply chains detail two key issues. First, little research has been undertaken in the Halal supply chain sector that specifically explores the operational and supply chain systems. Second, little evidence exists about how the Halal food sector is coping with increases in demand for products and whether the industry suffers from unique and deep-rooted systemic problems in attempting to cope with this demand.

2.2. Sustainability in the Halal Food Industry

Tieman *et al.*, (2012) are one of a few who focus their sustainability agenda on the Halal supply chain and introduce the 'Halal Supply Chain Model' to optimise the design of Halal food supply chains. They outline that the development of robust quality assurance systems and the creation of a highly effective logistics function, along with its associated business processes (transportation, warehousing and terminal operations), are key determinants for the Halal supply chain performance. Their findings show that product characteristics (bulk versus unitised, ambient versus cool chain) and market requirements (Muslim or non-Muslim country) determine the supply chain vulnerability to Halal contamination, for which Halal control activities and quality assurance activities are put in place to reduce supply chain vulnerability. Halal supply chain management is different from conventional supply chain management, which requires a Halal policy and specific design parameters for supply chain objectives, logistics control, supply chain network structure, supply chain business processes, supply chain resources and supply chain performance metrics.

The majority of Halal-specific literature centres on the technical aspects of Halal meat identification, analysis and assurance (Demirhan *et al.*, 2012; Nakyinsige, *et al.*, 2012; van der Spiegel *et al.*, 2012; Xu *et al.*, 2012; Nurjuliana, *et al.*, 2011). A smaller body of literature examines the practices and challenges that beset Halal food production, but it is extremely valuable since it indicates that there can be serious operational shortcoming (Thomas *et al.*, 2015).

Van der Spiegel *et al.*, (2012) review the quality control systems and regulations that pertain to Halal food production and conclude that the lack of a worldwide standard for Halal rearing and slaughter can contribute to a decrease in consumer trust in products. White & Samuel (2016) further our understanding of Halal certification systems by building a conceptual model of the Halal food labelling system and identify that it is the inherent heterogeneous definition and interpretations of what constitutes 'Halal' that makes the development and adoption of a single certification highly

problematic. Other literature has developed a framework to optimise the design of Halal food supply chains (Tieman *et al.*, 2012), discussed the brand marketing strategies of Halal food producers (Cheng, 2008), examined Muslim consumer trust in Halal food producers (Bonne & Verbeke, 2008) and the concept of developing Halal food-producing 'hubs' (Othman, *et al.*, 2009). This in an attempt to quality assure Halal products with the aim of developing trusted Halal supply chain systems to meet consumer demand.

A study of the Halal food industry undertaken by Omar and Jaffar (2010) notes that the Halal concept has gained increasing attention due to Halal food consumption as a result of the rising global Muslim population (approximately 1.8 billion). Yousef (2010) highlights that the Halal food market constituted about 16 percent of the world food trade, estimated as RM 1,628.60 billion (US$547 billion). Consequently, the trend has attracted countries to generate more Halal food producers. In a predominantly Muslim populated country such as Malaysia, the support of the Malaysian government has created the Halal Development Corporation (HDC). As one of the agencies set up under the Ministry of International Trade and Industry (MITI), HDC's role is to develop the awareness on understanding the Halal ecosystem (HDC Global, 2020). Ariffin *et al.*, (2014) note that broilers account for 70% of the meat consumed in Malaysia and that in 2009 there were 3,300 farms, 22.9% of which they class as large farms with more than 50,000 broilers per cycle, 26.2% that are medium scale carrying 20,000- 50,000 broilers per cycle, and the remainder classed as small farms with 20,000 broilers per cycle.

The development of Halal products has been further stimulated through the designation of areas known as the Halal hub in each state in Malaysia. The Halal concept is not only confined to food but also covers the process of handling, packaging, storing and delivering (Tieman, 2012). If the food is not handled or stored accordingly, it would not be considered as Halal (Tieman, 2011). Recently, customers have not only increased demand for Halal products but also for the Halal process and certification (Bonne & Verbeke, 2008; Marzuki *et al.*, 2012). As a result, customers choose to buy Halal products because of the Halal process. The Halal supply chain is complex and has been misinterpreted and misunderstood by industry and without knowing the fundamentals of it, interpreted as adding extra cost (Haleem & Khan, 2017; Tieman *et al.*, 2013). Consequently, an awareness of the Halal supply chain is needed for industry players as well as consumers.

The literature indicates that there is a wealth of research on identifying the environmental impact and sustainability of food supply chains. However, there is a paucity of research on the social and economic sustainability issues surrounding Halal food production. This research focuses on establishing the operational and supply chain issues that affect the ability of a Halal slaughter facility to meet its economic and social sustainability responsibilities. The rationale for addressing this is two-fold. Firstly, the demand for Halal food products has increased significantly and growth is projected to continue. Indeed, Sungakar & Hashim, (2009) identify that the Malaysian Halal food market sector has grown by approximately 25% since 2005. Therefore, the Halal food supply chain must respond to this demand whilst ensuring that companies are efficient and effective in their operations and maintaining rigorous food hygiene, specific Halal rituals and have QA systems in place. Secondly, the Halal slaughter facility is the main interconnecting system between the farm and the wholesaler/retailer. As with other supply chains, the slaughter facility acts as the decoupling point in the chain and is therefore where it is likely that most problems and issues will arise.

2.3. Department of Islamic Development Malaysia (JAKIM)

JAKIM (Department of Islamic Development Malaysia) is an agency established by the Malaysian government in September 2002 and is responsible for Islamic affairs including halal certification (Halal History, 2020). Food certification in Malaysia is determined by the Malaysian Standard MS 1500:2009 that offers practical guidelines in preparing and handling halal food (Zakaria, 2008). JAKIM's responsibility is to assure and guide Muslim consumers of halal products produced in accordance with Shariah (Halal History, 2020). As well as enjoying strong government support in Malaysia JAKIM is internationally recognised as having rigorous criteria, and a strong industrial and commercial set up to produce and market halal products with the major trading nations of the world (Badruldin *et al.*, 2012). Other than controlling the standard of halal via its agency - JAKIM also control the price of chicken in Malaysia through the Control of Supplies Act 1961 (Ministry of Domestic Trade and Consumer Affairs, 2020).

3. Research Methodology

A three-stage research methodology was constructed to obtain a systematic chain of information and research data for further synthesis and analysis. Stage 1 comprised a questionnaire that was sent to the Managing Directors of ten slaughterhouses in Malaysia. Stages 2 and 3 comprised the in-depth observation of practices within Malaysian slaughterhouses. This pluralistic approach enabled the instrumental and situational triangulation of findings (Chamberlain *et al*., 2011) and the opportunity to observe how behaviours are conducted over time (Spanjaard *et al*., 2014). Immersion in the research landscape also aids the fostering of deeper relationships with key actors and facilitates the nuanced interpretation of data and observations (Heath, et al., 2018).

For Stage 1, the authors adopted the question framework developed by Thomas *et al*., (2008) in their studies on advanced manufacturing technology implementation and adapted some of the questions to focus specifically on business and operational issues within slaughterhouses. The team members undertook courtesy telephone calls to the owners in order to ensure the questionnaires had been completed and deal with enquiries on interpretation – no questions were raised by the owners. As well as capturing the current and future business pressures facing the companies, and the level and extent of technology employed in the slaughter process, the questionnaire also covered the following quantitative data:

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

Company profile –number of employees, direct and indirect staffing ratios

The questionnaire captured the following qualitative data:
Business type – growth profile, customer base, relationships with customers, types of products processed, methods of slaughter employed, labour skills and knowledge base.

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

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

Operational Processes – how and in what way had the management style structure and approach changed to facilitate the increase in demand? How effective were the production operations? What problems are faced as a result of any increase in demand?

Working Processes – how and in what way have the roles, values and business principles and practices changed over the years? How effective were the new business systems employed?

IT, Information and Communication Processes – what IT systems were being used? How has the skill level of operators been affected as a result of the IT systems employed? In what way has the sophistication of IT systems changed? How are your customers better connected with your company as a result?

In Stage 2, the team developed a list of key findings from the survey. In order to triangulate these, a researcher visited four slaughterhouses to follow up the issues raised in the questionnaire and to observe the operations and systems employed. This process enabled the team to validate the current period data.

Finally, Stage 3 consisted of the team selecting a single company from the four visited to undertake a four-week in-depth investigation of its processes and systems. This was partly undertaken to assist in the triangulation of the data but also to obtain a much deeper understanding of the operational systems and strategic pressures.

In Stages 2 and 3, the researcher developed 'in the moment' interviews to explore salient topics with key organizational actors (Fetterman, 2010). These discussions, along with observations of practices, were captured using instantaneously sampled fieldnotes (Paolisso & Hames, 2010) and, where practicable and verbally consented, a Dictaphone (Duclos, 2017). The fieldnotes and observations were used to reflexively develop further lines of questioning (Halcomb & Davidson, 2006).

4. Results

The questionnaire provided key insights into the operational capabilities of the production facilities and a focus for further investigation at Stage 2 and 3 of the research. This section will not divulge the financial and company profile data for fear of identifying the companies concerned and will only provide a narrative on the qualitative sections of the questionnaire.

The findings from Stage 1 of the programme have been aggregated and shown in Table 1:

Table 1: Responses to Questionnaire Survey (*n=10*)

Growth Profile	On average a growth of up to 10% year on year over the past five years has been seen by the respondents
Customer Base	*G*enerally Malaysian government. However, an increase in foreign customers from UK and USA coming into the market over the past 2 years.
Relationships with customers	Primarily transactional, little collaboration shown
Types of products processed	*M*ostly poultry (some 80% on average)
Methods of slaughter employed	Four from ten – traditional methods employed, six from ten employed automated systems of slaughter
Labour skills and knowledge base	Basic operative level although slaughterer was considered skilled since he was key to the Halal process
Attitude to Technology	Basic with only six for the ten surveyed having automated equipment. Equipment was basic processing technology where it existed
Attitude to Developing Business	No clear strategies for business growth were shown by any of the companies surveyed. Concern at present is in meeting demand whilst controlling and meeting QA and Halal standards. Companies are not sustainable where cost of production is increasing but control of pricing means that profits are reducing
Operational Processes	No specific 'Lean' approaches adopted. Allocation of labour and long working hours are the main methods that the companies adopt to meet demand.
Working Processes	Strictly controlled by Halal traditions. Production volume is subordinate to the Halal tradition and in the companies employing hand slaughtering methods, the production volumes are at least twice as slow as the automated plants. However, demand for product is higher in these facilities
IT, Information and communication Processes	Basic MRP systems employed in three out of ten companies. The remainder rely on telephone and internet communication systems (email etc)

Stage 2 allowed the team to contextualize the issues raised in the questionnaire responses and these were:

Although Halal food production was increasing rapidly in Malaysia and, every respondent stated that demand for their facility had increased, the pricing and volume control placed on the company by the government made it difficult to secure enough profit for future investment in new systems and processes. Although demand had increased substantially, production was close to full capacity and substantial investment was needed for new technologies, premises and systems to cope with future demand.

To manage the increased volumes whilst coping with fixed pricing, six of the ten companies had invested in automatic slaughter machines. However, over the previous 18 months or so the companies had noticed a dwindling demand for their products. It is suggested that this is because customers are concerned that automatic slaughter did not meet 'true' Halal requirements. Customers favour traditional Halal methods of slaughter and companies who slaughter in the traditional way see the highest demand. However, these companies struggle to maintain profits due to the highly labour intensive and slower production rates (see SyD map).

Stage 3 of the programme involved an in-depth case study of a single company. Selection was based on the need to focus on a slaughter facility that employed traditional 'hand' slaughter methods since this area suffered from increased demand but slower production efficiencies.

4.1. Case Description

The company is a medium-sized farm employs 50 full time staff at its slaughter facility in Malaysia. Its principal supplier is its own farm and its customer base primarily comprises government hospitals and agencies. The owner of the company reported that they business has grown over the past 5 years to become one of the major suppliers of Halal poultry products. Much of this success has come from a stable supply of raw; quality assured poultry products and ownership of the mass-rearing farm that places the supply chain decoupling point within the complete control of the company. Other slaughterhouses do not have this capability and therefore cannot provide the same level of assurance on quality, cost and delivery of raw material.

Although overall sales orders continue to increase year-on-year, the company owners were cognisant of the financial pressure on slaughterhouses in Malaysia and that many have become insolvent. Therefore, taking this as an initial trigger for analysis and investigation, the singular increasing success of this case company was an initial point of focus to identify and establish the key sustainability factors that have achieved growth for them.

4.2. Halal Slaughter

For poultry and other non-pork meat products to be declared Halal the animal must not be dead at the time of slaughter. It must be slaughtered by a skilled operator severing a specified number of structures in the animal's throat without severing the head. Blood must be drained out and prayers must be said during the process.

It is recognised in this text that 'Halal' is the term for products that are deemed 'permissible' while 'Haram' refers to 'not permissible', and also that the term 'Zabiha' refers specifically to meat that has been slaughtered in accordance with scripture. For simplicity, in this paper the term 'Halal' is used to refer to food produced in accordance with the requirements of Muslim consumers.

The use of mechanised slaughtering methods is the subject of much debate. Some insist that the slaughter must be performed by a slaughterman (IFI, 2012). Others maintain that provided the appropriate structures in the animal's throat are severed then mechanical means can be used. There is further discussion over the appropriate way to recite the prayers when machine slaughter is used. Some suggest that the recital of prayers upon starting the machine is sufficient; others insist that the prayers must be recited over each animal that is slaughtered. Bonne & Verbeke (2008) identify that Muslim consumers have expressed concerns over the legitimacy of Halal foods. Both Bonne & Verbeke (2008) and Chen (2008) identify consumers' need for a reputable authority to confer the status of Halal foods and suggest that this may be communicated to the consumer through the use of labelling. The review of industry reports in this section suggests that, for consumer trust, labelling should also note the method of slaughter.

This paper does not offer acceptable practices for the processing of Halal food products; however, the literature indicates consumers and producers have differing expectations around what constitutes an acceptable method of slaughtering poultry to declare it 'Halal'. Consequently, there is a need to align the practices of Halal slaughterhouses with the expectations of consumers in order for the sector to be socially sustainable. Similarly, the ability of an organization to cater for the needs and expectations of

its customers directly influences its economic and social sustainability, and longevity in the marketplace.

4.3. Analysis – The Case Study

Figure 1 is a process map of the poultry-processing route within the company. The process covers the activities from poultry farm, to slaughter, packing and despatch. The organization adopts a chase demand strategy, increasing the number of hours that are worked according to demand. A clear bottleneck in the system is seen at the slaughter area. This creates a unique problem that becomes exaggerated within the Halal industry in that the method of slaughter is what determines primarily whether the product is Halal. It requires specialist slaughter operations and as such has the greatest possibility of rendering the product 'Haram' as opposed to 'Halal. Therefore, to assure product quality and conformity, the slaughtering operation is of key interest. In this instance, the slaughtering operation is performed manually by a single slaughterman. The slaughterman works a one-hour shift before being replaced by a colleague. Only one operator performs the operation at a time. At each changeover the slaughterman recites a prayer that is part of the ritualised process required for the product to be pronounced Halal. The slaughtering operation is seen as being the capacity constraint within the process and as such forms the basis of the next section of work on Systems Dynamics analysis of the business process.

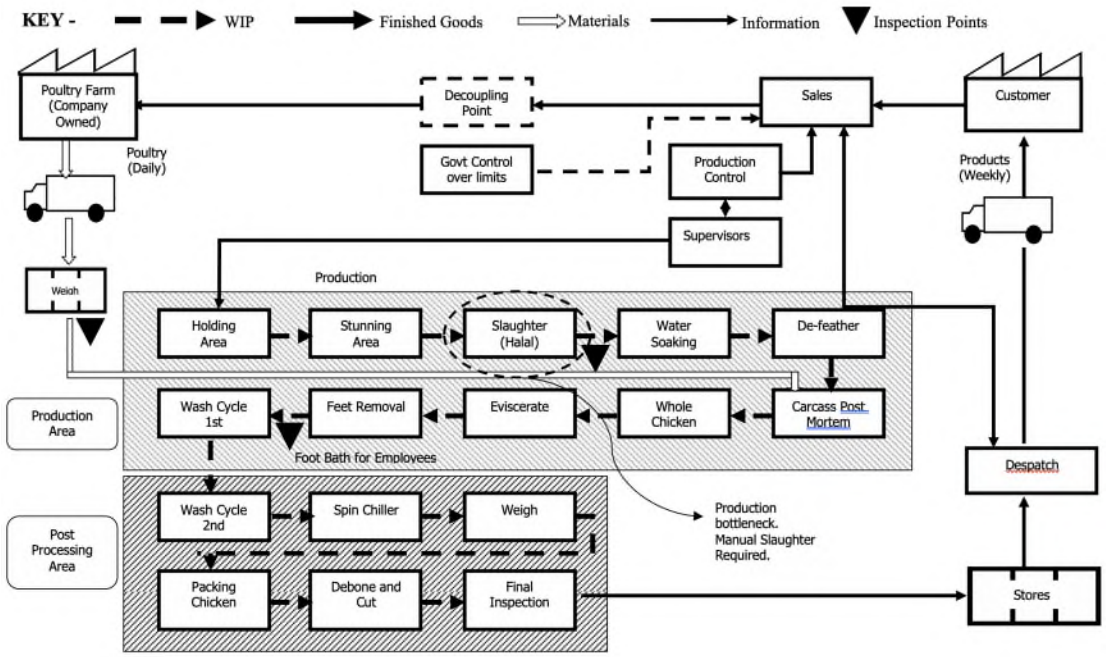

Figure 1 - Schematic VSM of the Poultry Processing System (Source: Authors)

4.4. Systems Dynamics Techniques

A Systems Dynamics (SyD) approach is adopted to analyse and present the interplay of internal and external forces and systems upon the poultry production process (Figure 2). SyD has its roots in Industrial Dynamics initially developed by Jay Forrester in the 1960s and later by John Parnaby in the 1980s. It uses information feedback and control in order to evaluate business performance by uncovering the complex relationships that exist between the main business processes in an organisation. SyD undertakes a functional analysis of the business system where its basic premise is that any complex system can be described in terms of elements and flows (the relationships between the elements).

A substantial body of literature has utilised modelling techniques to understand food supply chains that substantiate the approach adopted in this study (see for example, Ahumada & Villalobos, 2009; Rong, *et al.*, 2011; Apaiah & Hendrix, 2005; Ilbery *et al.*, 2004; Kumar & Nigmatullin, 2011; Mohan *et al.*, 2011). In particular, these techniques have been successfully used to understand the sustainability issues of food supply chains (van der Vorst *et al.*, 2009; Zanoni & Zavanella, 2011).

An initial assessment of the Halal food industry offers a number of exciting and positive opportunities for growth. On the one hand, the demand for Halal products is increasing and an internal analysis of company operations shows that with the exception of the slaughter area, there is excess capacity to take additional work. Coupling these issues with the specialist Halal slaughter methods and the creation of trusted supply chains surrounding this area is seen working positively towards a company being able to increase profits and become economically sustainable.

However, the SyD approach uncovered the complex nature of the Halal supply chain and identified the risks and fragility of a supply chain that may limit a company's ability to become economically sustainable. Figure 2 shows a section of the SyD causal diagram and the interlinking nature of the two themes of economic and social sustainability that are the focus of this paper. Social sustainability is affected primarily by the external issues surrounding the company. Governmental control over the volume and pricing of the product creates a controlled environment with limited free market opportunity to exploit. The fixed price of product along with significant competition in the marketplace can lead to many slaughter companies becoming insolvent which in turn leads to greater negative social impact.

The SyD analysis also highlights that the economic sustainability of the company is at risk even though the opportunities for growth are very much in the company's favour. Figure 1) shows that the major 'pinch point' is within the 'slaughter area' of operations. This is due to the need to assure the high integrity of slaughter to meet the strict demand of Halal food production. In adhering to the manual slaughter of the animal, a trusted supply chain can be developed which will lead to high orders generated through greater demand from more conservative customers. Mechanical slaughter is only acceptable to certain groups of Halal consumers and so the market opportunity is reduced. However, manual slaughter requires greater labour intensity around the animal slaughtering stage with the possibility of human error causing quality problems. Therefore, a counter-intuitive issue emerges in that automated slaughter will provide the velocity and volume requirements of the consumer but is not trusted by all Halal consumers. The capabilities of the system are not met by the capacity and demand from customers (supply outstripping demand), whereas the traditional manual slaughter process is much slower requiring more labour input and hence greater cost but provides the greatest demand from its customer base (demand outstripping supply). Therefore, the traditional tension between assuring Halal quality food is produced whilst trying to drive up product volume to meet increasing demand is the very issue that limits a company's ability to become economically sustainable.

By tabling elements, A through to H on the SyD diagram (Figure 2) it is possible to show the dynamic nature of the system and the complex inter-relations that can conspire to reduce supply chain effectiveness as the information and materials pass through the factory.

Element A indicates the strong and increasing demand for Halal product throughout the world. This provides a positive input into the system, which creates the initial dynamic for the system. Element A connects to element C which also identifies another positive driver in that opportunities exist for slaughter companies that employ traditional and manual methods of slaughter as demand for this is increasing. Element C connects to element D indicating that generally, excess capacity in the system should provide an additional positive driver for exploiting the opportunity for growth. This all leads to the connection at element G that connects a number of key sustainability inputs together before this connects to element E where the increased demand is limited to the slaughter area of the internal company operations and has the effect of limiting or reducing company capacity and profitability. This in essence connects this loop together and shows a negative or balancing loop in this instance because the initial positive driver is cancelled or balanced by the negative element E in that loop. Element E in turn connects to other loops in the system that build complex relationships which in turn connect the social and economic sustainability issues together. Through this analysis it is possible to simulate the system by undertaking a number of what-if scenarios on the given inputs. For instance, what-if the government released control over production and pricing? What if the company released the bottleneck over the slaughtering process by introducing automated or mechanical slaughtering processes in order to increase capacity? It is then possible to analyse the effect of the system to those given inputs. Each scenario is developed further below.

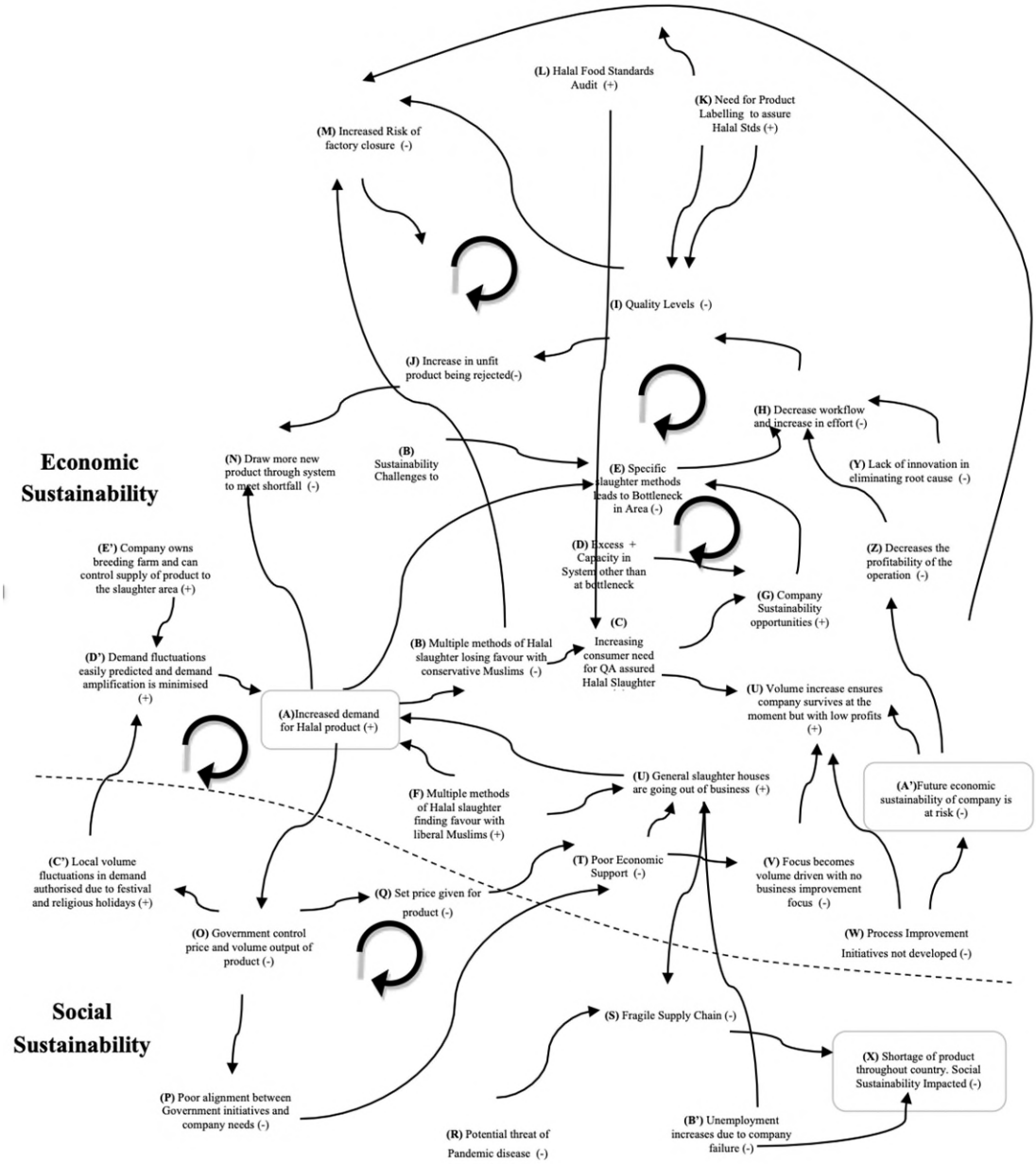

Figure 2 – Systems Dynamics Map of Halal Poultry Production

4.5. Removing Governmental control

Opening the system to a free-market economy provides clear advantages and opportunities for economic growth for the Halal supply chain. Likewise, removing the production bottleneck will enable supply and demand volume matching. However, by running the effects through the SyD system and concentrating on the balancing loop, a more complex environment emerges.

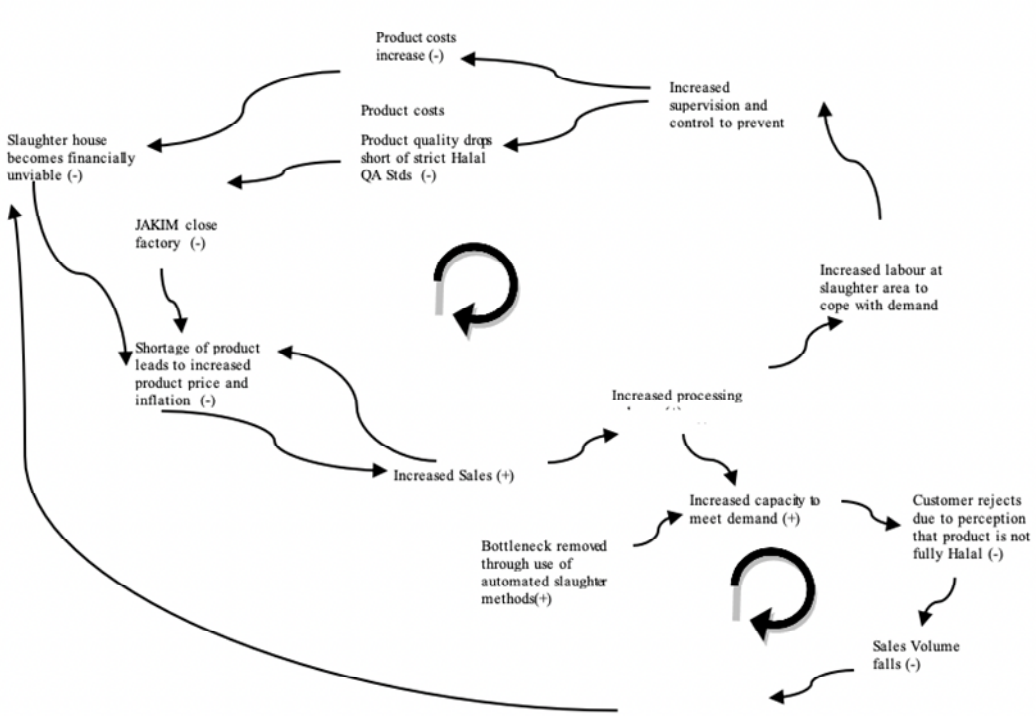

Figure 3 – Simulation Loop of Removal of Volume & Pricing Caps, and Production Bottleneck

The SyD loop at Figure 3 shows that as demand increases due to free market opportunities, the subsequent resolving of the slaughter bottleneck will enable greater throughput which in-turn will satisfy the demand inputs. However, if the company were to employ automated slaughter methods, the likelihood is that demand will start to drop as customers realise that the product may not meet 'full Halal' requirements. The company therefore could potentially be in situation where capacity outstrips demand for the product thereby placing the company at risk of insolvency.

The second loop on Figure 3 shows the effect of maintaining the traditional slaughter methods so that the product is assured to be fully Halal. In this case economic and social sustainability is affected because to maintain the traditional methods of slaughter; multiple slaughter staff must service the area. This raises significant internal pressures for assuring quality of product. This is of concern because the primary reason for company insolvency in this industry is due to JAKIM (regulatory authority that enforces Halal methods of slaughter) factory closures owing to the company not meeting the strict Halal requirements. Therefore, increasing the number of staff at the slaughter point could, potentially affect the long-term viability of the company from both a quality and product price point of view especially as the product costs will rise in order to pay for the increase in labour. In mitigation the costs would need to be offset by increased volume throughput.

5. Discussion

The Halal poultry slaughtering process is influenced by rising consumer demand, increasing consumer concern and varying expectations of the slaughtering process, and, in this instance, the setting of production targets and product prices by government.

Each of these influences applies pressure to the slaughtering operation that can result in a cycle of negative decline. These influences operate collectively and are a significant source of tension for the industry. In other regions where production targets and prices are not set by government, the increasing demand for Halal food products and the increasing concern and diversity of its consumers over the legitimacy of the produce, still conspire to differentiate this sector from other forms of food production.

Adopting mechanised slaughtering technology is one avenue that would alleviate the cyclic pressures upon the slaughtering operation to increase output. However, consumer concerns over the authenticity of Halal products means that this approach may only be acceptable to those that have a relatively low degree of religious conservatism. Furthermore, changeovers are known to be points at which errors can occur and costs can be incurred, in many industries, including food production (McIntosh *et al.*, 2010). Changeover issues have been identified as being particularly problematic in high-risk environments, such as between shift workers in hospitals (Sharit, *et al.*, 2008). In this instance of Halal poultry production there is the potential for the prayer to be omitted or for delays to occur and thus the poultry become spoiled. Either of these failure modes can result in the product being declared not Halal. This results in the need to order and process greater numbers of poultry, thus further increasing the demand placed upon the slaughtering process.

Alternatively, slaughterhouses may endeavour to adopt adaptable process technologies that enable them to alter the slaughtering operation to cater for the specific needs of consumers. However, this would require the distinct labelling of the products and the establishment of appropriate quality assurance systems and standards, coupled with suitable auditing bodies and certification.

There is some suggestion that conservative consumers view slaughterhouses that produce non-Halal products more sceptically (ISNA, 2012). It follows that such consumers may also exhibit reduced trust in those slaughterhouses that practice less stringent forms of ritualised slaughter even if there was independent auditing, assurance and labelling that clearly identified the difference between those products and others that were produced in strict accordance with their conservative expectations.

5.1. Economic Sustainability

The organization's interest in its economic sustainability requires that it achieve and maintain a level of process efficiency that results in profit. This is largely dependent upon the primary process constraint, which in this case is the manual slaughtering operation.

The adoption of mechanised process technology to improve process output is limited by the degree of religious conservatism of consumers. In Malaysia the involvement of the government in setting production targets and prices for the sector further conspires to necessitate process efficiency improvements. The economic sustainability of the Halal poultry processing sector in Malaysia is therefore largely outside the control of the individual organisation.

Governments must be mindful of supporting this sector so that it possesses capacity to cope with forecast demand. Additionally, prices must be set at levels such that both large and small slaughterhouse enterprises may realise a profitable return. Failure to do so would result not only in a detrimental impact upon the social sustainability of the sector through the unemployment of skilled people, but also the reduction of capacity to meet future peaks in demand and the further decline in the sector.

5.2. Social Sustainability

The degree of consumers' religious conservatism is a constraining factor on the social sustainability of Halal poultry processing plants outside areas where governments set production targets and prices. It is possible that slaughterhouses using processes that are engineered to satisfy the requirements of its local consumers can service countries or areas with homogenous Muslim communities who share similar degrees of religious conservatism. Contrastingly, highly heterogeneous Muslim communities, of differing degrees of religious conservatism, may require separate slaughterhouses that cater for the differing demands of its local consumers. Each product may additionally require distinct auditing, certifying and labelling systems and standards, and this is likely to result in added costs for the organizations.

Accordingly, international Halal providers may well face difficulties in satisfying the varying requirements of heterogeneous target consumer populations. It is possible that the food produced by organizations that operate on a global scale may be less desirable to religiously conservative consumers who have heightened concern over the authenticity of Halal products.

The difficulty in catering for the diverse requirements of the global Muslim community makes the establishment of global standards and certification problematic. Failure to recognise and satisfy differing requirements may result in failure of individual organisations to be economically sustainable. More significantly, the attempt to develop global standards that ignore the requirements of heterogeneous Muslim consumers may make such endeavours socially unsustainable. That is, unless a global standard is developed which caters for the requirements of those that are most conservative, in which case, slaughterhouses will be faced with adopting the least efficient method of slaughter.

6. Conclusion

This research contributes to the knowledge of food supply chain sustainability through exploration of the idiosyncrasies of Halal food production. It proposes and adopts a Dynamic Mapping technique that enabled the capture of internal and external process knowledge, and the simulation of what-if scenarios to determine the effect of the complex interplay of multiple systems upon the economic and social sustainability of the organization.

Through the examination of a poultry slaughterhouse in Malaysia it finds that both external and internal issues affect the sustainability of the company. From an internal perspective, the slaughtering operation is characterized by the ritualized requirements of the Muslim faith. This resembles the issues of product quality assurance that previous literature has highlighted as significant to the sustainability of food supply chains.

The slaughtering operation is the primary source of capacity constraint. Dynamic Mapping identified that with a clear lack of formalized business improvement approaches that focus on improving the bottleneck constraint, additional demand will only serve to exacerbate the situation and create a serious threat to the economic viability of the company.

From and external perspective, the industry is controlled by governmental quotas and constraints that limit production and pricing. The ability of any company to make appropriate profits margins invest in new equipment and business processes that could lead to an improvement in product quality is limited. Therefore, the external pressure placed on such companies by the government affects the long-term social and economic viability of the company and serves to prevent the company improving its internal production systems.

The requirement for manual slaughter is not a ubiquitous expectation of Muslim consumers; some may accept poultry that has been slaughtered mechanically. However, the varying degrees of religious conservatism among Muslim consumers, and their differing expectations regarding poultry slaughtering methods, demands that any global standard for Halal slaughter would need to recognize the many interpretations of what constitutes authentic Halal food. Failure to recognize and satisfy these varying expectations is expected to contribute to a decline in the economic sustainability of Halal slaughtering businesses.

In order to satisfy the needs of heterogeneous Muslim communities, recognizing their preferences for methods of slaughter and their concern around the authenticity of the product through certification and labeling, we proffer that small, local slaughterhouses that have proximity to homogenous Muslim communities may be more economically sustainable. Also, since they are more able to understand and therefore meet the expectations of local consumers, the provision of smaller, local slaughterhouses may also serve to support the social sustainability of the communities that they serve.

7. REFERENCES

Acar, M.F., Aktas, E., Agan, Y., & Bourlakis, M. (2019). Does Sustainability Pay? Evidence from the Food Sector. *Journal of Foodservice Business Research*, 22(3), 239-260.

Adams, R. J. (2008). Fast Food and Animal Rights: An Examination and Assessment of the Industry's Response to Social Pressure. *Business and Society Review*, 113(3), 301-28.

Ahumada, O., & Villalobos, J. (2009). Application of planning models in the agri-food supply chain: a review. *European Journal of Operational Research*, 195, 1–20.

Apaiah, K.R., & Hendrix, E.M.T. (2005). Design of a supply chain network for pea-based novel protein foods. *Journal of Food Engineering*, 70(3), 383–391.

Ariffin A.S., Mohtar, S., & Baluch, N. (2014). Broiler Industry with Emphasis on Short Supply Chain in Malaysia. *Proceedings of International Conference on Technology and Operations Management*, 34-46.

Badruldin, B., Mohamed, Z., Sharifuddin, J., Rezai, G., Mahir Abdullah, A., Abd Latif, I. & Ghazali, M. (2012). Clients' perception towards JAKIM service quality in Halal certification. *Journal of Islamic Marketing*, 3(1), 59-71.

BBC (2003). *Halal and kosher slaughter 'must end'*. http:// news.bbc.co.uk/1/hi/uk/2977086.stm

Bonne, K., & Verbeke, W. (2008). Muslim Consumer Trust in Halal Meat Status and Control in Belgium. *Meat Science*, 79, 113-123.

Brundtland Report (1987). *Report of the World Commission on Environment and Development: Our Common Future*". http://www.un-documents.net/wced-ocf.htm

Chamberlain, K., Cain, T., Sheridan, J., & Dupuis, A. (2011). Pluralisms in Qualitative Research: From Multiple Methods to Integrated Methods. *Qualitative Research in Psychology*, 8, 151–169.

Cheng, P. L. K. (2008). The Brand Marketing of Halal Products: The Way Forward. *The Icfai University Journal of Brand Management*, 5(4), 37-50.

Childerhouse, P. & Towill, D.R. (2003). Simplified Material Flow Holds the Key to Supply Chain Integration" *OMEGA*, 31, 17-27.

Costard. S., Mur, L., Lubroth. J., Sanchez-Vizcaino, J.M., & Pfeiffer, D.U. (2013). Epidemiology of African swine fever virus. *Virus Research*. 173, 191–197.

Dabbene F., Gay P., & Sacco N. (2008). Optimisation of fresh food supply chains in uncertain environments, Part I: Background and methodology. *Biosystems Engineering*, 99, 348-359.

Demirhan, Y., Ulca, P., & Senyuva, H., Z., (2012). Detection of PorcineDNA in Gelatine and Gelatine-Containing Processed Food Products – Halal/Kosher Authentication. *Meat Science*, 90, 686-689.

Duclos, D. (2017). When ethnography does not rhyme with anonymity: Reflections on name disclosure, self-censorship and storytelling. *Ethnography*, 20(2), 175-183.

Fetterman, D. M. (2010). *Ethnography*: *Step-by Step Guide*, 3rd Edition, Sage, Los Angeles.

Fatt, C. K., Khin, E. W. S., & Yap, P. (2010). Doctrine of corporate governance and competition laws: The Malaysian perspectives. *African Journal of Business Management*, 4(6), 1175-1184.

Grandin, T. (1996). Animal Welfare in Slaughter Plants. In *29th Annual Conference of American Association of Bovine Practitioners*. Spokane, W.A (Ed.), *American Association of Bovine*

Practitioners (pp. 22-26). https://www.grandin.com/welfare/general.session.html
Halal Development Corporation (2020). www.hdcglobal.com

Halal history (2020). http://www.halal.gov.my/v4/index.php?data=bW9kdWxlcy9uZXdzOzs7Ow==&utama=corporate&ids=corporate

Halcomb, E. J., & Davidson, P. M. (2006). Is verbatim transcription of interview data always necessary? *Applied Nursing Research*, 19, 38–42.

Haleem, A., & Khan, M. I. (2017). Toward successful adoption of Halal logistics and its implications for the stakeholders. *British Food Journal*, 119(7), 1592-1605.

Heath, J., Williamson, H., Williams, L., & Harcourt, D. (2018). Parent-perceived isolation and barriers to psychosocial support: a qualitative study to investigate how peer support might help parents of burn-injured children." *Scars, Burns & Healing*, 4. DOI: 10.1177/2059513118763801

Hong, I., Dang, J., Tsai, Y., Liu, C., Lee, W., Wang, M., & Chen, P. (2011). An RFID application in the food supply chain: A case study of convenience stores in Taiwan. *Journal of Food Engineering*, 106, 119–126

IFI (2012), Halal Food and Certification by IFI. http://islaminireland.com/assets/images/pages/pdf/HalalFoodAndCertificationByIFI.pdf

Ilbery, B., Maye, D., Kneafsey, M., Jenkins, T., & Walkley, C., (2004). Forecasting food supply chain developments in lagging rural regions: evidence from the UK. *Journal of Rural Studies*, 20, 331–344.

ISNA (2012) https://www.isna.ir

Jacxsens, L., Luning, P. A., Van der Vorst, J. G. A. J., Devlieghere, F., Leemans, R., & Uyttendaele, M. (2010). Simulation modelling and risk assessment as tools to identify the impact of climate change on microbiological food safety — The case study of fresh produce supply chain. *Food Research International*, 43, 1925−1935.

Krabbe, J., J. (1993). A Physiocratic Approach to Sustainability. *International Journal of Social Economics*, 20(9), 15-21.

Kumar, S., & Nigmatullin, A. (2011). A system dynamics analysis of food supply chains- case study with non-perishable products. *Simulation Modelling Practice and Theory*, 19(10), 2151-2168.

Li, Y., Kramer, M., R., Beulens, A.J.M. & van der Vorst B, J.G.A.J. (2010). A framework for early warning and proactive control systems in food supply chain networks. *Computers in Industry*, 61, 852–862.

Manthou, V, Matopoulos A, & Vlachopoulou, M (2005). Internet-based applications in the agri-food supply chain: a survey on the Greek canning sector. *Journal of Food Engineering*, 70, 447–454.

Marzuki, S. Z. S., Hall, C. M. & Ballantine, P. W. (2012). Restaurant manager and halal certification in Malaysia. *Journal of Foodservice Business Research*, 15(2), 195-214.
Mason, C. (2014). Animal welfare and non-stun slaughter. *Animal Welfare*, 23(4).

McCarthy I. P., Tsinopoulos C., Allen P.M & Rose-Anderssen C. (2006). New product development as a complex adaptive system of decisions. *Journal of Product Innovation Management*, 23(5), 437-456.

McIntosh, R., I., Matthew, J., Mullineux, G., & Medland, A., J. (2010). Late Customization: issues of mass customization in the food industry. *International Journal of Production Research*, 48(6), 1557-1574.

Minegishi, S., & Thiel, D., (2000). System dynamics modeling and simulation of a particular food supply chain. *Simulation Practice and Theory*, 8, 321-339.

Ministry of domestic trade and consumer affairs, (2020). *List of Controlled Goods.* https://www.kpdnhep.gov.my/en/trade/business/business/business/business/kawal-selia-barang-kawalan/list-of-controlled-goods.html

Mohan, S., Gopalakrishnan & Mizzi, P.J. (2011). Improving the efficiency of a non-profit supply chain for the food insecure. *International Journal of Production Economics*, 143(2), 248-255.

Nakyinsige, K., Che Man, Y., B., & Sazili, A., Q. (2012). Halal Authenticity Issues in Meat and Meat Products. *Meat Science*, 91, 207-214.

Nicholson C. F., Gómez M. I., & Gao O. H. (2011). The costs of increased localization for a multiple-product food supply chain: Dairy in the United States. *Food Policy*, 36, 300–310.

Nurjuliana, M., Che Man, Y., B., Mat Hashim, D., & Mohamed, A., K., S. (2011). Rapid Identification of Pork for Halal Authentication Using the Electronic Nose and Gas Chromatography Mass Spectrometer with Headspace Analyzer. *Meat Science*, 88, 638-644.

Paolisso, M., & Hames, R. (2010). Time diary versus instantaneous sampling: A comparison of two behavioural research methods, Field *Methods*, 22, 357-377.

Rahman, M., & Shaarani, S. (2012). *Study on the effectiveness of Halal certification in slaughtering house around Kota Kinabalu, Sabah*. Proceedings in International Conference on Food Science and Nutrition (895–918), http://www.researchgate.net/publication/235338157_

Rahman, N. A., Amin, N., & Ahamat, H. (2014). The Interface between Competition Law and Consumer protection: A Malaysian Perspective. *Australian Journal of Basic and Applied Sciences*, 8(16), 316-323.

Rantavaara, A., Wallin, H., Hasunen, K., Harmala, K., Kulmala, H., Latviof, E., Liskola, K., Mustonen, I., Nieminen, I., & Tainio, R. (2005). Finnish stakeholder engagement in the restoration of a radioactively contaminated food supply chain. *Journal of Environmental Radioactivity*, 83, 305-317.

Regenstein, J., Chaudry, M., & Regenstein, C. (2006). The kosher and halal food laws. *Comprehensive Reviews in Food Science and Food Safety*, 2, 111–127.

Reiner, G. & Trcka, M. (2004). Customized supply chain design: problems and alternatives for a production company in the food industry. A simulation-based analysis. *International Journal of Production Economics*, 89(2), 217-29.

Riaz, M., & Chaudry, M. (2003. *Halal food production*. London: CRC Press.

Rong, A., Akkerman, R., & Grunow, M. (2011). An optimization approach for managing fresh food quality throughout the supply chain. *International Journal of Production Economics*, 131, 421–429.

Sanchez-Cordon, P. J., Montoya, M., Reis, A. L. & Dixon, L. K. (2018). African swine fever: A re-emerging viral disease threatening the global pig industry. *The Veterinary Journal*, 233, 41–48.

Shafie, S., & Othman, M. N. (2003). Halal Certification: An international marketing issue and challenges. *International Marketing and Service*, 13, 1–11.

Sharit, J., McCane, L., Thevenin, D., M., & Barach, P. (2008). Examining Links Between Sign-Out Reporting During Shift Changeovers and Patient Management Risks. *Risk Analysis*, 28(4), 969-981.

Sisaye, S. (2011). Ecological Systems Approaches to Sustainability and Organizational Development. *Leadership & Organization Development Journal*, 32(4), 379-398.

Sohaib, M., & Jamil, F., (2017). An Insight of Meat Industry in Pakistan with Special Reference to Halal Meat: A Comprehensive Review. *Korean Journal for Food Science of Animal Resources*, 37(3), 329.

Spanjaard, D., Young, L., & Freeman, L. (2014). Emotions in supermarket brand choice: A multimethod approach. *Qualitative Market Research: An International Journal*, 17(3), 209-224.

Sungar, I., & Hashim, D, (2009, 30-31 July). *The Global Halal Food Market And Updates On Global Halal Standards*. The World Bank, First EAP Regional Agribusiness Trade and Investment Conference on Agro-enterprise Without Borders, Singapore.

The Institute for Sustainability, URL http://theinstituteforsustainability.com/.

Thomas, A.J., Barton, R., & John, E.G. (2008). Advanced manufacturing technology implementation: a review of benefits and a model for change. *International Journal of Productivity and Performance Management*, 57(2), 156-76.

Thomas, A., White, G.R.T., Plant, E. & Zhou, P. (2015). Challenges and Practices in Halal Meat Preparation: a case study investigation of a UK slaughterhouse. *TQM & Business Excellence*, 1-20.

Tieman, M. (2011). The application of Halal in supply chain management: in-depth interviews. *Journal of Islamic Marketing*, 2(2), 186-195.

Tieman, T., van der Vorst, J., & Ghazali, M.C. (2012). Principles in Halal supply chain management. *Journal of Islamic Marketing*, 3(3), 217 – 243

Tieman, M., Ghazali, M.C. & van der Vorst, J.G. (2013). Consumer perception on Halal meat logistics. British Food Journal, 115(8), 1112-1129.

Van der Vorst, J.G.A.J., Tromp, S.O., & van der Zee, D.J., (2009). Simulation Modelling for Food Supply Chain Redesign; Integrated Decision Making on product Quality, Sustainability and Logistics. *International Journal of Production Research*, 47(23), 6611–6631.

Van Der Vorst & Beulens, A.J.M. (2002). Identifying sources of uncertainty to generate supply chain redesign strategies. *International Journal of Physical Distributions and Logistics*, 32(6), 409-430.

Van Der Vorst, J.G.A.J., Tromp, S.-O., & Van Der Zee, D.J. (2009). Simulation modelling for food supply chain redesign; integrated decision making on product quality, sustainability and logistics. *International Journal of Production Research*, 47(23), 6611–6631.

White, G.R.T. & Cicmil, S. (2016). Knowledge Acquisition Through Process Mapping: factors affecting the performance of work-based activity. *International Journal of Productivity and Performance Management*, 65(3), 302-323.

White, G.R.T., & Samuel, A. (2016). Fairtrade and Halal Food Certification and Labeling: Commercial Lessons and Religious Limitations. *Journal of Macromarketing*, 36(4).

White, G.R.T., Samuel, A., Zhou, P., Razak, A.A., & Thomas, S. (2017). Religious heterogeneity of food consumers: The impact of global markets upon methods of production. *Journal of Consumer Behaviour*, 17(1), 3-12.

Wognum, P. M., Bremmers, H., Trienekens, J.H., van der Vorst, J.G.A.J., & Bloemhof , J.M. (2011). Systems for sustainability and transparency of food supply chains - Current status and challenges. *Advanced Engineering Informatics*, 25, 65-76.

Womack, J. and Jones, D., (1996). *"Lean" Thinking*, Simon & Schuster, New York, NY.

Wood, J. (2012). *Food manufacture*.
http://foodmanufacture.co.uk/Regulation/Halal-chicken-sold-at-KFC-maynot-be-real-halal.

Vlajic, J. V., van der Vorst, J. G. A. J., & Haijema, R. (2011). A framework for designing robust food supply chains", *International Journal of Production Economics*, 137(1), 176-189.

Xu, L., Cai, C., B., Cui, H., F., Ye, Z., H., & Yu, X., P. (2012). Rapid Discrimination of Pork in Halal and non-Halal Chinese Ham Sausages by Fourier Transform Infrared (FTiR) Spectroscopy and Chemometrics. *Meat Science*, 92(4), 506-510.

Yousef, D., K., (2010). UAE: Halal food numbers look tasty. Size of global Muslim population creates significant customer base. http://gulfnews.com/business/general/Halal-food-numbers-look-tasty-1.679007.

Zakaria, Z. (2008). Tapping into the world Halal market, some discussions on Malaysian laws and standards. *Jurnal Syariah*, 16 (Keluaran Khas), 603-616.

Zanoni S, & Zavanella L. (2011). Chilled or frozen? Decision strategies for sustainable food supply chains. *International Journal of Production Economics*, 140(2), 731-736

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