

**STUDY OF FOOD SECURITY IMPEDIMENTS IN
INDIA**

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by

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CERTIFICATE

This is to certify that the thesis entitled “**Study of Food Security Impediments in India**” being submitted by Rachita Gupta to the Indian Institute of Technology Delhi for the award of the degree of **Doctor of Philosophy (Ph.D.)**, is a record of bonafide research work carried out by her. She has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which has attained the requisite standard required for Ph.D. degree from the Indian Institute of Technology Delhi. The results presented in this thesis have not been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

The economic growth of a nation is governed by its capability to ensure availability of enough quantity of safe and quality food to the people. Despite the vitality of food sector, all countries, be it a developed or a developing nation, face a number of challenges which affect the security and safety of food. Increasing globalization and complexity of food supply chain lead to the situation of unavailability and inaccessibility of food, which makes it more difficult to cater to the needs of the growing populace. It is therefore necessary to assess the inefficiencies in food supply chain management to ensure security and safety of food. In this research, Indian food supply chain and food security system have been studied.

Despite arguably being one of the largest agriculture based and agriculture dependent economy in the world, India is facing the issue of food security, which is referred to as Public Distribution System (PDS) as a whole. In order to understand existing inefficiencies in the food supply chain (FSC), firstly a conceptual framework has been developed in this study, using “Soft System Methodology (SSM)”, to explore the issues and possible solutions. The output of SSM provides the scope and directions for conducting further research. Initially, various food security impediments and their associated risks are identified. Severity assessment of impediments is then performed on the basis of their effects on social, economic and operational perspectives, using fuzzy evidential reasoning algorithm (FERA). Further, an attempt is made to profile the identified risks on the basis of decision makers’ behavioral preference towards considered perspectives, categorizing these into three profiles: highly severe, moderately severe and low severe risks.

One of the most severe impediments comes out to be inappropriate conduct done by different actors in the FSC. This outcome motivated us to perform an in-depth study on Indian PDS system for understanding the effect of various inappropriate conduct (collusive behavior). Based on the

literature review followed by a formal interaction with the concerned experts, a few critical inappropriate conducts have been identified and their severity was evaluated using interval 2-tuple linguistic toposis (ITL-TOPSIS) method. The result of this analysis together with the solution output from SSM encouraged to perform a study on traceability implementation in PDS to deal with the issues. Therefore, last section of the research deals with the identification of critical success factors (CSFs) of food traceability system implementation. Two important theories, “stakeholder theory” and “theory of critical success factor”, have been used for this purpose. Post-identification, these CSFs were subjected to “Exploratory factor analysis (EFA)” to test their significance followed by analysis of their inter-relationships using total interpretive structural modeling (TISM).

The thesis provides various insights to concerned authorities and policy makers involved in Indian PDS and also to the practitioners and academicians working in the area of food distribution and supplies. The thesis provided the roadmap to the practitioners while dealing with the issues of food security and enables the decision makers to ensure security of safe and quality food to the needy sections of the society.

सार

एक राष्ट्र का आर्थिक विकास लोगों को पर्याप्त मात्रा में सुरक्षित और गुणवत्ता वाले भोजन की उपलब्धता सुनिश्चित करने के लिए अपनी क्षमता से शासित है। खाद्य क्षेत्र की जीवन शक्ति के बावजूद, सभी देश, चाहे वह एक विकसित या विकासशील राष्ट्र हो, भोजन की सुरक्षा और सुरक्षा को प्रभावित करने वाली कई चुनौतियों का सामना करते हैं। खाद्य आपूर्ति श्रृंखला की बढ़ती भूमंडलीकरण और जटिलता से अनुपलब्धता और भोजन की पहुंच की स्थिति बढ़ जाती है, जिससे बढ़ती जनसंख्या की जरूरतों को पूरा करना अधिक कठिन हो जाता है। इसलिए उन कारकों को समझना जरूरी है जो अप्रभावी खाद्य आपूर्ति श्रृंखला प्रबंधन को जन्म देते हैं जिससे खाद्य सुरक्षा और सुरक्षा की उपलब्धि में बाधा आती है। खाद्य सुरक्षा की इन बाधाओं की पहचान और विश्लेषण के उद्देश्य से, और उनके संभावित समाधान, इस शोध में भारतीय खाद्य आपूर्ति श्रृंखला और खाद्य सुरक्षा प्रणाली पर विचार किया गया है। तर्कसंगत रूप से दुनिया में सबसे बड़ी कृषि आधारित और कृषि निर्भर अर्थव्यवस्था में से एक होने के बावजूद, भारत को वर्षों से खाद्य सुरक्षा के साथ-साथ खाद्य सुरक्षा के मुद्दों का सामना करना पड़ रहा है। भारत में खाद्य सुरक्षा प्रणाली को सार्वजनिक वितरण प्रणाली (पीडीएस) के रूप में जाना जाता है। खाद्य आपूर्ति श्रृंखला (एफएससी) के भीतर अक्षमता के कारण पीडीएस की खराब स्थिति को ध्यान में रखते हुए, यह शोध पहले मौजूदा एफएससी मुद्दों का पता लगाने की कोशिश करता है और फिर "सॉफ्ट सिस्टम मेथडोलॉजी (एसएसएम)" का उपयोग करके इसका निपटारा करने के लिए एक वैचारिक ढांचा विकसित करता है। एसएसएम का उत्पादन आगे अनुसंधान करने के लिए पथ की रूपरेखा तैयार करता है। प्रारंभ में, खाद्य सुरक्षा के चार स्थापित आयामों में खाद्य सुरक्षा की विभिन्न बाधाओं की पहचान और वर्गीकरण किया जाता है। इसके अलावा, बाधाओं से जुड़े जोखिमों की पहचान की जाती है और उनकी प्रोफाइलिंग तीन श्रेणियों में होती है, अत्यधिक गंभीर, मामूली गंभीर और कम गंभीर जोखिम।

विचारधारात्मक दृष्टिकोणों का यह जोखिम प्रोफाइलिंग, निर्णय निर्माताओं की व्यावहारिक दृष्टिकोण के आधार पर किया जाता है। हमारे सर्वोत्तम ज्ञान के मुताबिक, यह अध्ययन सामाजिक, आर्थिक और परिचालन दृष्टिकोण के प्रति निर्णय निर्माताओं की बदलती प्राथमिकताओं के आधार पर जोखिमों को वर्गीकृत करके खाद्य सुरक्षा जोखिमों के

व्यवहार-आधारित प्रोफाइलिंग के प्रति एक अभिनव प्रयास करता है। इस अध्ययन के परिणाम से पता चलता है कि "एफएससी के विभिन्न कलाकारों द्वारा अनुचित आचरण" उच्च गंभीरता वाले प्रमुख बाधाओं में से एक है क्योंकि यह सभी तीन दृष्टिकोणों को प्रभावित करता है। इस खोज से प्रेरित होकर, विभिन्न एफएससी कलाकारों द्वारा किए गए विभिन्न प्रकार के अनुचित संचालन (धोखाधड़ी का व्यवहार) की पहचान करने के लिए भारतीय पीडीएस प्रणाली के काम को समझने के लिए गहराई से अध्ययन किया गया है। एक बार पहचानने के बाद, विभिन्न धोखाधड़ी वाले व्यवहारों का गंभीरता मूल्यांकन, अंतराल 2-ट्यूपल भाषाई टॉपिस (आईटीएल-टोप्सिस) विधि का उपयोग करके किया जाता है। शोध इन मुद्दों के समाधान के लिए आगे बढ़ता है, जो एसएसएम से पीडीएस में ट्रेसिबिलिटी कार्यान्वयन के रूप में बाहर आता है। इसलिए, अनुसंधान का अंतिम भाग भोजन ट्रेसिबिलिटी सिस्टम कार्यान्वयन के महत्वपूर्ण सफलता कारकों (सीएसएफ) की पहचान के साथ संबंधित है। इस उद्देश्य के लिए दो महत्वपूर्ण सिद्धांत, "हितधारक सिद्धांत" और "महत्वपूर्ण सफलता कारक सिद्धांत" का उपयोग किया गया है। पहचान के बाद, इन सीएसएफ को "अन्वेषण कारक विश्लेषण (ईएफए)" का उपयोग करके महत्व परीक्षण के अधीन किया गया था, जिसे उनके सांख्यिकीय महत्व का परीक्षण करने के लिए नियोजित किया गया है। इसके बाद सांख्यिकीय रूप से महत्वपूर्ण सीएसएफ के बीच अंतर-संबंधों का पता लगाने के लिए कुल व्याख्यात्मक संरचनात्मक मॉडलिंग (टीआईएसएम) का उपयोग किया जाता है। टीआईएसएम का परिणाम एक पदानुक्रमित संरचना में होता है जो सीएसएफ के बीच प्रासंगिक ड्राइविंग शक्ति और निर्भरता के आधार पर प्रासंगिक संबंधों को दर्शाता है। थीसिस अनुसंधान से प्राप्त निष्कर्षों के साथ समाप्त होता है, जो विशेष रूप से संबंधित पीड़ितों और भारतीय पीडीएस में शामिल नीति निर्माताओं और खाद्य उद्योग में काम कर रहे चिकित्सकों और शिक्षाविदों के लिए सामान्य रूप से उपयोगी हो सकता है। यह थीसिस खाद्य सुरक्षा मुद्दों से निपटने के हेतु, प्रबंधकों के लिए मूल्यवान अवलोकन और अंतर्दृष्टि के साथ आता है। इसने खाद्य सुरक्षा के मुद्दों से निपटने वाले अधिकारियों को रोडमैप प्रदान किया है और निर्णय निर्माताओं को समाज के जरूरतमंद वर्गों को सुरक्षित और गुणवत्ता वाले भोजन की सुरक्षा सुनिश्चित करने में सक्षम बनाया है।

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LIST OF ABBREVIATIONS

AAUS	Availability Accessibility Utilization Stability
AAY	Antyodaya Anna Yojana
AHP	Analytical Hierarchy Process
ANP	Analytical Network Process
APEDA	Agriculture & Processed Food Product Development Authority
BPL	Below Poverty Line
CAC	Codex Alimentarius Commission
CACP	Commission for Agricultural Costs and Prices
CSFs	Critical Success Factors
CWC	Central Warehousing Corporation
DFPD	Department of Food and Public Distribution
EFA	Exploratory Factor Analysis
EI	Economic Impact
EMA	Economically Motivated Adulteration
ER	Evidential Reasoning
EV	Expected Value
F2F	Farm-To-Fork
FAO	Food and Agricultural Organization
FCI	Food Corporation of India
FDA	Food and Drug Administration
FERA	Fuzzy Evidential Reasoning Algorithm
FGSC	Food Grain Supply Chain
FMEA	Failure Mode And Effects Analysis
FPDS	Food and Public Distribution System
FPS	Fair Price Shop
FSA	Food Standards Agency
FSC	Food Supply Chain
FSD	Food Storage Depot
FST	Fuzzy Set Theory

GPS	Global Positioning System
HAS	Human Activity System
ICDS	Integrated Child Development Services
ICTs	Information Communication Technologies
IFAD	International Fund for Agricultural Development
IGMRI	Indian Grain Storage Management and Research Institute
IPM	Integrated Pest Management
ISM	Interpretive Structural Modeling
ISO	International Organization for Standardization
ITHWD	Interval 2-Tuple Hybrid Weighted Distance
ITL-TOPSIS	Interval 2-Tuple Linguistic TOPSIS
KMO	Keyser–Mayer–Olkin
KMS	Kharif Marketing Season
MCDM	Multi-Criteria Decision Making
MICMAC	Impact Matrix Cross-Reference Multiplication Applied to a Classification
MSP	Minimum Support Price
NFFWP	National Food For Work Programme
NFS	National Food Security
NFSA	National Food Security Act
NIC	National Informatics Centre
OI	Operational Impact
OU	Objective Uncertainty
OWS	Other Welfare Schemes
PCA	Principal Components Analysis
PD	Perspective Dependent
PDS	Public Distribution System
PEG	Private Entrepreneurs Guarantee Scheme
PI	Perspective Independent
PIB	Press Information Bureau
PPP	Public Private Partnership

RFID	Radio Frequency Identification
RMS	Rabi Marketing Season
RPDS	Revamped Public Distribution System
SEM	Structural Equation Modeling
SFC	State Food Commission
SI	Social Impact
SoT	Schools Of Thought
SS	Severity Score
SSM	Soft System Methodology
SWC	State Warehousing Corporation
TFNs	Triangular Fuzzy Numbers
TISM	Total Interpretive Structural Modeling
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
TPDS	Targeted Public distribution System
WCD	Women and Child Development
WFP	World Food Programme
WSFS	World Summit On Food Security