CONTENTS

Part 1
The Application of AI Innovation in Business Innovation

Development of a System for Automatic Classification of Fake News in Portuguese Language
Roger Oliveira Monteiro, Rodrigo Ramos Nogueira ........................................ 1

The Sixth Wave of Innovation: Artificial Intelligence and The Impacts on Employment
Marcelo Augusto Vieira Graglia, Patricia Giannoccaro Von Huelsen,
José Arnoldo de Hoyos Guevara................................................................. 6

Does Viral Marketing create Brand Awareness? An Exploratory Study with University Students
Rafael Taino, Rafael Rodrigues Cardoso, Alexandre Luzzi Las Casas,
ArnoldJose de Hoyos Guevara................................................................. 17

Improved Genetic Algorithm for Solving TSP
Li Yigao, Han Hua................................................................................. 24

How Does Leader’s Support for Eco-Innovation Promote Corporate Environmental Responsibility in Organization?
Goli Yao Sidoine, Ye Jianmu, Ye Yongling............................................. 35

Research on the Impact of High-tech Enterprise Technology Diversification Development Strategy on Enterprise Performance
Mou Jiongxu, Liu Ying........................................................................... 42

Yang Fangjing...................................................................................... 51

An Analysis Of The Transformation of Mega-pharma Business Model Toward the Indian Market
Yaeko Mitsumori................................................................. 61
Application of Artificial Intelligence Technology in Legal Practice
Ma Nan ........................................................................................................69

Monitoring Node Selection in Wireless Sensor Networks Based on
Fuzzy Logic Scheme
Hammad Mushtaq, Syed Nouman Ali Shah, Naveed Ahmad Faraz ..................78

Exploring the Ethics of Innovation Education in Artificial Intelligence
Wang Xiumei ..............................................................................................85

Prospect for the Development of Artificial Intelligence in the Core Business of
Libraries
Yuan Xueqing, Liu Lin ..................................................................................91

Construction and Management of MOOCs Platforms for Business English
Translation Course
Tang Lijun .......................................................................................................98

Part 2

Internet of Things, Big Data and Business Analysis

Relationship between Big Data Analytics and Decision Making: A Cluster Analysis
Gustavo Grander, Luciano Ferreira da Silva, Arnoldo José de Hoyos Guevara,
Paulo Sérgio Gonçalves de Oliveira, Alan Tadeu de Moraes .........................106

The Influence of Digital Presentation on Consumers' Perceived Value Based on
Evidence from Eye Movement Experiments
Li Jiang, Liu Chun, Jiang Yushi ......................................................................113

Study on Factors Affecting Continued Usage Intention of Mobile News Apps in India
Saurabh Sharma, Cheng Yanxia, Prashant Sharma ........................................133

Research on Bio-Information Risk Identification Management under Big Data
Environment
Chen Ruiying, Zhang Haili, Shen Jun ............................................................139

Research on Grid Management Mode Application in College Student Management in
New Era
Research on the Governance of Government Network Public Opinion in the Age of Big Data
Wang Chunjuan, Zhu Xiao..............................................................154

Research on the Influence of Consumer Perceived Product Innovation on Brand Evangelism
Wang Pengtao, An Yamei..............................................................162

Research on Service Innovation of the Cloud Logistics Platform Based on Factor Analysis
Wu Xia, Zhang Jianming..............................................................169

Performance Evaluation of Listed Commercial Banks Based on Factor Analysis
Xiong Bin..............................................................177

Research on the Industrial Development Mode of “Internet plus Hunan Embroidery”: from the Perspective of Intangible Cultural Heritage Protection
Wang Aimin, Liu Wenhua..............................................................186

Application of Big Data Analysis in the Innovation of Information Resources Management
Luo Qifeng, Yang Jiaqi, Li Siqian..............................................................196

Separate Sections and Key Points: The Application of Big Data in Agricultural Science and Technology Information Service: Based on the Two Main Bodies of Supply Side and Demand Side
Yang Yu, Liu Jun..............................................................202

Research on Agricultural Science and Technology Information Service Model and Its Problems Based on Big Data
Li Yulin, Liu Jun, Wu Yongzhang..............................................................209

Research on University Library Self-built Resource Repositories in a Big Data Environment
Sha Zhengyu..............................................................217

Universal Conceptual Intelligence Structure Based on Visual Intelligence for Automatic Recognition of All Objects without the Big Data
Xu Xuetao..............................................................224
Study on Rural Logistics Mode Based on "Internet Plus": Taking Some Cities in Hubei Province as an Example

Li Jue, Zeng Xueqin ................................................................. 234

Research on Operation Performance Evaluation System Construction for National Digital Publishing Bases

Liu Yuhan, Liu Yongjian ........................................................... 245

Research on Enterprise Management System Innovation in the Era of “Internet +”

Wang Jianguo ........................................................................... 254

Research on Operation Management of Video Websites in China

Lv Rui, Ping Yue ...................................................................... 263

Foreign Experience and Reference in Operation Supervision of Sharing Bike

Yang Jiaqing ........................................................................... 270

Research on Optimal Path of Sports Variety Program Content Production Based on 4V Marketing Theory

Sun Jinrong, Hu Xuehui ............................................................ 278

Research on the Driving Factors of Customer Loyalty: Regarding iPhone as An Example

Deng Gang ............................................................................. 285

Campus Skill Exchange APP in Smart Campus Environment

Nie Zutian ............................................................................... 292

A Study on the Corelation between the Technological Sophistication Index of imports in Producer Service Industry and Technological Innovation Ability of Manufacturing Industry

Huang Huiping, Zhong Ruojun, ZhaoYulin ..................................... 301

The Application of Big Data Technology in College Academic Achievement Management

Xie Kai, Guo Fangming ............................................................ 314

Part 3

Safety Engineering and Risk Management

Research on the Influence of Airport Staff Safety Risk Perception on Violation
Behavior
Zhang Qian, Luo Fan.................................................................320

Media Reporting Strategies for Public Opinion Risk Management Based on Emergency---A Case of the Sinking Incident of Oriental Star Ship
Zhang Wuqiao........................................................................327

A Stock Price Movement Prediction Model Based on Artificial Neural Networks
Uzapi Hange, Siyanda Andrew Xaba........................................335

Study on Shutdown Time of Enterprises under Flood Disaster Scenario: A Case of Yuyao Companies after Typhoon Fitow
Yang Lijiao, Ding Xiaonan, Jiang Xinyu....................................341

Study on the Credit Customer Default of Local Commercial Bank in Southern Jiangsu Province Based on Logistic Model
Zhang Haoru, Fang Ming..........................................................351

Research on Innovation Performance of High-Tech Enterprises from the Perspective of Venture Capital
Ye Xiaofen, Cheng Liang............................................................357

Study on Employee Relationship Risk on the Effectiveness of Enterprise Structure Change in Cote d’Ivoire
Monhéséa Obrey Patrick Bah, Akadje jean Roland Edjoukou........365

Research on Early-warning and Control Strategies for Risk Conduction of Enterprise Financial Management System
Deng Xun, Deng Mingran..........................................................374

Risk Analysis and Control of Business Mode Transformation in HD Company
Yin Limei.................................................................................383

Theoretical Analysis and Practical Exploration of the Prevention and Control Management of Integrity Risk in Universities
Yan Yan..................................................................................390

Risk Analysis of Ships Navigation Safety in Wuhan Port
Mao Senpeng, Jiang Feifei........................................................399

Research on Risk Factors of Enterprise Product Innovation Design
Deng Jun .................................................................................406
Internet Financial Risk Early Warning Based on Fuzzy Analytic Hierarchy Process
Yang Yuxin.................................................................415
Research on Network Security Evaluation of Big Data Center Based on Rough Set
Liu Bin........................................................................432
Analysis of the Project Management of EPC Project General Contracting
Pei Linyu, Xu Dongming................................................438
Wu Yifan, Fang Jun........................................................445
Risk Assessment for College Students' Sudden Death Based on AHP
Huang Tingting, Xia Jiajia(455)
Research on Network Culture Security Management in Universities from Network Public Opinion
Li Huiyuan, Zhang Yan...............................................461

Part 4

Environmental Innovation and Sustainable Development

Is the Importance of Sustainable Development Goals Universal Across Development Stage of Economies
Yuko Hayashi, Frans Stel..................................................469
Cash Crop Innovation System and Networks: Findings from Smallholder Cocoa Farmers in Ghana
Patience Pokuua Gambrah, Yu Qian................................480
Application of Entropy Based TOPSIS in Analysis of Sustainability Performance of Sri Lankan Hotels
P.R. Weerathunga, Cheng Xiaofang, WHMSS amarthunga, KMMCB Kulathunga...........................................486
Historical Heritage and Sustainable Urban Development: Challenges imposed on owners and managers of listed historical buildings in the city of São Paulo
Arnoldo Jose de Hoyos Guevara, Fernanda Cardoso Romão Freitas,
Research on Innovation Performance Analysis of Financial Policy: from the Perspective of Technology-based SMEs

Wan Guochao, Zhang Lingzi, Tang Ling

Prediction Model of Energy Development Trend Based on SVM

Lin Hui

A Ranking for the Sustainable Development Goals Focusing on the 5Ps

Arnoldo de Hoyos Guevara, Agris L. Dumpe

A Ranking of Countries concerning Progress towards a Society 5.0

Arnoldo José de Hoyos Guevara, Daniela Mary Terra,
Jerônimo Henrique Ports, José Luiz Alves da Silva, Kallita Ester Magalhães

Effect of Environmental Regulation on Corporate Financial Performance: Mediating Role of Green Technological Innovation

Chen Xiaofang, Tong Xiaohong, Xia Wenlei, Chen Xin

Awareness of the Worth of Life Within/Without for Systemic Resilience under Climate Change Disasters: The Amazon Bioma and the Gender-Differenciated Vulnerability

Arnoldo José de Hoyos Guevera, Daniela Gasperin, Christine Syrgiannis,
Anastasia Zabaniotou, Ivani Fazenda

Research on Evaluation of Industrial Sustainable Development Ability in China: Based on Dynamic Entropy Weight and DEA Mode

Chen Mengxue, Zou Wei

Corporate Social Responsibility: A Multiple Case Study of the Civil Construction Industry in the State of Bahia, Brazil

Paulo Melo, Manoel Joaquim F. de Barros, Arnoldo José de Hoyos Guevara,
Edson Jorge M. De Sousa

Study on the Driving of Energy Saving and Emission Reduction to the Transformation of Resource-based Cities

Chen Qiang, OuYang Xiao

Research on the Relationship between R&D Coupling Coordination and Upgrading of Equipment Manufacturing Industry: An Empirical Study of Shandong Province
Employment Efficiency Evaluation of Innovation and Entrepreneurship Policy in China
Zhu Hua...............................................................................................................589

Study on the Evaluation of Industrial Innovation Capacity in Hubei Province
Song Weiwei, Zou Wei..........................................................................................598

An Empirical Study on the Effect of Innovation on Employment from the Industry Level Perspective: A Case of China
Allaberdiyev Guychmyrat, Wei Long......................................................................607

A Study on Environmental Uncertainty, Internal Control and Earnings Management
Yang Yu..................................................................................................................616

Research on the Effect of Inbound and Outbound Open Innovation on Firm Innovation Performance
Hou Jie, Li Xue, Gao Pengbin(624)

A Study on the Relationship between Servitization of Manufacturing Industry and Enterprise Performance: Based on the Perspective of Life Cycle
Zhu Zhangli, Fang Ming..........................................................................................631

The Innovation and Management of China’s Urban Brand Image under Experience Service Economy
Li Huipeng, Zhang Yazhou......................................................................................640

Part 5

Operation Management, Supply Chain Management and Transportation Management Innovation

House of Quality-Based Analysis of Green Supply Chain Management for the Sustainable Investment Decisions with Interval Type 2 Fuzzy Hybrid Model
Luis Martínez, Hasan Dinçer, Serhat Yüksel............................................................646

Tourist Forecasting Model of Short Holiday Based on Network Data: A Case Study of Mount Emei Scenic Area
Ma Zhaofeng, Huang Ping, Guo Chuangle, Abdoulaye Boiro,
Wen Zhili, Zhan Fei, Yin Zizhong.................................................................656
Influencing Mechanism of Business Mode Innovation Risk in Business Groups
Mo Guoyong, Liang Benbu.................................................................664
Dual Pre-Strategy Analysis of Clothing E-Commerce Reverse Logistics for Small and
Medium-Sized Enterprises
Li Tianbiao, Shen Jingye, Wei Qian, Zhang Yao, Dai Jinshan....................671
Research on Optimization and Collaboration of Cross-border E-commerce Logistics
Supply Chain
Wang Aimin, Ji Tingting, Zhong Qianru..................................................680
Regional Difference Analysis of Logistics Industry Service Innovation Capability in
Hubei Province of China: Based on Porter’s “Diamond Model”
Lv Yuejiao, Liu Mingfei.................................................................687
Research on the Innovation Operation Mode of Science and Technology Business
Incubator and its Influence on Innovation Economy
Han Wensi, Xie Jialong.................................................................695
Management and Operation of Trace Evidence Laboratory under the CNAS Review
System
Lv Caihong, Liu Guomin, Fang De..................................................705
Study on Simulation and Optimization of Container Truck Path in Multi-quayside
Crane Cooperation Mode
Ye Yani, Ding Tao, Xiang Shengbin..................................................712
Simulation Research of AGV Configuration Optimization in Automated Container
Terminal
Chen Ning, Tao Hui.................................................................722
Supplier Relationship Quality and Supply Chain Performance in Engineering
Enterprises: The Regulating Role of Cooperation Vision
Yin Long, Liu Mingfei.................................................................730
Business Mode Innovation Based on Iceberg Theory
Yu Xiaoyu, Zheng Zhan.................................................................740
Research on B2C E-commerce Enterprise Logistics Mode Selection Based on
Analytic Hierarchy Process: Taking Jingdong Mall as an Example
Part 6

Human Resources and Organizational Behavior

Sick Organizational Culture: Leadership that Makes People Sick
   Alan Tadeu de Moraes, Luciano Ferreira da Silva, Arnoldo José de Hoyos Guevara, Gustavo Grander, Diego de Melo Conti

The Effect of Work-Family Enrichment on Employees’ Task Performance: The Mediate-Moderate Effect of Work Satisfaction and Social Support
   Li Guiqing, Wang Minxia, Du Wanyan, Ji Pei

Gamification Results in Training and Development Processes
   Siméia de Azevedo Santos, Leonardo Nelmi Trevisan1, Elza Fatima Rosa Veloso, Arnoldo de Hoyos Guevara

Research on the Influence Mechanism of Transformational Leadership on Enterprise Innovation Performance
   Na Risu, Cui Hainan, Zhang Di

Impact of Emotions on Conflict Management Styles
   Qamaruddin Maitlo, Farhan Aslam, Khaliq Ur Rehman

Review of Narcissistic Leadership Research
   Wan Wei, Li Mingze, Yang Mengxi

Creativity in the Design Process: SNA of Fit Perceptions and Satisfaction among Tertiary Students in Ghana
   Fortune Ama Amegah, Patience Pokuaa Gambrnah, Isaac Kuma Yeboah

An Analysis and Solution Research of the Voluntary Unemployment of College Graduates from the Perspective of Employability
   Han Fang

Research on the Influence of Salesperson’s Characteristics on Customer Trust
   Sun Wei, Pan Jieyun, Zhang Jiajia

Research Prospect of Children's Education Network Platform from the Perspective of Organizational Behavior
Chang Yuming………………………………………………………………………836
Research on the Influence of College Students’ Entrepreneurial Team Heterogeneity on Innovation Performance: Taking Team Cohesion as Moderator Variable
Zhou Yu, Hu Yan……………………………………………………………………843
An Analysis on the Management Mode of Universities’ Target Responsibility System
Ding Huifang…………………………………………………………………………851
The Influence of Teacher Support on the Positive Behavior of College Students
Duan Zhaolin…………………………………………………………………………859
The Influence of Differential Leadership on the Innovation Behavior of Platform-based Enterprises Employees
Yang Kun, Gui Ping, Xie Tong…………………………………………………………866
Personality Traits of Risk-learning Serial Entrepreneur
Cao Qian…………………………………………………………………………………875
Research on the Effect of Human Capital on the Producer Service Industry
ZouWei, Liu Changjian………………………………………………………………887
Research on Ecological Niche Optimization of College Students’ Ideological and Political Education
Wang Wenhui1, Sun Xu………………………………………………………………895
Institutional Transformation of Public Institutions to Enterprises
Xian Lei, Wu Xiaoyan………………………………………………………………903
Influencing Mechanisms of Responsible Leadership towards Employees’ Voluntary Green Behavior: A Multi-theory Perspective
Ma Ying, Naveed Ahmad Faraz, Cheng Yanxia, Hammad Mushtaq, Ali Raza…910
Research on the Relationship between Work Stress, Psychological Capital and Turnover Intention of Frontline Service Personnel
Xiao Shuzhen, Qin Yuanjian…………………………………………………………917
Research about Precision Incubation Model of Innovation and Entrepreneurship Based on the Incubation Network
Wen Ge, Xia Yongmei, Huang Yangbo, Han Yu……………………………………926
Curve Impact of Knowledge Heterogeneity on Team Creativity: The Moderating
Effect of Internal Social Capital
Dai Wanliang, Lu Wenling, Su Lin ................................................................. 935

Impact of Employee’s Resilience on Organizational Resilience: Mediating Role of Compassion
Khaliq Ur Rehman, Farhan Aslam, Qamar Uddin Maitlo ........................................ 945

Study on Employee Reward System Satisfaction and the Impact on Their Sustainable Behavior: A Case of High Learning Institution Employees in Tanzania
Jacob Julius Rombo, Luo Fan, Monhesea Obrey Patrick Bah ................................. 953

Homesickness and Proactive behavior: Collectivist Human Resource Management Practices as a Cross-Level Moderato
Zheng Weili ........................................................................................................ 962

Research on Relationship Marketing Framework and Implementation Path of Railway Freight Oriented by Customer Value
Xu Fengwei, Zhang Zhenfang ............................................................................. 971

A Study on Enterprise Life Cycle, Executive Compensation and Earnings Management
Du Wanxin ........................................................................................................... 979

Organization and Human Resource Transformation Based on Three-Pillar Theory
Du Ya ................................................................................................................... 988

Research on the Cultivation Status and Measures of Innovative Talents of Marketing Major
Ma Ying, Chen Long ............................................................................................ 996

Part 7
Systems Engineering, Financial Engineering, Design Engineering and Industrial Engineering

Evolutionary Game Analysis on Credit Behavior of Three Parties in Logistics Finance
Xu Fengwei, Zhang Zhenfang, Yu Bowen ............................................................ 1006

An Integrated BWM and MOORA Method for Engineering Quality Evaluation in Project Management
Gang Jun, Tu Yan, Wei Ying ................................................................................. 1013
The Impact of China's Monetary Policy on Bank Risk-Taking
Feng Rui, Xie Xiaoping, Chen Yuchun1103

Research and Design of University Student Honor System Based on Information System
Lv Zuheng, Wang Jinsong, Dou Zihan ...................................................... 1032

Assessing Land Use and Cover Change Effects on Vegetation in Ghana from 2002 to 2018: a Case Study of New Juaben Municipality
Isaac Kuma Yeboah, Emmanuel Yeboah, Emmanuel Kojo Gyamfi, Henrietta Suapim ...................................................... 1039

Research on Governance Effect of Equity Structure: The Perspective of Mixed Ownership Reform in State-owned Enterprises
Deng de Yu, Hong Hong, Xiang Shouren ...................................................... 1047

A Study on Earnings Management, Analyst Forecasts and Equity Liquidity
Fu Keke .................................................................................................. 1059

Does Cost Stickiness Affect a Company's Financial Risk
Li Yiwen .................................................................................................. 1067

The Feasibility Analysis of Popularizing Prefabricated Buildings in the Project of College Student Dormitory
Zheng Feng ............................................................................................. 1075

Optimization Design of Wuhan Riverside Landscape Regulatory Plan
Peng Yuha .................................................................................................. 1084

The Analysis of Effectiveness of Cost Control Strategy on the Profitability of Coca-Cola Company from 2015 to 2017
Xiao Zhiqi, Zhang Jingxian ....................................................................... 1091

Part 8

Intellectual Property, Knowledge Management, Industry-University-Research Cooperation and Strategic Alliance

Competency Management, Knowledge Management and Corporative Education: A Study on Brazilian Companies
Fernando José Lopes, Vivian Gava Malta de Abreu, Roberto Shizuo Kumasaka, Alessandro Marco Rosini, Arnoldo José de Hoyos Guevara ......................... 1099
Research on Development Tendency of Chinese Automobile Industry from the Perspective of International Industrial Chain

Gu Zhiqiang, Wang Chaoyang ................................................................. 1108

A Research on The Innovation Performance of Agricultural Science and Technology Achievements Transformation in Sichuan

Tang Ling, Wan Guochao ................................................................. 1126

Six-Element Mode of International Science and Technology Cooperation in China

Mei Yanlan, Xie Kefan ................................................................. 1138

Research on the Development of Compound Fertilizer Industry Based on Patent Analysis

Liu Li ................................................................. 1145

Research on the Improvement of Mental Health Education Ability of College Counselors Based on Knowledge Management Process

Zhu Xi ................................................................. 1154

Survey on Research-University-Industry-Based MTI Education and Suggestions on Its Sustainable Development

Yu Yanling, Ao Xinyue, Wang Danni, Zhao Jian ................................................................. 1166

Optimization of transformation path based on conversion rate analysis of scientific and technological achievements

Ma Yinbo, Lu Jing ................................................................. 1173


Wang Jue, Chen Long ................................................................. 1186

A Case Study of Chinese Students’ Attitudes towards Flipped Classrooms

Tang Xiaofei ................................................................. 1195

The Impact of CBI on Non-English Majors’ Critical Thinking Skills

Wan Zi ................................................................. 1206

Research on the Influence of Five-chain Coordination on Regional Innovation Capability

Teng Liangwen, Zhou Jiang, Chang Yuming ................................................................. 1214

Research on Evaluation System of Biological and New Medicine Technology
Achievements from the Perspective of Technology Transfer
Yan Jingdong, Li Fangting, Feng Cao..........................1224
Analysis on the Management Mode of University Library Makerspace
Xu Fang, Su Hua, Liu Qin ........................................1235
Characteristics of R&D Teams and Innovation Performance under Different Innovation Strategies: The Mediating Effects of Organizational Climate in Joint Ventures
Li Shunjun, Peng Huatao .............................................1243
Innovative Construction of Blended Teaching Patterns of College English Online Open Courses in the New Age
Feng Yali, Han Yue ..................................................1258
The Practice and Innovation of Task-Base Language Teaching
Lu Xiaoli, Ke Jianhua ................................................1265

Part 9
Investment, Corporate Finance and Corporate Governance

Financial Literacy and SMEs Performances; Mediating Role of Risk Attitude
Kulathunga KMMCB, Ye Jianmu, Weerathunga P.R ..................1273
Information Disclosure, Executive Compensation Incentive and Analysts’ Earnings Forecast Errors
Chen Yu, Zhang Youtang ..............................................1284
Media attention to the Impact of Earnings Management on Listed Companies
Ji Yayuan ..............................................................1301
Replacing China’s Business Tax with Value-Added Tax Reform and Cost Stickiness: Evidence from the Service Industry Firms
Hui Lili, Xie Huobao, Liu Xiaoning ................................1310
Evaluation and Analysis of Enterprise Investment Activities Based on Financial Quality Perspective: Taking Haier as an Example
Xu Shiying, Li Xinjie, Luo Xuan .................................1328
Comprehensive Financial Evaluation of Listed Biomedical Companies Based on
Factor Analysis and Cluster Analysis

Huang Ziyu........................................................................................................1340

Empirical Research on Corporate Social Responsibility and TaxRadical: Independent Directors as Adjustment Variables

Li Zhouliang, Yu Shuang, Zhou Guoqiang.........................................................1349

Research on Information Disclosure Behavior of Listed Companies: Taking *ST Olefin Carbon as An Example

Zhu Hanlin, Wan Youqing................................................................................1357

A Study on Foreign Direct investment and Economic Growth in China: The Role of Human Capital Development

Zhang Yuling, Wu Zihao, Brima Sesay.................................................................1372

Empirical Research on Financial Capability of Listed Companies in Northwest Five Provinces in China Under the Background of “One Belt and One Road” Strategy

Song Tianqi, Liang Shanshan..............................................................................1379

A Study on the Influencing Factors of Financial Leverage: Taking Real Estate Industry as a Sample

Shen Jialu.............................................................................................................1391

A Study on The Impact of Accounting Conservatism on Corporate Debt Financing Cost from the Perspective of Environmental Uncertainty

Li Jiaying, Hong Hong.........................................................................................1400

A Study on Carbon Accounting Information Disclosure of Listed Companies in China's Steel Industry

Ma Huizhi, Tang Miao........................................................................................1411

A Study on the Influence of Interest Rate Liberalization on Enterprise Investment Efficiency: Based on the Nature of Property

Dong Xueqin, Zhang Youtang............................................................................1422

A Research on the Contributing Factors of Cash Dividend Policy in Chinese Listed Companies

Huang Ziying.......................................................................................................1432

Media Coverage, Political Connections and Corporate Risk

Zhou Yi, Zhang Youtang......................................................................................1444

A Study on Public Demand and Optimization Strategies for University Libraries Based on Big Data from Search Index

Liu Nan...............................................................................................................1461
Part 10

Miscellaneous

Study on the Public Service Satisfaction Perception Structure and Its Differentials: Based on the Research Data from Tourism City of Guilin ASC, China
  
  Zhang Rui, Wu Zhongjun, Yu Bo, Ning Yongli ........................................ 1506

Evaluation Theory of the Core Competence of Art Design Industry Based on “Four-Three Structure” Model
  
  Wang Jun, Zhao Yiran, Yang Zhixuan .................................................. 1520

Thematic Selection and Distribution in Management Academic English Writing
  
  Xiao Xianming ................................................................. 1527

Evaluation of Wushu Tourism Synergic Development Based on Fuzzy Hierarchy Analysis
  
  Yang Wei, Yi Peng .......................................................... 1536

A Research on Innovative Teaching Practice: A Net-based Case Study of Culture and Translation Course
  
  Yang Jing, Wang Aijun*, Li Lahua .................................................. 1545

College Students’ Social Entrepreneurship: Status Quo, Determining Factors and Training Channels
  
  Xiang Yongkun ................................................................. 1553

Study on Ideal and Faith Education Effectiveness of University Student Backbone Team Based on
Attitude Theory
Wang Xiao .......................................................... 1563
James Joyce’s Araby in Interarts Perspective of Chinese Classical Art Theories
Hu Min .............................................................. 1571
Original Family: An Analysis of the Key Factors Influencing the Ideological and Moral Education of Adolescents
Cheng Gaojie ......................................................... 1578
China Standards "Going Out" Strategy to Improve the International Discourse Power of Chinese Enterprises: Take Infrastructure Construction as An Example
Mao Shishi, Chen Shu .............................................. 1586
Analysis on the Mode of Medical Care and Pension Support in Rural Areas Based on “Healthy China”
Wu Qian, Qiu Yinggui ............................................. 1594
Impulse Response Analysis of Collaborative Performance to Synergy Degree in Comprehensive Design
Fang Jun, Wu Dingyuan, Zai Yue .................................. 1601
Learning English and Learning about English: Some Thinking on Non-English Major Graduate English Teaching
Wu Lan ................................................................. 1618
Research on Service Level Improvement Strategy of Basic Nursing Management in College Hospitals based on PDCA Cycle
Yu Wen ............................................................... 1627
Study on the College French Teachers’ TPACK Level and the Influence Factors under the Background of "Internet + Education": Taking Wuhan Universities as the Example
Bai Yanyuan .......................................................... 1633
A Case Study on the Exhibit Ability of Popular Music in Museums
Lv Qingtian .......................................................... 1642
Analysis on the Reports of French Media on People-to-People Exchanges between China and France
Zhang Rui ............................................................ 1648
Research on User's Requirement of Game Handle Products Based on KANO Model
Li Qiong, XuWei .................................................... 1656
Research on the Advantages of University Online Courses Based on “Super Star Learning platform”
Zhan Wei. Investigation and Research on Community Property Management: Take a Certain District in Wuhan as an Example
Wei Minghua. Research on the Entrepreneurship Intentions for Undergraduates in the background of “Mass Entrepreneurship and Innovation”
Liu Jia, Li Kai. Inheritance and Innovation, Adjustment and Accumulation: On the Modernization Thinking of Chinese Traditional Culture from the Development of the Cultural and Creative Industry of the Forbidden City
Zhu Meifan, Ai Wenjing. Exploration of the Constructing Mode of Talents in Colleges and Universities Based on Information Technology
Yin Yang. Effectiveness of Social Work Intervention in Classroom Management of Moral Education
Zhang Xiaoxiao. Research on the Cultivation of Chinese College Students’ Global Competence from the Perspective of Internationalization
Lu Yan. Study on the Double-helix Coupling Interactive Mode and Realization Path of University Culture, Ideological and Political Education
Ma Jiaming, Li Qian, Zhang Sijie, Liu Xu. The Differences of Chinese Vocabulary between Mainland China and Taiwan: A Case Study of Picture Book Title Translation
Jiang Fan. A Study on the Path and Method of the Improvement of University Counselor’s Professional Ability
Yu Qinfang, Wang Meixia. The Predicament of the Current Home-based Elderly Care Service in China and the Countermeasures for the Rule of Law
Xu Zhihua, Zhao Jing. The Discussion on the Curriculum Management of Undergraduate Voluntary Service in University
Chen Yinghua…………………………………………………………………1762

The Research on the Delicacy Management of College Student Affairs
Xiao Jianbo, Ma Ke, Cai Wenzeng………………………………………………………1772

Inheritance and Development of Craftsman Spirit from the Perspective of Cultural Confidence
Han Lu, Chen Mengyun, Han Mingdan…………………………………………………1781

A Study of Pragmatic Vagueness in Chinese Officialdom Discourse
Wu Qian……………………………………………………………………………………1792

Study on the Influencing Factors and Mechanism of Residents Satisfaction in the Public Space of Urban Community Based on the Grounded Theory Analysis
Tan Liman, Zhou Ling……………………………………………………………………1798

On the Innovative Application of Micro-Media in Ideological and Political Education in Colleges and Universities in the New Era
Lin Kai……………………………………………………………………………………1809

Research on the Status Quo and Influencing Factors of Art Education in Science and Engineering Universities in China
Li Fang……………………………………………………………………………………1815

How to Develop Cultural Resources to Promote Sustainable Development of Cultural Industry a Case Study of Yellow Crane Tower, Wuhan Cultural Resources
Qiao Juying………………………………………………………………………………1823

Research on the Curriculum System of International Cooperation Training of Excellent Art and Design Talents
Dai Fuxiang, Dai Bo………………………………………………………………………1831

Research on Process Management of University Students with Learning Difficulties: From a Survey of Management Status
Wang Xiao…………………………………………………………………………………1836
House of Quality-Based Analysis of Green Supply Chain Management for the Sustainable Investment Decisions with Interval Type 2 Fuzzy Hybrid Model

Luis Martínez¹, Hasan Dinçer², Serhat Yüksel³
1 Universidad de Jaén, Spain,
2 Istanbul Medipol University, Turkey,
(E-mail: martin@ujaen.es, hdincer@medipol.edu.tr, serhatyuksel@medipol.edu.tr)

Abstract: The aim of the study is to propose a set of criteria for the customer needs and technical requirements of green supply chain management in the sustainable investment decisions. For that, house of quality has a unique role to evaluate the customer and technical factors at the same time. Accordingly, house of quality-based analysis of green supply chain management for the sustainable investment decisions is applied for measuring the performance of technical requirements with respect to customer expectations. A hybrid decision making method is applied for ranking the technical factors of green supply chain management for the sustainable investment decisions. Interval type 2 fuzzy DEMATEL is used for weighting the criteria of customer expectations and then interval type 2 fuzzy TOPSIS is employed for ranking the factors of technical requirements for the green supply chain management. The findings show that reuse of product and services is the most significant criterion. It shows that companies should firstly focus on this issue to gain an opportunity to reduce costs. Another important conclusion is that waste management is the most important technical requirement for the green supply chain management. Therefore, it is recommended that companies should make technological investments in waste management. In this context, they should provide necessary comprehensive machines, materials and equipment in the context of innovative strategy, employ qualified personnel capable of using this equipment and give necessary training to the existing personnel.

Key words: Green supply chain management; House of quality; Investment; Interval type 2 fuzzy sets; DEMATEL; TOPSIS

1 Introduction

With globalization, there has been a significant increase in world trade. The main reason for this is the abolition of trade borders between countries. This increasing trade around the world has been effective in increasing both production and consumption. As a result, there has been a significant increase in the competition in the market. High competition has led companies to develop new strategies. Otherwise, they will not be able to continue their activities in this harsh competitive environment. Within this framework, companies have tried to produce innovative strategies in order to gain competitive advantage (Gabrielsson et al., 2016).

Logistics sector is one of the most important sectors affected by globalization. This increased trade has made the logistics sector more important worldwide. In order to maintain international trade in a healthy way, the products must be delivered to the other party completely. In this context, the concept of supply chain is the general name given to the movement of the product, service or money flow from the supplier to the customer and the activities within this process. This concept has emerged especially in order to meet the many needs arising from increasing international trade. In this period, a good logistics strategy was needed to adapt to the change in the production market and to manage more complex logistics networks (Ceniga and Sukalova, 2015).

The most important problem in the logistics sector is considered as carbon dioxide emission due to excessive energy consumption. This has become a serious problem for the ecological environment. However, sensitivity to environmental issues is increasing throughout the world. As a result, it has become necessary for logistics companies to take action against this problem (Paksyoy et al., 2019). In this context, logistics companies have taken serious steps to find innovative solutions. For this purpose, the most prominent solution is the green supply chain implementation. It is a kind of supply chain management in which environmentally friendly product or service production strategies are combined (Zhu et al., 2017). It mainly aims to reduce environmental negative impacts of companies. In addition, it also increases efficiency and provides a major competitive advantage in innovation and processes. Green purchasing, green production and material management, green distribution and marketing and
reverse logistics are accepted main implementations of this issue (Shibin et al., 2016; Tachizawa et al., 2015).

In this study, it is aimed to evaluate the green supply chain management for the sustainable investment decisions. For this purpose, a set of criteria for the customer needs and technical requirements of green supply chain management is proposed. In the analysis process, interval type 2 fuzzy DEMATEL is used to weight the criteria of customer expectations. On the other side, technical requirement factors for the green supply chain management are ranked by using interval type 2 fuzzy TOPSIS approach. According to the analysis results, strategies can be developed to obtain the sustainable investment policies by selecting the criteria of green supply chain management.

This study includes many different novelities. Firstly, house of quality approach is implemented to evaluate the customer and technical factors at the same time. This situation provides us to understand the most significant technical requirement based on these expectations. In addition to this situation, interval type-2 fuzzy logic is firstly considered in this study to make analysis for logistic industry. Hence, this issue has an important contribution to the originality of this study. Finally, a weighted set of criteria is provided to understand the customer expectations regarding green supply chain management subject.

This study has mainly 5 different sections. In this section, general information related to the issues of logistic, supply chain management and green supply chain management are provided. In the second section, the studies regarding green supply chain management and investment decisions are analyzed. The third section includes the explanations about the methods used in this study. Furthermore, analysis results are shared in the fourth section. In the last section, necessary recommendations are discussed.

2 Literature Review

The green supply chain management subject was discussed in the literature very much. It is obvious that most of these studies are related to the performance analysis of this issue. Chin et al. focused on the green supply chain management performance in Malaysia (Chin et al., 2015). They concluded that companies should consider environmental factors to provide sustainability in supply chain management activities. Also this issue was identified in (Cousins et al., 2019). Vanalle et al. evaluated the performance of supply chain activities for Brazilian automotive industry (Vanalle et al., 2017). The similar result was also underlined according to the analysis results. Parallel to them, other studies emphasized the importance of this factor (Geng et al., 2017; Li et al., 2016; Govindan et al. 2015).

Additionally, it is seen that different methodologies were taken into consideration in these studies. (Dubey et al., 2015; Tachizawa et al., 2015; Kirchoff et al., 2016) conducted a survey analysis to measure the performance of the green supply chain in many different regions. In this process, they asked different questions to many people. According to their answers, they aimed to identify the important points. On the other side, (Uygun and Dede, 2016; Kusi-Sarpong et al., 2016) considered fuzzy multi-criteria decision making techniques to reach this objective. In the analysis process, firstly, they defined many different indicators. With the help of these methodologies, they tried to find the significances of these indicators.

Some studies defined that an important factor of green supply management is customer satisfaction. For instance, in (Laari et al., 2016) was stated that companies should consider customer expectations in green supply chain operations. Similarly, (Chavez et al., 2016; Teixeira et al., 2016; Zhu et al. 2017) conducted an analysis to improve the performance of the green supply chain activities. They reached the conclusion that customers should be satisfied for the success of the green supply chain management. Furthermore, (Zhu et al., 2017; Schmidt et al., 2017; Seles et al., 2016; Luthra et al., 2015) aimed to analyze this situation and identified that companies should understand and satisfy customer expectations to have higher performance in green supply chain management.

Moreover, risk assessment of the green supply chain management was made by many different researchers. They mainly aimed to identify the significant risk of the companies in this process. After that, they tried to identify which of these risks are more important for the companies. In the final stage, necessary actions were defined to manage these risks. For instance, (Mangla et al., 2015) determined 25 common risks of the green supply chain management by reviewing the similar studies in the literature for Indian companies. These risks are weighted by using fuzzy AHP approach. Also in (Paksoy et al., 2019) was made this analysis by using the same methodology. In addition, (Wang et al., 2016; Shibin et al., 2016; Tachizawa et al., 2015) are other studies which performed similar analysis.
On the other hand, investment decisions on green supply chain management were considered in many different studies. As an example, (Bai et al., 2016) conducted a study to manage investment in green supply management. In the analysis process, fuzzy clustering approach is considered. In (Yan et al., 2018) was also made similar analysis while implementing prisoner's dilemma on competing retailers' investment in green supply chain management. Additionally, (Sun et al., 2019) made a similar analysis and concluded that government subsidy mechanism plays a very significant role to make investment in green supply chain management, (Wu et al., 2019; Yang et al., 2019; Rostamzadeh et al.,2015) also focused on similar issues in their studies. As a result of the literature review, it is determined that a new study can be conducted to evaluate investment issues in green supply management with a new methodology, such as interval type-2 fuzzy logic.

3 Methodology

In this section, different methods used in this study are explained. In this framework, firstly, interval type-2 fuzzy sets are explained. After that, necessary information is given about interval type-2 fuzzy DEMATEL and interval type-2 fuzzy TOPSIS.

3.1 IT2 fuzzy sets

\( \bar{A} \) refers to the type-2 fuzzy set. On the other side, the membership function is given as \( \mu_{\bar{A}(x,u)} \). It can get a value between 0 and 1. The details of these items are given on the equation (1) (Xu et al., 2019; Liu et al., 2019; Dincer et al., 2019a).

\[
\bar{A} = \{((x,u)\mu_{\bar{A}(x,u)}) \mid x \in X, u \in J_x \subseteq [0,1] \} \text{ or } \bar{A} = \int_{x \in X} \int_{u \in J_x} \mu_{\bar{A}(x,u)}(x,u) \text{ } I_x \subseteq [0,1]
\]  

(1)

Moreover, this membership function can be replaced with \( \Sigma \) regarding the discrete universe. Equation (2) gives information about this process.

\[
\bar{A} = \int_{x \in X} \int_{u \in J_x} 1/(x,u) \text{ } I_x \subseteq [0,1]
\]  

(2)

\( \bar{A}^u_i \) and \( \bar{A}^l_i \) explain the upper and lower trapezoidal membership functions detailed in the equation (3).

\[
\bar{A}_i = (\bar{A}^u_i, \bar{A}^l_i) = (a^u_{i1}, a^u_{i2}, a^u_{i3}, a^u_{i4}, a^l_{i1}, a^l_{i2}, a^l_{i3}, a^l_{i4}) (H_1(\bar{A}^u_i), H_2(\bar{A}^l_i))
\]  

(3)

On the other side, the equations (4)-(8) give all details about the calculation process.

\[
\bar{A}_1 \oplus \bar{A}_2 = (\bar{A}^u_1 \bar{A}^l_1) \oplus (\bar{A}^u_2 \bar{A}^l_2)
\]  

(4)

\[
\bar{A}_1 \ominus \bar{A}_2 = (\bar{A}^u_2 \bar{A}^l_2) \ominus (\bar{A}^u_1 \bar{A}^l_1)
\]  

(5)

\[
k\bar{A}_1 = (k \times a^u_{i1}) k \times a^l_{i1} k \times a^u_{i2} k \times a^l_{i2} k \times a^u_{i3} k \times a^l_{i3} k \times a^u_{i4} k \times a^l_{i4}
\]  

(6)

\[
\frac{\bar{A}_1}{k} = \frac{1}{k} \times a^u_{i1} \frac{1}{k} \times a^l_{i1} \frac{1}{k} \times a^u_{i2} \frac{1}{k} \times a^l_{i2} \frac{1}{k} \times a^u_{i3} \frac{1}{k} \times a^l_{i3} \frac{1}{k} \times a^u_{i4} \frac{1}{k} \times a^l_{i4}
\]  

(7)

3.2 IT2 fuzzy DEMATEL

DEMATEL approach is used to identify the importance of different criteria under the complex environment. In addition to this issue, the main advantage of DEMATEL approach is that it can be used to identify the impact relationship map among the criteria. Hence, it can be possible to understand the influencing and influenced criteria. This methodology can be considered with interval type-2 fuzzy logic. In the first step of the analysis process, expert opinions are converted to the interval type-2 fuzzy logic (Dincer & Yüksel, 2019; Pandey et al., 2019; Dincer et al., 2019b; C. Tang & Dincer, 2019). Initial direct relation matrix is generated in the second step as in the equation (9) and (10).
demonstrates = help

\[ Z = \begin{bmatrix} 0 & \tilde{z}_{12} & \cdots & \cdots & \tilde{z}_{1n} \\ \tilde{z}_{21} & 0 & \cdots & \cdots & \tilde{z}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \vdots \\ \vdots & \vdots & \cdots & \ddots & \vdots \\ \tilde{z}_{n1} & \tilde{z}_{n2} & \cdots & \cdots & 0 \end{bmatrix} \] (9)

\[ \overline{Z} = \frac{Z^1 + Z^2 + Z^n}{n} \] (10)

Thirdly, this matrix is normalized with the help of the equations (11), (12) and (13).

\[ x_{ij} = \frac{z_{ij}}{r} = \left(\frac{z_{ij}}{r}, \frac{z_{ij}}{r}, \frac{z_{ij}}{r}; H_1 \left(\frac{x_{ij}}{r}\right), H_2 \left(\frac{x_{ij}}{r}\right)\right) \] (12)

\[ r = \max \left(\sum_{j=1}^{n} z_{ij}; \sum_{i=1}^{n} z_{ij}\right) \] (13)

After that, in the next step, the total influence fuzzy matrix (\( \overline{T} \)) is created by using the equations (14-18).

\[ X_{\alpha} = \begin{bmatrix} 0 & a'_{12} & \cdots & \cdots & a'_{1n} \\ a'_{21} & 0 & \cdots & \cdots & a'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \vdots \\ \vdots & \vdots & \cdots & \ddots & \vdots \\ a'_{n1} & a'_{n2} & \cdots & \cdots & 0 \end{bmatrix}, \ \ \ \ X_{h} = \begin{bmatrix} 0 & h'_{12} & \cdots & \cdots & h'_{1n} \\ h'_{21} & 0 & \cdots & \cdots & h'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \vdots \\ \vdots & \vdots & \cdots & \ddots & \vdots \\ h'_{n1} & h'_{n2} & \cdots & \cdots & 0 \end{bmatrix} \] (14)

\[ \overline{T} = \lim_{k \to \infty} \overline{X} + \overline{X}^2 + ... + \overline{X}^k \] (15)

\[ \tilde{t}_{ij} = \alpha_{ij} \beta_{ij} \epsilon_{ij} \delta_{ij} \left( x_{ij} \right) ; H_1 \left( x_{ij} \right), H_2 \left( x_{ij} \right) \] (17)

\[ a_{ij} = X_{\alpha} \times \left( I - X_{\alpha} \right) ^{-1}, \ \ \ \ \ \ h_{ij} = X_{h} \times \left( I - X_{h} \right) ^{-1} \] (18)

Finally, the influence degrees are calculated as in the equations (19) and (20).

\[ D_i = \sum_{j=1}^{n} t_{ij} \] (19)

\[ \overline{R}_i = \sum_{i=1}^{n} \tilde{t}_{ij} \] (20)

The sum of all vector rows is represented by \( D_i \) whereas the sum of all vector columns is named as \( \overline{R}_i \). Hence, \( \left( \overline{D}_i + \overline{R}_i \right) \) demonstrates the total degree of the influence among criteria. Also, the defuzzification process is performed to calculate the weighting results of criteria as in the equations (21-24).

\[ Def_T = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} t_{ij} - \sum_{i=1}^{n} \sum_{j=1}^{n} t_{ij} + \sum_{i=1}^{n} \sum_{j=1}^{n} t_{ij} + \sum_{i=1}^{n} \sum_{j=1}^{n} t_{ij}}{4} \] (21)

\[ Def_T = T = \left[ t_{ij} \right]_{n \times n}, \ \ \ i,j = 1,2,..,n \] (22)
\[ \bar{D}_i^{def} = r = \left[ \sum_{j=1}^{m} t_{ij} \right]_{n \times 1} = (r_1, \ldots, r_n) \]
\[ \bar{R}_i^{def} = y = \left[ \sum_{j=1}^{m} t_{ij} \right]_{1 \times n} = (y_1, \ldots, y_n) \]

### 3.3 Interval type 2 fuzzy TOPSIS

TOPSIS approach is a type of multicriteria decision making models. The main aim of this methodology is to rank different alternatives (Opricovic and Tzeng, 2004). In this process, positive \((A^+)\) and negative \((A^-)\) ideal solutions are identified. They are demonstrated on the equation (25). In this equation, the term \(v_i\) gives information about the weighted values (Yüksel et al., 2019).

\[ A^+ = max(v_1, v_2, \ldots, v_n) \]  

In addition to this process, the values of \(D^+\) and \(D^-\) are computed as in the equations (26) and (27) (Chen et al., 2019).

\[ D_i^+ = \sum_{i=1}^{m} (v_i - A_i^+)^2 \]  
\[ D_i^- = \sum_{i=1}^{m} (v_i - A_i^-)^2 \]

Moreover, the closeness coefficient \((CC_i)\) is calculated in the final step. The details are shown in the equation (28) (Efe, 2019).

\[ CC_i = \frac{D_i^-}{D_i^- + D_i^+} \]

### 4 Analysis

In this study, it is aimed to analyze the house of quality-based factors of green supply chain management for the sustainable investment decisions. For this purpose, a hybrid model based on interval type 2 fuzzy sets is proposed. The steps of the analysis are detailed as follows.

Step 1. Define the problem of customer and technical factors of green supply chain management. For that, a set of criteria is defined with the supported literature as seen in Table 1 and Table 2 respectively.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing the pollution (Criterion 1)</td>
<td>(Franzoni, 2011; Khoshnava et al., 2018; Sun et al., 2017)</td>
</tr>
<tr>
<td>Clean energy sources (Criterion 2)</td>
<td>(Bhattacharya et al., 2015; Tao et al., 2016; Kucukvar et al., 2016)</td>
</tr>
<tr>
<td>Reuse of product and services (Criterion 3)</td>
<td>(Kriwet et al., 1995; Ferrer, 1997; Krikke et al., 1999)</td>
</tr>
<tr>
<td>Varieties of distribution channels (Criterion 4)</td>
<td>(Onat et al., 2015; Doll et al. 2017)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste management (Criterion 1)</td>
<td>(Deif, 2011; Islam et al., 2017)</td>
</tr>
<tr>
<td>Energy efficiency (Criterion 2)</td>
<td>(Klassen and Whybark, 1999; Vachon, 2007; Baines et al., 2012)</td>
</tr>
<tr>
<td>Recycling process (Criterion 3)</td>
<td>(Johnson and Wang, 1995; Mishra et al., 2012; Misni and Lee, 2017)</td>
</tr>
<tr>
<td>Integrated transport systems (Criterion 4)</td>
<td>(Jensen et al., 2001; Jensen, 2008; Martinsen and Björklund, 2012)</td>
</tr>
</tbody>
</table>

Step 2. Appoint the expert team to collect the linguistic evaluation for the criteria. Three decision makers are selected from the industry. They are experienced at least ten years in the field of clean technology and supply chain. The expert valuation results for the customer and technical criteria are given by using the linguistic scales in Table 3 and 4. And the results are illustrated in Table 5 and 6.
Table 3 Evaluation Scales for the Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>IT2TrFNs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolutely Low (AL)</td>
<td>((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.1;0))</td>
</tr>
<tr>
<td>Very Low (VL)</td>
<td>((0.0075, 0.0075, 0.015, 0.05525;0.8), (0.0,0.0,0.02,0.07;1.0))</td>
</tr>
<tr>
<td>Low (L)</td>
<td>((0.0875, 0.12, 0.16, 0.1825;0.8), (0.04,0.10,0.18,0.23;1.0))</td>
</tr>
<tr>
<td>Medium Low (ML)</td>
<td>((0.2325, 0.255, 0.325, 0.3575;0.8), (0.17,0.22,0.36,0.42;1.0))</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>((0.4025, 0.4525, 0.5375, 0.5675;0.8), (0.32,0.41,0.58,0.65;1.0))</td>
</tr>
<tr>
<td>Medium High (MH)</td>
<td>((0.65, 0.6725, 0.7575, 0.79;0.8), (0.58,0.63,0.80,0.86;1.0))</td>
</tr>
<tr>
<td>High (H)</td>
<td>((0.7825, 0.815, 0.885, 0.9075;0.8), (0.72,0.78,0.92,0.97;1.0))</td>
</tr>
<tr>
<td>Very High (VH)</td>
<td>((0.9475, 0.985, 0.9925, 0.9925;0.8), (0.93,0.98,1.0,1.0;1.0))</td>
</tr>
<tr>
<td>Absolutely High (AH)</td>
<td>((1.0, 1.0, 1.0, 1.0;1.0), (1.0, 1.0, 1.0, 1.0;1.0))</td>
</tr>
</tbody>
</table>

Table 4 Evaluation Scales for the Alternatives

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>IT2TrFNs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Poor (VP)</td>
<td>((0.0,0.0,0.1;1.1), (0.0,0.0,0.05;0.9,0.9))</td>
</tr>
<tr>
<td>Poor (P)</td>
<td>((0.1,0.1,0.3;1.1), (0.05,0.1,0.1;0.2,0.9,0.9))</td>
</tr>
<tr>
<td>Medium Poor (MP)</td>
<td>((0.1,0.3,0.5;1.1), (0.2,0.3,0.4;0.9,0.9))</td>
</tr>
<tr>
<td>Fair (F)</td>
<td>((0.3,0.5,0.7;1.1), (0.4,0.5,0.6;0.9,0.9))</td>
</tr>
<tr>
<td>Good (G)</td>
<td>((0.5,0.7,0.9;1.1), (0.6,0.7,0.7;0.8,0.9,0.9))</td>
</tr>
<tr>
<td>Very Good (VG)</td>
<td>((0.7,0.9,0.9,1;1.1), (0.8,0.9,0.9,0.95;0.9,0.9))</td>
</tr>
<tr>
<td>Best (B)</td>
<td>((0.9,1,1,1;1.1), (0.95,1,1,1;0.9,0.9))</td>
</tr>
</tbody>
</table>

Table 5 Linguistic Evaluations for the Criteria of Customer Expectation

<table>
<thead>
<tr>
<th>Criteria</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DM1</td>
<td>DM2</td>
<td>DM3</td>
<td>DM1</td>
</tr>
<tr>
<td>C1</td>
<td>-</td>
<td>-</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>C2</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>C3</td>
<td>MH</td>
<td>MH</td>
<td>M</td>
<td>MH</td>
</tr>
<tr>
<td>C4</td>
<td>MH</td>
<td>MH</td>
<td>MH</td>
<td>MH</td>
</tr>
</tbody>
</table>

Table 6 Linguistic Evaluations of Technical Requirements for the Decision Matrix

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DM1</td>
<td>DM2</td>
<td>DM3</td>
<td>DM1</td>
</tr>
<tr>
<td>Reducing the pollution (Criterion 1)</td>
<td>VG</td>
<td>B</td>
<td>B</td>
<td>G</td>
</tr>
<tr>
<td>Clean energy sources (Criterion 2)</td>
<td>B</td>
<td>B</td>
<td>VG</td>
<td>G</td>
</tr>
<tr>
<td>Reuse of product and services (Criterion 3)</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Varieties of distribution channels (Criterion 4)</td>
<td>G</td>
<td>F</td>
<td>MP</td>
<td>F</td>
</tr>
</tbody>
</table>

Step 3. Weight the criteria of customer expectations. For this purpose, the computation procedures of interval type 2 fuzzy DEMATEL is applied and the results are given in Table 7.

Table 7 Defuzzied Total Relation Matrix and the Weights for the Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>r</th>
<th>y</th>
<th>r+y</th>
<th>r-y</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>3.43</td>
<td>3.59</td>
<td>3.33</td>
<td>3.03</td>
<td>13.37</td>
<td>14.83</td>
<td>28.21</td>
<td>-1.46</td>
<td>0.251</td>
</tr>
<tr>
<td>C2</td>
<td>3.36</td>
<td>3.25</td>
<td>3.14</td>
<td>2.87</td>
<td>12.61</td>
<td>14.89</td>
<td>27.50</td>
<td>-2.28</td>
<td>0.245</td>
</tr>
<tr>
<td>C3</td>
<td>3.97</td>
<td>3.99</td>
<td>3.54</td>
<td>3.38</td>
<td>14.88</td>
<td>13.78</td>
<td>28.66</td>
<td>1.10</td>
<td>0.255</td>
</tr>
<tr>
<td>C4</td>
<td>4.08</td>
<td>4.07</td>
<td>3.77</td>
<td>3.31</td>
<td>15.23</td>
<td>12.59</td>
<td>27.83</td>
<td>2.64</td>
<td>0.248</td>
</tr>
</tbody>
</table>

According to the results, Criterion 3 has the highest importance in the criteria of customer
expectations while criterion 2 is the weakest important factor among the criteria set.

Step 4. Rank the alternatives of technical requirements. The method of TOPSIS based on the interval type-2 fuzzy sets is applied for measuring the house of quality-based performance of green supply chain management for the sustainable investment decisions. The results are represented in Table 8.

<table>
<thead>
<tr>
<th>Table 8 Ranking Results for the Performance Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Waste management (Alternative 1)</td>
</tr>
<tr>
<td>Energy efficiency (Alternative 2)</td>
</tr>
<tr>
<td>Recycling process (Alternative 3)</td>
</tr>
<tr>
<td>Integrated transport systems (Alternative 4)</td>
</tr>
</tbody>
</table>

The ranking results demonstrate that waste management (alternative 1) has the best house of quality-based performance of technical requirement for the green supply chain management whereas energy efficiency (alternative 2) is ranked at last among the technical requirements.

5 Conclusion

This study aims to evaluate the green supply chain management for the sustainable investment decisions. For this purpose, the house of quality-based factors of green supply chain management for the sustainable investment decisions are determined. In this framework, 4 different criteria are defined related to the customer expectations of green supply chain management. On the other side, with respect to the technical requirements, different 4 factors are identified based on literature review. In the analysis process, the criteria of customer expectations are weighted by using interval type-2 fuzzy DEMATEL. Additionally, with the help of interval type-2 fuzzy TOPSIS method, the alternatives of technical requirements are ranked.

The results show that reuse of product and services (Criterion 3) has the highest weight. In addition, it is also determined that reducing the pollution (Criterion 1) is the second most important criterion. The issue of product reuse is the most prominent aspect in green supply chain management. The main reason for this is that thanks to re-used products, companies have the opportunity to reduce costs. This has a direct and significant impact on the profitability of these companies. In the literature, (Kriwet et. al., 1995; Ferrer, 1997; Krikkke et. al., 1999) reached the similar conclusion.

In addition to them, the ranking results indicate that waste management (alternative 1) has the best house of quality-based performance of technical requirement for the green supply chain management. On the other side, energy efficiency (alternative 2) takes the second-best place among the technical requirements. As can be seen from these results, companies should make technological investments in waste management. The waste management process involves the use of many comprehensive machines, materials and equipment. In this framework, it is important that companies provide these tools and equipment in the context of innovative strategy. However, qualified personnel capable of using this equipment should also be employed. Existing personnel are also required to receive the necessary training. This will provide the necessary technical competencies for an efficient green supply chain investment. In the future studies, a different methodology can be considered to make a comparative analysis.

References

and the Environment, 2016,25(3), 205-220
Material Criteria Based on the Three Pillars of Sustainability Using the Hybrid Multi Criteria Decision Making Method [J]. Journal of Cleaner Production, 2018, 173, 82-99


342-355


[58] Wang, Z., Mathiyazhagan, K., Xu, L., & Diabat, A.A Decision Making Trial and Evaluation Laboratory Approach to Analyze the Barriers to Green Supply Chain Management Adoption in a Food Packaging Company [J]. Journal of Cleaner Production, 2016, 117, 19-28


[60] Xu, Z., Qin, J., Liu, J., & Martinez, L. Sustainable Supplier Selection Based on AHP-Sort II in Interval Type-2 Fuzzy Environment [J]. Information Sciences, 2019,483, 273-293


