

# جامعة صحر SOHAR UNIVERSITY



## Faculty of Computing & IT

### MASTERS THESIS

Thesis submitted in partial fulfillment of the requirements for the M.Sc.

Degree in Computer Science

## Self-Organized Food Safety Systems: An Agent-Based Model

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# Abstract

This thesis presents an agent-based model of food safety management. The model proposed by McPhee-Knowles, 2015 involving consumers, regulators and stores is extended to evaluate the phenomena of “the wisdom of crowd” towards conditions leading to more efficient and dependable system. Through multi-parameter simulation, it is revealed that consumers, regulators and stores effect one another in interesting ways. The model presented by McPhee-Knowles, 2015 is successful in combining various sub-systems which are relevant; such as, inspection system, immune system, effect of consumer avoidance, and stores signaling on their own, and investigated inspectors behavior influence on the food safety. We extend this model to investigate about consumers and store owners, the social dimension. We propose that consumers and owners of the stores accepting existence of “the wisdom of crowd”, can make good decision; good for themselves, but at the same time, beneficial for the society as a whole. For example, more vigilance in correction measures by stores (if contaminated) ensures a majority consumers still loyal to the contaminated store. We also replaced stores self-signaling by social networking, acting as a medium to spread the information and helping other consumers finding stores which are not contaminated. As a whole these findings also conform to self-organizing behavior of the population. It is evidenced that an active society has a capability to self-organize even in the absence of any regulatory compulsion. The implications of these findings are enormous. System components taking a self-organized corrective action resists against system going towards a highly skewed distribution, thus, improving its stability and robustness.

**Key words:** Food safety, Agent-based modeling, wisdom of crowd. social simulation

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# Chapter 1

## Introduction

### 1.1 Introduction

Food safety is a growing concern. The population of the world is increasing exponentially.

This growth is uneven, where, the population in economically poor countries is growing more rapidly than the economically stable countries McPhee-Knowles (2015). It means that the countries which can spend more on food safety are less vulnerable, and, already have better systems and healthcare facilities. Whereas, countries which have issues in their economics systems and healthcare, are most likely to suffer more due to exceptional growth in population.

Scientific advancements provide opportunities towards standardized harvesting and logistics procedures, and safeguarding against contamination in stores. But still a lot needs to be done McPhee-Knowles (2015). This is evident from on going concerns in government circles Marks (2015) and Kim (2013) and communities Borrusso and Quinlan (2013) and Unnevehr and Grace (2013). At operational level, no doubt, the regulatory authorities of a country have a major role, which should have an effective, and robust mechanism to deal with modalities of food contamination.

Over the past years, the global food distribution and supply chain has become very complex due to an increase in the population in general, and more specifically, an increase in farmers, suppliers, traders and consumers. This has led to several food safety crises recently. Due to this,

a debate is underway towards many solutions, including, making more strict laws, rethinking about prevalent industrial practices and a fresh approach to understand consumers' behaviors Birk-Urovitz (2011). For example, the scandal in the European Union when horse meat was found in ready-made foods that were classified as beef products, led to the request for a new law that is more stricter Birk-Urovitz (2011).

Assessment and correction of food contamination is usually done using food inspection programs in which, stores providing food get central attention. However, it is observed that due to lack of standards, the allocation of inspection resources and agreeing on contamination thresholds has become a challenge Hoag et al. (2007) and Thanh (2015). On the other hand, consumers are equally important Thanh (2015). The psychological factors representing the perceptions Van Kleef et al. (2007) and Kher et al. (2013) and attitudes Bredahl (2001) of consumers about the food quality is as important as food inspections mechanisms.

Most social systems including food delivery and consumption evolve with time, based on society's needs and restrictions. However, most of these systems are far from perfection due to:

- Diversity of human race, which manifests into a heterogeneous population in terms of resources, and capabilities.
- Inherent lack of balance in human cognition due to selfishness and drawbacks in social and political justice.
- Existence of a gap between social / scientific knowledge and development of an individual, which practically keeps these system in a state often not optimized.
- Flaw in human knowledge and judgment.

Computational Social Science (CSS) McPhee-Knowles (2015) is a young discipline, which focus on using computations to solve social problems. It uses the power of abstraction and modeling to mimic real systems in a formal way so that computers can understand and process

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