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New trends in cold chain monitoring applications - A review

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14 **Abstract**

15 Current global food supply chains are faced with an ever increasing variety of modern day
16 societal challenges. As a direct result of these challenges many of these supply chains are
17 operating in a "below ideal" state, resulting in approximately one third of the food produced
18 for human consumption being wasted across the globe. A key contributory factor to such high
19 waste is an inability to control / monitor temperature across global food supply networks. This
20 is an issue that needs to be addressed both nationally and internationally to meet the complex
21 challenges surrounding modern day food security, safety and integrity.

22 There is no one single "one solution fits all" approach when it comes to addressing cold chain
23 inefficiencies. Latest cold chain technologies, their respective advantages and disadvantages,
24 applied to the industry are presented in the present work. Technological solutions including
25 Radio Frequency (RF) technologies and Wireless Sensor Networks (WSN) are discussed within
26 this manuscript. Their key success metric is their strategic complementarity, give the fact
27 WSN lacks robustness and Radio Frequency Identification (RFID) lacks reading range and
28 possess limited sensing systems.

29 Other solutions discussed include temperature estimation methods for reducing the numbers
30 of sensors deployed, when comparing them, Neural Networks showed better approximations
31 than Kriging and Capacitor methods given the non-linear relationship between the
32 temperature target and the temperature source. Computational Fluid Dynamics is also
33 presented as a commercial method to correct inefficiencies at pre-cooling stages. Thermal
34 imaging (thermal infra-red camera) have proven to be a good temperature source for the
35 Neural Network in temperature estimation. This article also focuses on and emphasizes the
36 importance of a technological Internet-of-Things approach, given the fact it is key in
37 facilitating the information exchange between items in the cold chain, RF technologies and

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