

## Research Article

### Supervision on the Processing and Production Chain of Meat Products Based on Internet of Things in China

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**Abstract:** In recent years there are some food incidents happened in China, especially in meat product industry, which caused great panic among people. This study lists some of the cases and analyzes the influence from different angles. It illustrates how to supervise processing and producing meat products under the technology of Internet of things, like sensor, RFID and trackers etc. The purpose is to offer a safe food environment in China and lead enterprises to set up a sound operation system to gain long-term profits as well.

**Keywords:** Database, food security, internet of things, meat products, processing and production

#### INTRODUCTION

In recent years, food security incidents have caused wide concerns in China for their fatal threats to public health. A large number of diseases, disability and even death has occurred and aroused panic in the whole country. "Scientific Interpretation of Food security Issues Press of 2013" was hosted on 9<sup>th</sup> January 2014 in Beijing by CIFST (Chinese Institute of Food Science and Technology). In this conference, 30 food security issues were put forward by public and media and analyzed by the officials (Chinese Food Security Newspaper, 2014).

As it is pointed out that pollution of raw materials and willful frauds are the key words in food security issues (Caswell *et al.*, 1998), especially in meat product industry. The public is increasingly showing its worries and concerns on this problem, which is also the focus of Chinese government in the following year. It calls for a revamp to supervision practices in the processing and producing procedure as well.

**Case analysis:** In November 2012, it was reported that KFC took use of Instant Chicken, which chicken farmers fed by 18 kinds of antibiotics to boost their growth. Although this kind instant chicken cannot lead to death, it is quite harmful to people's health. Besides, this incident sees other reasons, like the neglect of supervision from the government, etc., because it is easy to get a CIQ (Certificate of Inspection and Quarantine).

On May, 2013, it was reported that some enterprises sold rat meat, duck to replace the mutton. In

order to reduce costs, manufacturers resort to some illegal measures. Some operators also added meatloaf water-retaining to keep water content. But excess volume of water-retaining agent did harm to the absorption of calcium in human's body and may cause the loss of calcium, especially for some senior people, young kids and the pregnant. The potential hazard was great.

It is shown in Fig. 1 that from 2009 to the first half year of 2013, the frequency of exposed Chinese food security incidents increased rapidly. In 2009, the number of exposed food security incidents was over 20. In 2012, the number is over 40, which is the maximum. According to the chart, in 2013, the number of exposed food security incidents is smaller than that of in 2012. However, it is a remarkable fact that the number in 2013 is just on the first half year and it has reached up to about 35. This severe phenomenon must be taken seriously.

All these illegal behaviors not only do harmful to the health of consumers, but also disturb the sound development of meat industry. It also results in business credit crisis in this market. The consumers' purchasing power is decreased (McElhattoy and Marshall, 2006). So how to supervise the feeding, processing and selling procedures of meat in the whole chain become a technical issue, because it involves farmers, enterprises and inspection departments to bear their responsibility to set up a sound chain, which can guarantee the circulation of meat products. Under such a high-tech world, internet of things has been put into uses in human's life. The network, just like in the chain of meat industry has been highly valued for its accuracy and wide coverage (Motarjemi and Adams, 2006).

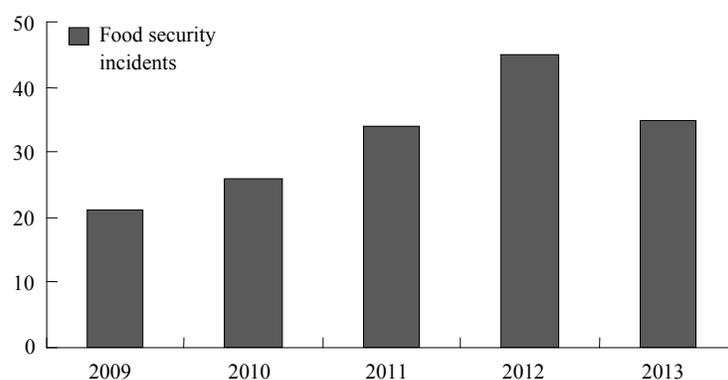


Fig. 1: Exposed food security incidents from 2009 to 2013

## MATERIALS AND METHODS

**Present situation of meat product supply chain in China:** Meat processing industry in China has not formed a perfect supply chain management mode; its industrial chain is short and every link of information is asymmetry and connection is unsmooth. Production and processing and distribution methods are mostly mainly in small scale decentralized rearing, relatively loose and lack of centralized management. Small farmers underestimate scientific feeding knowledge and it is prone to cause the source of pollution of meat product. Meat product on sale in the market, which is mostly run by individual households slaughtering, is lack of effective monitoring and inspection and can lead to the pollution and decay of meat easily.

What's more, it lack of effective communication of each link. In a series of standards for food safety management, the principles of maintaining necessary communication in food supply chain are unanimously demanded and the importance of synergistic effect in each stage of food chain is emphasized (Mead, 2005). For meat product supply, it is no exception as well. From the livestock and poultry breeding in the beginning to finally reach the sellers it goes through lots of links and each link does not communicate with each other enough so even if there is something wrong, which is a link cannot be informed. Being short of mutual supervision mechanism is easy to result in nonstandard operation behaviors.

Last, Meat product supply involves in breeding, slaughter and processing, warehousing, logistics distribution, consumer terminal of many links. Except for using traditional effective site management, it is in shortage of advanced technology management like the internet, Internet of Things and bar code of information technology. The necessary monitoring equipment is absent in processing factory site and key parts and the solution to food is not good in control, not only that, there are no sustained track records about controlling fresh in transit. So when things go wrong, it is difficult to find out where the cause is for a time.

According to this situation, it seems that the Internet of things, originated from network of radio frequency identification system of MIT Auto-ID centre in 1999, which firstly put forward by Professor Ashton, can provide solutions for this problem with uniting item code, RFID and internet technology. Currently, the most common perception of Internet of Things is a kind of network connecting any items with the internet according to the stipulated agreement to exchanging information and communicating aiming to realize intelligent recognition, positioning and tracking, monitoring and management through information sensing equipment such as RFID, infrared sensors, GPS, laser scanner and etc. EPC Internet of Things applies maturely and extensively and this article studies based on EPC system which is constituted by three parts of global electronic product code encoding system, RFID system and information network system.

**The key technology in internet of things:** The technical architecture and workflow of EPC Internet of Things in this study adopt 3 tier architectures (Wu, 2011): perception layer, network layer and application layer. Perception layer collects the original information and data of markers by QR code, RFID systems and various sensors. Network layer transmits and manages information taking use of sensing network and internet. Application layer processes massive data by mining and analysis and intelligent computing, intelligently controls things and provides support for decision making and other application services with the help of various supporting platforms, cloud computing and pattern recognition. Among Internet of Things consisted in EPC label, reader-writer, Savant server, ONS server, Internet, EPCIS and many database, radio frequency technology automatic inducts and recognizes the EPC label attached to the goods, then the reader reads EPC just as a piece of information reference and according to it, find out the IP address from the internet and obtain information of related items stored in it and specific realization is taking advantages of Savant

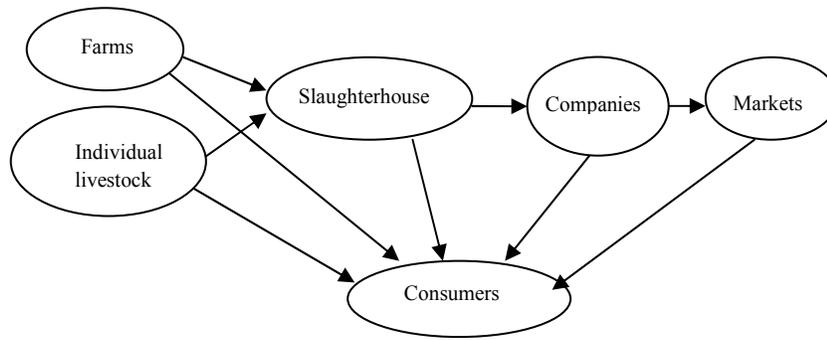


Fig. 2: Meat supply chain

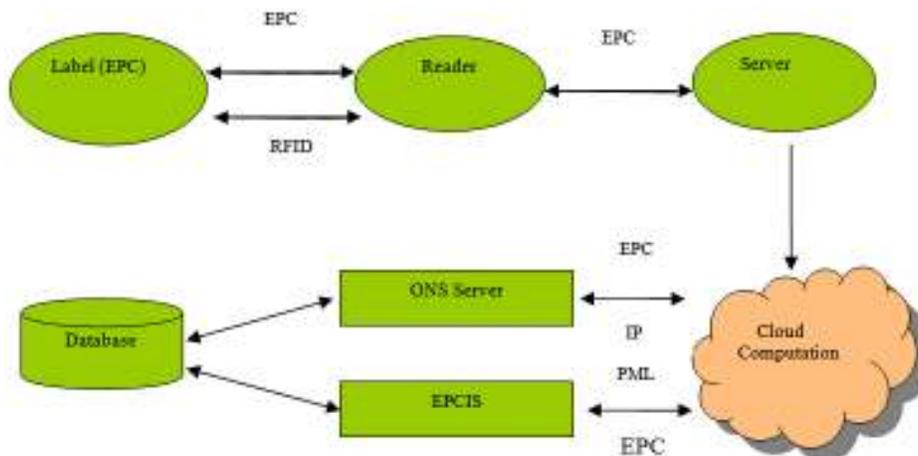


Fig. 3: Workflow of EPC in the internet of things

software system and EPCIS. Savant system processes and manages a string of EPC information which is read by reader and if the computer wants to gain other information matching uniquely identified EPC; it will need ONS to provide automated network database service. Savant delivers EPC to ONS and then ONS indicates Savant to a PML server in which is saved a product document to search and this document can be copied by Savant, therefore, the product information in the document can be delivered to the product supply chain. The specific flow of work is as shown in Fig. 2.

## RESULTS AND DISCUSSION

Meat industry chain is longer than other chains and it goes through many links like breeding, slaughter, initial cut, segmentation and sale which can reach to the consumers, as is shown in Fig. 3. Of them, the breeding of livestock is a long term process and many of them are from individual farmers which are scattered around different areas. Because of lacking of capital, farmers usually choose not registering for their livestock, which is of great importance, like ear tag, farm households' information, fodder, inspection, etc. It is also the main reason that it is difficult to control meat quality from farm to table in the whole process. What's more, meat

supply is circulated from place to place and the form of the livestock in each link is not the same, so the key to ensure the safety supply is to record key information, transfer seamlessly and real-time monitor (Shanahan *et al.*, 2009).

**The application of EPC in the internet of things in meat supply chain:** Under the push of government and leading enterprises, the patterns of enterprise plus farmers" or "enterprise plus foundation plus farmers" are searched to solve the problem of scatter sources from place to place (Alessio, 2008). The experiment in supply chain of EPC Internet of Things is also made by the enterprises in that background. The three prominent characters of EPC Internet of Things are total awareness, reliable transmission and intelligence application. And the application in beef chain is shown in the Fig. 3. In order to make it easy for comprehension, the fist cutting and re-segmentation are combined into dressing as well as simplified to four parts. Such as the ear tag of the individual cattle, the eating of veterinary drug and feeding and the information of the feeders during cultivation, the information of the butcher and the pass inspection, the source of the acetone body during dressing and the information of cutting body, the transport vehicle and

operation stuffs and warehouse environment during the multi-link circulation process.

All of the information is needed to be identified and collected by the only national product identification code; some confused information may be needed to be checked with the help of camera, infrared and other various kinds of sensors. It even uses GPS to chase the whole-way of transport vehicles. Only in this way all information of beef in the life cycle can be widely recorded which not only presents a secure and complete supply chain process to consumers but also can trace back to the source as well as find out the point of problem once there is something wrong with the quality of products. During the period, inspection supervision departments can also make sure the standard operation of the enterprise as well as the quality of the products through regular or random checking (Frewer *et al.*, 2002). For individual firms, the collected information is firstly sent from EPC reader to SEVANT server and then sent to ONS server after filter. Enterprise can also check the information of products through ONS server by some ERP supply software.

After safety certification, every enterprise can search other's server and information system, which may play a mutual supervision role in the inspection. Enterprises should accept honest and legal partners and make sure all the operation in last link is normative before acceptance, which is not only responsible for both of them but also for most consumers. Government should also promote and encourage such practice through some relevant awarding measures as well as stimulate enterprise to be legal and honest. In addition, it can monitor the whole-way information in beef supply chain and find out the existing problems in time. And the most important link is tracing back to the point of problem. It can rather fleetly find out the unqualified information and then race back to it through information processing, data mining and standard information matching by cloud computing, pattern recognition and other intelligence techniques. Firstly, users need to input an EPC code, find the IP of EPCIS in EPC code through ONS Internet checking, then make collection with every node of PML server to gain circulation information of the product and combine with the geography information that is intuitively reflected in GPS.

**The security insurance in meat supply chain of EPC in the internet of things:** EPC is mainly used in the following three parts: standard unique identifier, the chasing of the unqualified meat and the whole information sharing.

**Standard unique identifier:** Enterprises need to apply for registration and get a global unique authentication code in the ANCC (Article Numbering Center of China) that is the only authorized code organization in

the mainland China before the application of EPC Internet of Things. In the supply chain, every part of the authentication code should refer to GSI standardized unique identifier (Paster, 2007). RFID ear tag is the only identifier of the livestock. What's more, different forms of bovine products and operation stuff also have their own unique standardized identifier, which is not only good to Anti-fake and reduce mistakes, but also make operation stuff get rid of muddled psychology to work hard.

**The chasing of the unqualified meat:** Nowadays most chasing systems of meat just begin from the slaughter instead of the source. While characters of meat are taken into consideration, each record for the livestock should be kept from the source and ear tags should be taken as the reference of acetone body and individual raised animals. Connection between acetone body and cutting body is also marked as long as pre-packaging. Once there is something wrong in the whole procedure, it is quite easier to track unqualified products from feeding to sales and take a good control in every link, which may make less influence to qualified products.

**The share of all the information:** A large amount of data and information about each link of meat supply chain are sent to the Internet reliably, consumers and supervision departments can know the process of supply by logging on certain websites at any time they like. Supervision departments can monitor the situation of supply in time through technological analysis and data processing. Consumers can also know the source of supply utterly and make sure the food they eat is healthy.

## CONCLUSION

From the above analysis, it is rather clear that with the help of EPC Internet of Things, achievements on improving traditional supply pattern and security of supply chain with have been gained in many ways. Social stability cannot be improved without credit and honesty in business world. For the enterprises it is also the best for its long-term running, which contribute a lot to win the competition in a fair market and healthy economical environment. Anyway it is not about individuals, but about a community. It may be that through rising global market structures, interdependency will become more evident and flourishing through mutual care can be facilitated by an expanded understanding of care as a virtue for everyone in this world.

But there are still some disadvantages. First of all, honesty of enterprises plays a main part in the process. What's more, there are also some difficulties for the enterprises to carry out this new technique, which asks the government to lead a right way for them through

some relevant measures (Mu, 2012). The relationship between supervision department and enterprises should be improved to cooperative development instead of traditional punishment. In addition, it also needs to improve the quality cultivation and moral standards of the staffs themselves. They had better set accurate standards but not ignore the health of others just for their own interests. As for consumers, they also need to strengthen the awareness of security insurance to protect their own legal right. In a word, the security of food supply needs the joint effort of every concerned member in the food chain.

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