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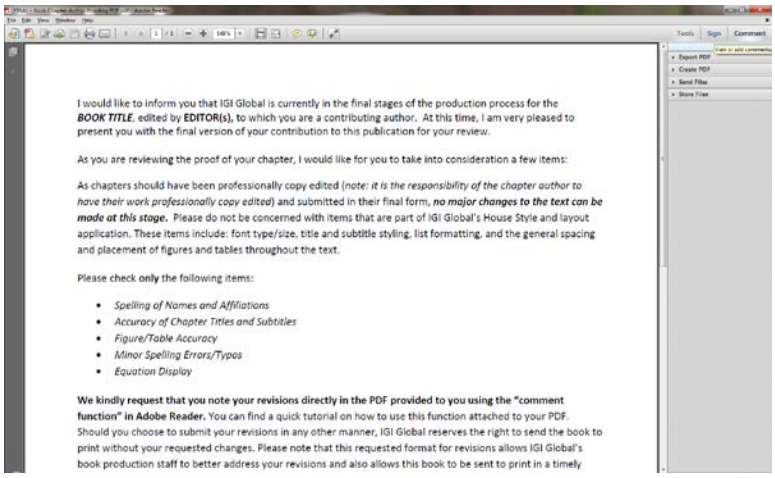

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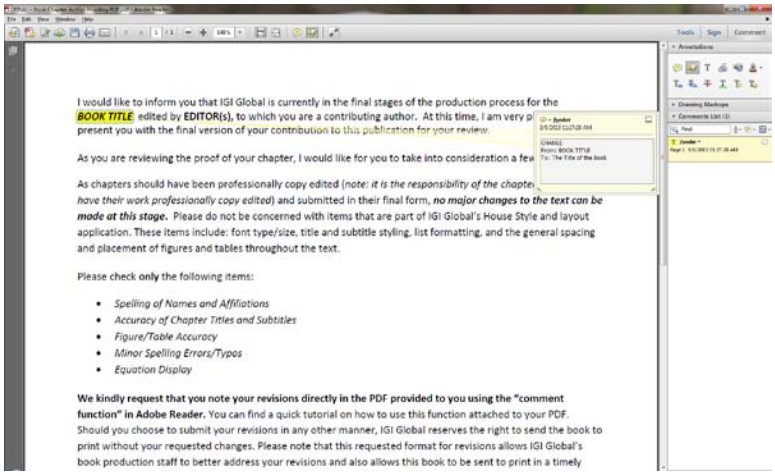

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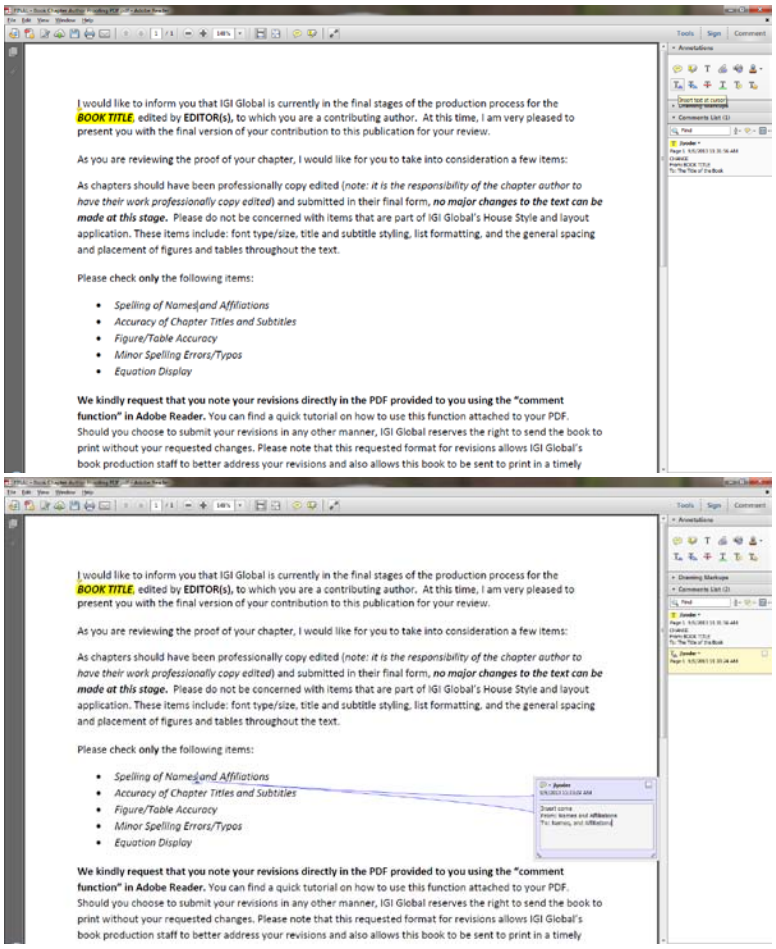

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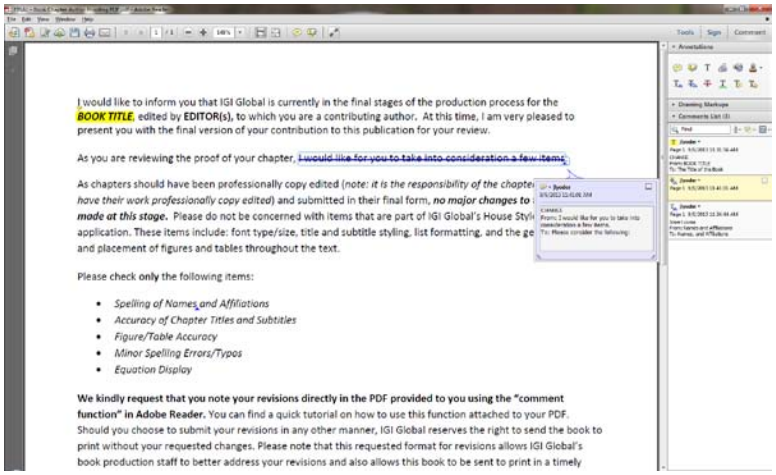

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Organizational Productivity and Performance Measurements Using Predictive Modeling and Analytics

Madjid Tavana
La Salle University, USA

Kathryn Szabat
La Salle University, Usa

Kartikeya Puranam
La Salle University, USA

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relationships. This study focuses on the components of: NPD models employed by FCT, early customer and supplier involvement, NPD-innovation integration techniques, demand change factors during the NPD process, and risk-mitigation strategies implemented by FCT during the NPD process. The study is segmented into three main sections: Introduction to NPD and FCT, the components of FCTs new product development process, and NPD implications on FCTs supplier and customer relationships.

Chapter 6

The implementations of successful Customer Relationship Management (CRM) and Supply Chain Management (SCM) systems and their associated techniques in order to optimize the analytics available in any organization are daunting task, especially in a new business venture. Upper management must to be committed to focusing these embedded systems in order to enhance supplier integration and customer satisfaction. This chapter focuses on the implementation of CRM systems and analytics as well as SCM considerations in the new startup of the Hard Rock Rocksino at Northfield Park (HRRNP) and the transformation/refinement of their systems over their few years of business. A combination of literature research, interviews of upper management, and personal observations, HRRNP has illustrate their ability to deal with these challenges in a continuous improvement and lean management approach.

Chapter 7

Human resources management is essential to any health care system. This paper proposes an assessment model to help the decision maker in the selection of an optimal team. In the proposed model, AHP method is applied to identify the weights of each criterion in the decision model. ELECTRE I method is used to obtain the best team that satisfies most of the decision maker preferences. We test the effectiveness of the model on the real data collected from the 'Habib Bourguiba' Hospital in Tunisia.

Chapter 8

The present research work shows the main steps conducted towards the exploitation of the LUMIR project, aiming at realizing a EHR framework in the Italian Region of Basilicata (also known as Lucania). It relates to a structure of network–enabled services capable of integrating the ICT solutions used by the operators of the Healthcare System of Basilicata Region. The adoption process of the LuMiR system was meant to address the issues connected to the design features as well as to the EHR diffusion and the acceptance aspects. The mathematical modeling approach introduced aimed at making possible to get to a measure "ex–ante" of both adequacy and significance of the adoption process itself. The final intent is to work out a scalable and exportable model of advanced management of clinical information, towards

a stronger cooperation among the provider organizations and a better governance of care processes, as crucial element within the more general path of modernization of the healthcare sector.

Chapter 9

Several studies have recently raised a common concern in the field of management, which is the overspending in marketing activities. In this paper, we propose and empirically test that overspending in marketing investments is an unfortunate outcome of information overload, in a sense that managers who confront too many risk informants in their decision environment tend to overinvest in marketing activities due to the overemphasis on the environmental risk. In a longitudinal experiment, where we manipulated the amount of information through marketing analytics, we demonstrate that firms employing simple marketing analytics are less prone to increase their marketing expenditures due to the fear of losing customers, and have a lower expectancy that their competitors will increase their brand-level advertising and promotional expenditures, compared to firms using a combination of simple and complex marketing analytics. Moreover, we demonstrate that firms employing simple marketing analytics keep their overall marketing spending at a lower level, and spend less in brand-level marketing, especially in promotional activities, compared to when using a combination of simple and complex marketing analytics.

Chapter 10

This chapter describes the overviews of Business Process Management (BPM) and Business Intelligence (BI); the importance of BPM in global business; and the importance of BI in global business. BPM enables organizations to align business functions with customer needs and helps executives determine how to deploy, monitor, and measure the organizational resources. When properly executed, BPM has the ability to enhance productivity, reduce costs, and minimize risk in global business. BI includes the applications, tools, and best practices that enable the analysis of information to improve organizational performance. Companies use BI to detect the significant events and identify the business trends in order to quickly adapt to their changing business environment. The chapter argues that applying BPM and BI has the potential to enhance organizational performance and reach strategic goals in global business.

Chapter 11

In this chapter, four latent variables will be analyzed to measure the impact of Information and

examining and capturing the complex hidden relationships and patterns among the quantitative variables. Regression analysis is widely used to: (a) collect massive amounts of organizational performance data such as Web server logs and sales transactions. Such data is referred to as "Big Data"; and (b) improve transformation of massive data into intelligent information (knowledge) by discovering trends and patterns in unknown hidden relationships. The intelligent information can then be used to make informed data-based predictions of future organizational outcomes such as organizational productivity and performance using predictive analytics such as regression analysis methods. The main purpose of this chapter is to present a conceptual and practical overview simple- and multiple- linear regression analyses.

Chapter 15

Performance models are well established in the literature. More specifically, student performance has been of growing concern at all levels. To confront the challenges, researchers have collected data, monitored performance criterion, developed quantitative models, and analyzed patterns to formulate theories and adaptive measures. At the university level, many students' performance deficiencies are keenly noticed and actualized for a variety of reasons. Some reasons may include transition from a home-reporting educational environment to an autonomous setting; lack of a friendly support system; or a host of behavioral circumstances which exacerbate latent academic deficits. One such technique for reviewing student performance can be employed and analyzed using absorbing Markov chains. The use of Markov Chains can provide quantitative information such the characterization potential delays (latency points) within and throughout the system, prediction of probabilistic metrics which define transitions between each stage of a defined state, and adaptability options for enrollment outcomes for use by school administrators. Furthermore, Markov chains can be employed to determine the impact on system resources such as limitations in faculty schedules, classroom assignments, and technology availability. Managers, administrators and advisors may find this information useful when notified of such limitations. This paper is of value to a broad audience such as researchers, managers, and administrators since it augments standard approaches of the Markov model. The blend of stochastic mathematics, applications of stochastic methods and retention theory, as well as the inclusion of adaptive sensitivity analysis are effective performance measures. Therefore, applications in Markov chains and subsequent forecasting models are of contemporary values in educational performance. Each of these concepts and methods contribute to a broader consideration of Markov properties in a branch of mathematics known as Markov Decision Processes (MDP). These types of processes allow researchers the ability to adjust parameters based on rewards, sets of actions, and discount factors. The cases outlined in this paper may be helpful when considering reductions in recidivism rates, improving policies to diminish recidivism, and increasing enrollment options using Markov analysis.

Chapter 16

With the extension of information technology, human resource management has experienced fundamental changes. One of the most important issues in human resource management is performance evaluation. Unlike number of studies in employee performance evaluation, there is a lack for systematic and

quantitative approaches. Issues such as incomplete information, subjective and qualitative metrics, and also the difficulty of evaluating the performance are the main problems of this field. Hence, the current study exploits the capabilities of information systems and presents an approach for quantitative and automatic evaluation of employee performance in office automation systems. The results reveal the automatic employee performance evaluation system is a discrete dimension for employee performance evaluation systems.

About the Contributors

Madjid Tavana is Professor and Distinguished Chair of Business Systems and Analytics at La Salle University, where he served as Chairman of the Management Department and Director of the Center for Technology and Management. He is Distinguished Research Fellow at Kennedy Space Center, Johnson Space Center, Naval Research Laboratory at Stennis Space Center, and Air Force Research Laboratory. He was recently honored with the prestigious Space Act Award by NASA. He holds a MBA, PMIS, and PhD in Management Information Systems and received his Post-Doctoral Diploma in Strategic Information Systems from the Wharton School at the University of Pennsylvania. He is the Editor-in-Chief of Decision Analytics, International Journal of Applied Decision Sciences, International Journal of Management and Decision Making, International Journal of Knowledge Engineering and Data Mining, International Journal of Strategic Decision Sciences, and International Journal of Enterprise Information Systems. He has published 10 books and over 170 research papers in scholarly academic journals.

***

Giner Alor-Hernandez is a full-time researcher of the Division of Research and Postgraduate Studies in Orizaba's technological institute: Tecnológico de Orizaba. He received a MSc and a PhD in Computer Science from the Center for Research and Advanced Studies of the National Polytechnic Institute (CINVESTAV), Mexico. He has led 10 Mexican research projects granted by CONACYT, DGEST, and PROMEP. He is author/coauthor of around 130 journal and conference papers on computer science. Also, he has been a committee program member of around 30 international conferences sponsored by IEEE, ACM, and Springer. He also holds the position of editorial board member of eight indexed journals; he has been guest editor of JCR-indexed journals such as Journal of Universal Computer Science, Pervasive and Mobile Computing, Journal of Educational Technology & Society, Science of Computer Programming Journal, International Journal of Software Engineering and Knowledge Engineering, Computational and Mathematical Methods in Medicine, Journal of Medical Systems, Journal of Industrial and Management Optimization. He is the main author of the book entitled Frameworks, Methodologies, and Tools for Developing Rich Internet Applications, published by IGI Global Publishing. His research interests include Web services, e-commerce, Semantic Web, Web 2.0, service-oriented and event-driven architectures, and enterprise application integration. He is an IEEE and ACM Member. He is a National Researcher recognized by the National Council of Science & Technology of Mexico (CONACYT).

Farzana Atique is a Ph.D. candidate at University of Delaware and a Highway Engineer at McCormick Taylor. She received her M.Sc. in Civil Engineering from University of Delaware (2004) and B.Sc. in Civil Engineering from Bangladesh University of Engineering and Technology (1999). Her research interest is in asset management of infrastructure, data analysis using statistical methods and copula modeling. She has published in the journal *Construction & Building Materials*.

Noor Azlinna Azizan is a Professor of Finance and Director of Entrepreneurship at Universiti Malaysia Pahang. She received her Ph.D. in Finance from University of Liverpool, England, M.Sc. in International Banking and Financial Studies from University of Southampton, England, and BBA in Finance from Western Michigan University, Kalamazoo, USA. Her specialization is in Derivatives Market, Investment Analysis, and Entrepreneurship. She also obtained a Postgraduate Diploma in Entrepreneurship from University of Cambridge, England in 2013. Her research interest includes investment analysis, derivatives market, risk management, and entrepreneurship. She has published in international and national journals including ISI and Scopus Journals.

Younes Boujelbene is a Professor at the University Sfax- Tunisia. He works currently on business, economics, Multi Criteria Decision Making, and data analysis. He is interested particularly on health insurance reform, management resources, parametric method and data envelopment analysis. He has published in journals such as Journal of Transportation Systems Engineering and Information Technology, International Journal of Productivity and Quality Management, Journal of Policy Modeling, among others.

Ryan Burke is an Assistant Professor in the Department of Military & Strategic Studies (MSS) at the United States Air Force Academy. Prior to his appointment at the Academy, Dr. Burke earned his Ph.D. from the University of Delaware where his research emphasized applying process improvement methodologies to complex military operations. Before academia, Dr. Burke was a captain and logistics officer in the U.S. Marine Corps, specializing in transportation logistics operations. Following his military career and before completing his Ph.D., he worked as a Senior Consultant and Logistics Analyst in the Pentagon performing long-range forecast analysis on military transportation and base infrastructure requirements. Dr. Burke has authored or co-authored research in a variety of fields and mediums including military and defense, disaster studies, public policy, and transportation engineering.

Miguel Ángel Canela is Visiting Professor at IESE Business School, University of Navarra. He holds a Ph.D. in mathematics from the Universitat de Barcelona and has been a professor in the Faculty of Mathematics of this university for the last thirty years, as well as a senior consultant and director of the Master in Quality Management at the Institut Català de Tecnologia. After some years devoted to research in mathematical analysis, Prof. Canela's interest was driven towards interdisciplinary research. His research experience covers a wide spectrum of applications, from statistics and mathematical modeling to diverse fields such as biochemistry, botany, nutrition and medicine. His main concern, however, is management science. He is the author of several papers on pure mathematics and has coauthored three books and a number of papers in various other fields.

Dennis Crossen is an instructor in the Business Systems and Analytics Department at La Salle University, where he teaches courses in Operations Management, Project Management, and Quantitative Models (Statistics), Mathematical Methods, Analytics, and Optimization. He also served as LaSalle's

faculty advisor for the Business Systems and Analytics (BS&A) Club. Dennis has taught and practiced in industry for over 35 years. He is the former Program Manager at the NASA Kennedy Space Center (KICS contract) and has participated within corporate, governmental, and commercial sectors having diverse levels of responsibilities. During his career, Dennis has developed complex technological solutions for numerous organizations including the United Nations, Department of Defense, Department of Health & Human Services, National Institute of Health, the Pentagon, RCA, Lockheed-Martin, Siemens, Verizon, and others. He has been a Guest on Comcast's' CN8 "Money Matters Today" and "Comcast Newsmakers" television programs speaking on technology issues. Dennis is a 2010 recipient of the Robert Noyce Teacher Scholarship from the National Science Foundation (U.S.) in Education. He holds MSc, MBA, and Electrical Engineering degrees from Drexel University. While in industry, he has completed academic programs at Oxford University (Computing) and Georgetown (International Business), as well as professional development coursework at Harvard (Information Systems), MIT (Computing), and Columbia University (Optics). He is currently completing his doctoral dissertation in Applied Management and Decision Sciences.

Amber A. Ditizio is presently a doctoral student in the Department of Kinesiology from Texas Woman's University in Sports Administration. While acquiring strong analytical and professional skills after completing MS in Sport Management, BSBA and MBA from Robert Morris University, with BS from Kent State University in athletic training and related studies, she also holds various personal certifications in the sports performance and athletic areas. She is the author of several academic articles in the sports performance and athletic fields and plans to pursue an academic teaching/research career upon graduation.

Abderrahman El Mhamedi is a Professor in the Production and Engineering Department of University Paris8-France. He is the Director of the QUARTZ-MGSI laboratory. His research interests include Multi-State Systems; Markov Graph, Interoperability, Dynamic Manufacturing Network, PLM. He has published in journals such as Journal of Decision Systems, International Journal of Revenue Management, Journal of Intelligent Manufacturing, among others.

Jorge Luis Garcia Alcaraz is a full time researcher of the Department of Industrial Engineering at the Autonomous University of Ciudad Juarez. He received a MSc in Industrial Engineering from the Colima Technology Institute (Mexico), a PhD in Industrial Engineering from Ciudad Juarez Technology Institute (Mexico) and a Postdoc from University of La Rioja (Spain). His main research areas are related to Multicriteria decision making applied to manufacturing, production process modeling and statistical inference. He is founding member of the Mexican Society of Operation Research and active member in the Mexican Academy of Industrial Engineering. Currently, Dr. Garcia is a National Researcher recognized by the National Council of Science & Technology of Mexico (CONACYT) and is working with group research from Colombia, Spain and Dominican Republic. Actually, Dr. Garcia is author/coauthor in around 120 journals, international conferences and congress.

Burçin Güçlü is Assistant Professor of Management in BES La Salle, Universitat Ramon Llull. Previously, she earned BA degrees in Business Administration and Economics from Koç University, and a Master of Research in Management (MRM) and PhD in Management from IESE Business School, University of Navarra. She also held teaching positions in EADA Business School, Toulouse Business

School and Universitat Internacional de Catalunya. Regarding her research, she is interested in quantitative methods in marketing, working on the applications of behavioral decision theory to managerial issues in marketing.

Juan L. Hernández-Arellano is full time teacher and researcher of the Design Department at the Autonomous University of Ciudad Juárez, Mexico. Dr. Hernandez´ research topics are industrial ergonomics, product design, structural equation modeling and biomechanics.

Sema Kalaian (Professor of Statistics and Research Methods) in the College of Technology at Eastern Michigan University. Professor Kalaian was a recipient of the (1) "Best Paper" award from the American Educational Research Association (AERA), and (2) "Distinguished Paper Award" from the Society for the Advancement of Information Systems (SAIS). Over the years, Dr. Kalaian taught introductory and advanced statistical courses such as Research Methods, Research Design, Multivariate Statistics, Survey Research, Multilevel Modeling, Structural Equation Modeling, Meta-Analysis, and Program Evaluation. Professor Kalaian's research interests focus on the development of new statistical methods and its applications. Much of her methodological developments and applications have focused on the (a) development of the multivariate meta-analytic techniques for combining evidence from multiple primary studies; (b) applications of the meta-analysis methods to various projects in different fields of study; and (c) developments of statistical methods for analyzing Delphi survey data.

Maryam Kalhori is a graduated student at the Department of Computer Engineering at University of Science and Culture, Tehran, Iran in M.Sc. degree in Software Engineering. She received her Bachelor in Applied Mathematics in Tehran University. Her research interest is information systems and information quality.

Mohammad Javad Kargar is an Assistant Professor at the Department of Computer Engineering at University of Science and Culture, Tehran, Iran. He received his Bachelor in Software Engineering, M.Sc. in Computer Architecture from University of Sciences and Researches, and Ph.D. in Information Technology and Multimedia System from University Putra Malaysia (UPM). He has published several articles in the science –research journals and IEEE and ACM conferences. Dr. Kargar has also been serving on the Editorial Review Board for the International Journal of Advancements in Computing Technology and International Journal of Science and Advanced Technology. His research interest is Web applications and mining, distributed systems and applications.

Kijpokin Kasemsap received his BEng degree in Mechanical Engineering from King Mongkut's University of Technology Thonburi, his MBA degree from Ramkhamhaeng University, and his DBA degree in Human Resource Management from Suan Sunandha Rajabhat University. He is a Special Lecturer at Faculty of Management Sciences, Suan Sunandha Rajabhat University based in Bangkok, Thailand. He is a Member of International Association of Engineers (IAENG), International Association of Engineers and Scientists (IAEST), International Economics Development and Research Center (IEDRC), International Association of Computer Science and Information Technology (IACSIT), International Foundation for Research and Development (IFRD), and International Innovative Scientific and Research Organization (IISRO). He also serves on the International Advisory Committee (IAC) for International

Association of Academicians and Researchers (INAAR). He has numerous original research articles in top international journals, conference proceedings, and book chapters on business management, human resource management, and knowledge management published internationally.

Nabeel R. Kasim is a Master's degree candidate at the College of Engineering in the Industrial and Operations Engineering department at the University of Michigan in USA. He holds a Bachelor's of Science degree also in Industrial and Operations Engineering from the University of Michigan in USA. His academic interests are aimed at operations research and engineering management.

Rafa M. Kasim served as a professor of statistics and research design in the College of Education at Kent State University prior to his joining the private sector as a statistician and research consultant and the faculty of Indiana Tech University. Previously he was a senior statistician at the Evaluation, Management & Training Associates Inc. (EMT). His research focused on the application of multilevel analysis to study the effects of educational and social contexts on educational outcomes and human development in large-scale longitudinal data sets. Some of Dr. Kasim work has also addressed the issues of selection and attrition bias in multi-site large studies. He has collaborated on numerous studies in fields such as adult literacy, education, and substance abuse treatments. Some of his work appears in Application of Multilevel Models (book chapter), Journal of Educational and Behavioral Statistics, Harvard Educational Review and Advances in Health Sciences Education.

Lyes Kermad is an Assistant Professor at the University of Paris 8-France. He works currently on risk management. He is interested particularly on risk management in the implementation of project, risk management in supply chain hospital and human resource management. He has published in journals such as Complex Systems Design & Management, International Journal of Behavioural and Healthcare Research and International Journal of Economics & Strategic Management of Business Process.

Ikram Khatrouch is a PhD in Industrial Engineering science and quantitative methods from the university of Paris8-France and university of sfax-Tunisia. His research interests are in human resource management, hospital logistics and risk management, Operations Research, Multi Criteria Decision Making and artificial intelligence. Ikram Khatrouch has published in journals such as European Journal of Industrial Engineering, International Journal of Behavioural and Healthcare Research, International Journal of Economics & Strategic Management of Business Process and Interdisciplinary Environmental Review.

Manoj Kumar received B.Tech in Production Engineering from Bihar Institute of Technology Sindri, India, M.Tech in Mechanical Engineering from Regional Institute of Technology Jamshedpur, India and Ph.D in Mechanical Engineering from Indian Institute of Technology Delhi, India. He is presently working as Director, Nalanda International Engineering Services, H. No.- 87A, RZI – Block, West Sagarpur, New Delhi – 110046, India. He has authored or coauthored over 55 research papers in Journals and Conferences. His research work appeared in International Journal of Physical Distribution and Logistics Management, International Journal of Production Economics, Computers & Industrial Engineering, International Journal of Integrated Supply Chain Management, and Advances in Industrial Engineering etc.

Aide A. Maldonado-Macías completed her bachelor degree, M. Sc. degree and Ph. D. studies at the Technological Institute of Ciudad Juarez Mexico. She is actually a professor investigator for the Autonomous University of Ciudad Juarez. She is a professional ergonomist and a member of the Mexican Society of Ergonomists and the Mexican Society of Lean Manufacturing. Her main research interests are applied ergonomics, work systems evaluation and design, cognitive ergonomics, work stress related studies, axiomatic design applications, structural equations and optimization of production systems. She has participated in multiple conferences and symposiums. She has published in the International Journal of Advanced Manufacturing Technology, Expert Systems with applications, International Journal of Industrial Engineering, Work: a Journal of Evaluation, prevention and rehabilitation among others. She has recognition of the National Council of Investigation.

Sue McNeil is Professor of Civil and Environmental Engineering and Professor of Urban Affairs and Public Policy at University of Delaware. A native of Australia, she earned her bachelor's degrees at the University of Newcastle in New South Wales and went on to earn master's and doctoral degrees in Civil Engineering at Carnegie-Mellon University. McNeil was formerly the Director of the Urban Transportation Center and Professor in the College of Urban Planning and Public Affairs and the Department of Civil and Materials Engineering at University of Illinois at Chicago; and Professor of Civil & Environmental Engineering and Engineering & Public Policy at Carnegie Mellon University. Her research and teaching interests focus on transportation infrastructure management with emphasis on the application of advanced technologies, economic analysis, analytical methods, and computer applications. McNeil is founding Editor-in-Chief for the ASCE Journal of Infrastructure Systems. She is a registered professional engineer.

Ezutah Udoncy Olugu is currently working as Senior Lecturer at the Faculty of Engineering, Technology and Built Environment, UCSI University, Malaysia. He obtained his B.Eng in Mechanical and Production Engineering from Nnamdi Azikiwe. University, Nigeria, M.Eng in Advanced Manufacturing Technology and PhD in Industrial and Manufacturing Engineering at the Universiti Teknologi Malaysia. He was involved in teaching, research and consultancy services at the Center for Product Development and Manufacture, University of Malaya, Malaysia. Dr. Olugu's current research interest includes Green Manufacturing, Sustainable Production, Green Supply Chain management, Reverse Logistics, Total Quality Management, Inventory management, Industrial Ergonomics and Maintenance Engineering.

Salwa Hanim Abdul Rashid is a Senior Lecturer in the Department of Mechanical Engineering, Faculty of Engineering, University of Malaya. She obtained her Doctorate Degree in Sustainable Manufacturing Management from Cranfield University, United Kingdom. She also holds both Masters and Bachelor degrees in Manufacturing Management from Loughborough and Salford University, United Kingdom, respectively. She is an active researcher interested in understanding issues in the implementation and management of the green strategies, with respect to design and manufacturing process in order for companies to achieve industrial sustainability. Her current research is focused on factors that drives, inhibits and enables manufacturing companies to implement sustainable design and manufacturing strategies. She has published more than 40 reputable academic journals, articles and conference papers.

Fabrizio L. Ricci is an Electronic Engineer. He is Research Director of the Italian National Research Council (CNR), and currently works at the Institute for System Analysis and Computer Science. He is also member of the LAVSE, Laboratory of Virtual Health Informatics of the CNR. His research activities mainly concern public and private information modeling (i.e. Electronic Healthcare Records Systems, protocols, clinical trials, tacit knowledge, among the others) for clinical, management and epidemiological purposes. He also deals with topics related to knowledge transfer and scientific communication in the fields of electronic health, connected health, and telemedicine.

Cuauhtemoc Sanchez-Ramirez is a full-time researcher of the Division of Research and Postgraduate Studies of the Orizaba Technology Institute. He received a PhD in Industrial Engineering from COMIMSA, center of research of National Council of Science & Technology of Mexico (CONACYT). His research projects have been granted by CONACYT, TNM and PRODEP. Dr. Sanchez is member founding of the Mexican Logistics and Supply Chain Association (AML) and member of the National Researcher System by CONACYT. His research interests are modeling and simulation of logistics process and supply chain from a system dynamics approach. He is author/coauthor around 20 journal and conference papers in logistics and supply chain management.

Tanja Sedej obtained her doctorate in business and economic science from the Faculty of Business and Economics of the University of Maribor in Slovenia. She is the founder and director of Raziskave in raziskave d.o.o., and has over ten years of practical experience in the areas of marketing and communication. She is also the author and co-author of several scientific and expert papers on marketing, corporate communications and entrepreneurship.

Ehsan Shekarian is currently a PhD candidate at the University of Malaya in Manufacturing Management. He received his BSc in Statistics in 2006 at the University of Allameh Tabataba'i in Tehran, Iran. He holds an MSc in Industrial Engineering from the Alghadir Higher Education Institution, Tabriz, Iran in 2009. His research interests are in the area of supply chain management, inventory systems, fuzzy set theory, multi-criteria decision making and heuristic applications of artificial intelligence methods. He has published various research papers in national and international journals such as Knowledge-Based Systems, European Journal of Industrial Engineering, Journal of Intelligent and Fuzzy Systems, Computers & Industrial Engineering, International Journal of Operational Research, International Journal of Housing Markets and Analysis, International Journal of Fuzzy Systems, and International Journal of Production Research. He is the editorial board member of some journals such as International Journal of Supply Chain and Inventory Management, International Journal of Multivariate Data Analysis.

Jyoti Singh is presently working as Research Analyst, International Engineering Services, H.No.-87A, RZI – Block, West Sagarpur, New Delhi – 110046, India. She has authored or coauthored over 5 research papers in Journals and Conferences. Her research work appeared in Advances in Industrial Engineering, IUP Journal of Mechanical Engineering, etc.

Priya Singh is presently working as Research Analyst, International Engineering Services, H.No.-87A, RZI – Block, West Sagarpur, New Delhi – 110046, India. She has authored or coauthored over 5 research papers in Journals and Conferences. His research work appeared in Advances in Industrial Engineering, IUP Journal of Mechanical Engineering, etc.

Alan D. Smith is presently University Professor of Operations Management in the Department of Marketing at Robert Morris University, Pittsburgh, PA. Previously, he was Chair of the Department of Quantitative and Natural Sciences and Coordinator of Engineering Programs at the same institution, as well as Associate Professor of Business Administration and Director of Coal Mining Administration at Eastern Kentucky University. He holds concurrent PhDs in Engineering Systems/Education from The University of Akron and in Business Administration (OM and MIS) from Kent State University, as well as author of numerous articles and book chapters.

Shahryar Sorooshian is lecturer of Faculty of Industrial management, Universiti Malaysia Pahang. He completed his B.Sc., M.Sc., and Ph.D. in Industrial Engineering. He is a member of the editorial board in some scientific journals and conferences. His research interest includes operational management, engineering management, and business modelling. He has served as the editorial and scientific committee member of some international journals and conferences in the area of engineering and management. He has published books, journals and conference papers.

Carlos Alberto Talamantes Padilla is a Masters student at the Autonomous University of Ciudad Juarez, Mexico. He received his bachelor's degree in industrial engineering from Durango Institute of Technology. Besides studying, Ing. Talamantes enjoys traveling and reading, his favorite author is Alexandre Dumas.

Oscar Tamburis is a Management and Industrial Engineer, with a PhD in Health Organization Management and a Post-Doc in eHealth Dynamics. He is an Adjunct Professor of 'Strategies of Healthcare Informatics' at the University of Naples Federico II, Italy. His main research interests concern innovation and strategic management for performance improvement in the public health field, with a particular emphasis on two main topics: the assessment and institutionalisation of emerging technologies in healthcare organisations, and the design and implementation of strategies for promoting knowledge-sharing behaviours among healthcare professionals.

Susanne Trimbath received her Ph.D. in Economics from New York University and holds an MBA in Management from Golden Gate University. Her research focuses on mergers and acquisitions, global economics and capital market regulation. Prior to forming STP Advisory Services in 2004, Dr. Trimbath was Senior Research Economist in Capital Studies at the Milken Institute and Senior Advisor on the Russian Capital Markets Project (USAID-funded) with KPMG/Peat-Marwick. She previously served as a manager in operations at Depository Trust Company in New York and the Pacific Clearing Corporation in San Francisco. Dr. Trimbath authored, edited and contributed chapters to six books, including *Mergers and Efficiency* (2002), and *Methodological Issues in Accounting Research* (2006). Her media credits include appearances in the Emmy® Award-nominated Bloomberg report Phantom Shares and *Radio Wars: The Secret History of Sirius-XM Satellite Radio* (2012), nominated for Best Documentary by the New York City International Film Festival.

Abd Hamid Zahidy is a Professional Engineer and the founder of an engineering consulting firm and a construction company. He is also a member of the Institution of Engineers, Malaysia. He obtained his B.Eng. (Hons) in Civil Engineering from Universiti Teknologi Malaysia, MBA from Universiti Utara Malaysia, and Eng.D. from Universiti Teknologi Malaysia. Currently, he enrolled his second doctoral program at the Faculty of Industrial Management, Universiti Malaysia Pahang. He has more than thirty years experience in the construction industry. His research interest includes construction engineering management, project management, quality management, and performance management. He has published several papers in international journals and conference proceedings.

Chapter 16
An Analytical Employee Performance Evaluation Approach in Office Automation and Information Systems

Maryam Kalhori
University of Science and Culture, Iran

Mohammad Javad Kargar
University of Science and Culture, Iran

ABSTRACT

With the extension of information technology, human resource management has experienced fundamental changes. One of the most important issues in human resource management is performance evaluation. Unlike number of studies in employee performance evaluation, there is a lack for systematic and quantitative approaches. Issues such as incomplete information, subjective and qualitative metrics, and also the difficulty of evaluating the performance are the main problems of this field. Hence, the current study exploits the capabilities of information systems and presents an approach for quantitative and automatic evaluation of employee performance in office automation systems. The results reveal the automatic employee performance evaluation system is a discrete dimension for employee performance evaluation systems.

INTRODUCTION

Human resources are the key assets in assisting organizations to maintain their competitive advantage (Ahmed, Sultana, Paul, & Azeem, 2013). Generally, in the studies that have been done in the field of human resource management, employee performance evaluation is seen as one of the most critical tools in this area (Fukui, 2015; Manoharan, Muralidharan, & Deshmukh, 2011). Hence, using efficient tools with high accuracy in the process of employee performance evaluation is welcomed by the managers.

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There are abundant studies in the field of evaluation employee performance. The main issue highlighted by these studies, is the accuracy of evaluation systems (Ahmed, et al., 2013; Manoharan, Muralidharan, & Deshmukh, 2012). Considering the fact that evaluation process is faced with problems such as subjective, incomplete Information, qualitative metrics, it leads to these systems are not readily accepted by users (Avazpour, Ebrahimi, & Fathi, 2013).

In recent years, with the advent of information technology, E-HRM (Yusliza & Ramayah, 2012) has become one of interesting subjects among researchers. In this regard, the computer systems that administer the evaluation are recently developed. However little attention has been paid to the relation between information systems and performance measurement systems (Dulebohn & Johnson, 2013; Garengo, Nudurupati, & Bititci, 2007; Nudurupati, Bititci, Kumar, & Chan, 2011). Generally evaluation systems are focused on recording the data, and there is no deep and meaningful outlook on data (Aqel & Vadera, 2010). While in web based office automatic systems, useful information is recorded automatically about individual's working procedure and they can be used for evaluating working performance.

Therefore, this chapter exploits the capabilities of information systems and proposes an appropriate approach for quantitative and automatic evaluation of employee performance in web base office automation systems. The chapter is organized as follows. In the next section, the review of the related literature is presented about assessment and ranking of employee performance. Then, in the next section the proposed approach is presented. In the last, we'll review the results of the system tests and will have the conclusion.

BACKGROUND

In general, recent researches attempt to remove the drawbacks of traditional evaluation methods (Deming, 1986; Manoharan, Muralidharan, & Deshmukh, 2009; Nudurupati, et al., 2011; Waldman, 1994) by implementing TOPSIS (Yue, 2014a), VIKOR (Park, Cho, & Kwun, 2013), non-parametric methods (Manoharan, et al., 2009), fuzzy neural network (Macwan & Sajja, 2013) and other ranking methods. Given that, evaluating and ranking performance evaluation systems are concerned with individual and personal factors, behavioral factors or the results; One of the difficulties of performance evaluation process is related to subjective judgment of the evaluators (Avazpour, et al., 2013) that is based on the past presuppositions. In this way some part of the data is always ignored either inadvertently or sometimes deliberately.

In this regard, present literatures can be classified into two groups: systematic and non-systematic methods. Non-systematic methods evaluate relying on evaluators' opinions and calculating individuals' absolute performance score (Espinilla, Andrés, Mart´ınez, & Mart´ınez, 2013) based on the mean of all opinions of evaluators or based on a proportion of input and output parameters (Manoharan, et al., 2009).Considering the role of evaluators in evaluation process in non-systematic methods, choosing who is going to do the evaluation process by itself has become a major challenge in evaluating individual's performance. Moon, Lee, and Lim (2010) believe in order for the evaluation to be fair, there should be no assumed segregation among evaluators. However, generally in ranking methods, the effect and importance of different evaluators' roles are considered differently (Andrés, Espinila, & Martínez, 2010; Espinilla, et al., 2013; Espinilla, Mart´ınez, & Mart´ınez, 2010; Park, et al., 2013) and (Xu, 2004). In such a way that in some studies like (Andrés, García-Lapresta, & González-Pachón, 2010; Espinilla, et al., 2010) and (Yue, 2014a) the opinion and effect of each evaluator on each criterion are not assumed equal. It

should be noted that the segregation among evaluators can sometimes reinforce biased opinions. On the other hand, this hypothesis cannot be completely discarded, as each group of evaluators is different as to their knowledge and perspective.

Given the fact that a variety of qualitative and quantitative criteria can be considered for evaluation, it is very important to determine the scales that distinguish the view of the evaluators with appropriate level of accuracy. Espinilla et al. (2013) emphasizes this issue by proposing a framework in 3 inputs formats (numerical, linguistic and interval-valued information). In addition Ahmed, et al. (2013) propose an approach that it determines the performance indices of employees considering their respective performance in various qualitative and quantitative evaluation criteria. The appropriate input type defined based on the very nature of the criteria, would be more understandable and facilitated for evaluators, in addition to being more accurate. Consequently, the ranking methods are considerable as to whether the input data is homogeneous or heterogeneous.

On the other hand, since the linguistic expressions are close to the natural language, they are identified as useful and simple tools to show the evaluators' perspectives in comparison to subjective and imprecise criteria (Espinilla, et al., 2013); but it is not easy to determine the appropriate linguistic scale either. Some research apply a single set of linguistic labels for all evaluators (Beheshti & Lollar, 2008; Gürbüz, 2010); while Espinilla, et al. (2013) and Andrés, García-Lapresta, & Martínez, 2010) have introduced different Multi-granular linguistic expressions. They believe that as to the lack of equal understanding of the evaluator from those individuals being evaluated, fair evaluation would not be possible with a single scale.

In this case, the conventional method used for ranking is based on the total sum weight of evaluation elements and the weight of criteria which will lead to a different decision making considering evaluators sets, evaluators' weights and sort of the inputs. This process is known as the aggregation phase. Aggregation phase is one of the conventional steps in the group decision making process. But in aggregation process, some part of the data is usually inevitably lost (Yue, 2013) ; therefore the extended TOPSIS method has been provided by (Yue, 2014a). Unlike traditional TOPSIS method and other decision making techniques, the new method does not require aggregation phase.

But some other non-systematic methods are based on proportion of input and output parameters (Osman, Berbary, Sidani, Al-Ayoubi, & Emrouznejad, 2011). These types of studies, unlike the absolute methods, apply nonparametric technique - DEA, AHP and fuzzy neural network- and perform the evaluation procedure uni-dimensionally. These studies that have proposed a model for relative performance evaluation and measurement of employees have a numerical structure and framework. The DEA, which was able to classify employees into the efficient and inefficient ones, and also to identify benchmarks for inefficient units, is one of the methods used in evaluating employee performance. Since DEA sometimes erroneously identifies a DMU unit (an employee) efficient, Manoharan, et al. (2009) applies the method suggested by Doyle and Green (1994) (as cited in Manoharan, et al. (2009)) which is an effective way of measuring the false index of DMUs to overcome this problem. The significant feature of this method is the sensitivity to the number of input and output parameters. This problem limits the applicability of this method in different situations. On the other hand, the DMUs must have absolutely identical properties. In other words evaluated employees must be from the same department, i.e. it is not possible to compare the various departments.

Macwan and Sajja (2013) use soft computing in the process of evaluating employee performance. The advantage of this method is the ability to learn from input evaluation parameters, available data and experience to provide unbiased decision.

Table 1. Recent studies in the field of employees' evaluation and measurement

Literature	Method	Research Focus	Decision Making	Data Collection	Heterogeneous
Ahmad (2013)	Fuzzy Approach	A fuzzy model for performance evaluation by using historical data of a company	by evaluator	Questionaries'	✓
Andres (2010)	Distance function mathematical model	Developing 360-degree appraisal model	by 360-degree	Questionaries'	-
Avazpour (2013)	Fuzzy AHP and TOPSIS	Developing a framework based on fuzzy hybrid multiple criteria decision making approach to identify the best person	by 360-degree	Questionaries'	-
Beheshti (2008)	Fuzzy logic	Developing a fuzzy logic framework to employee performance evaluation	by evaluator	Questionaries'	-
Espinila (2010)	Weighted average operator	Developing a Web based evaluation system	by 360-degree	Questionaries' on Web	-
Espinila (2013)	OWA/Weighted average operator/ Choquet integral	An integrated model for 360-degree performance evaluation	by 360-degree	Questionaries'	✓
Gürbüz (2010)	Choquet Integral/ MACBETH	To find the best employee	by DM	Questionaries'	-
Islama (2006)	AHP	Employee Performance Evaluation	by supervisors	Questionaries'	-
Javadein (2014)	Fuzzy TOPSIS	Developing an algorithm to assess and rank employees based on their protean and boundary less careers orientation	by evaluator	Questionaries'	-
Lan (2010)	Mathematics model	Performance assessment of R&D staff of the biological institute	-	Self-assessment	-
Macwan (2013)	Neural fuzzy	Modeling performance evaluation using soft computing techniques	by evaluator	Questionaries'/ Semi-Automatic	-
Manoharan (2009)	DEA	Evaluating of the performance of nurses in intensive care unit	by supervisors	Questionaries'/ Semi-Automatic	✓
Manoharan (2011)	FMADM	A model for employees' performance evaluation	by supervisors	Questionaries'/ Semi-Automatic	-
Moon (2010)	Fuzzy logic & Electronic nominal group technique	Developing a performance evaluation and promotion ranking system	by GDM	Questionaries' on Web	-
Osman (2011)	DEA	Aappraisal and relative performance evaluation of nurses	by evaluators	Questionaries'	-
Park (2013)	An extended VIKOR	To extend the VIKOR method to dynamic intuitionistic fuzzy environment	by evaluators	-	-
Rezaei (2011)	Data warehouse	Creating a decision tool for company managers to track employee performances	-	Automatic	-

continued on next page

Table 1. Continued

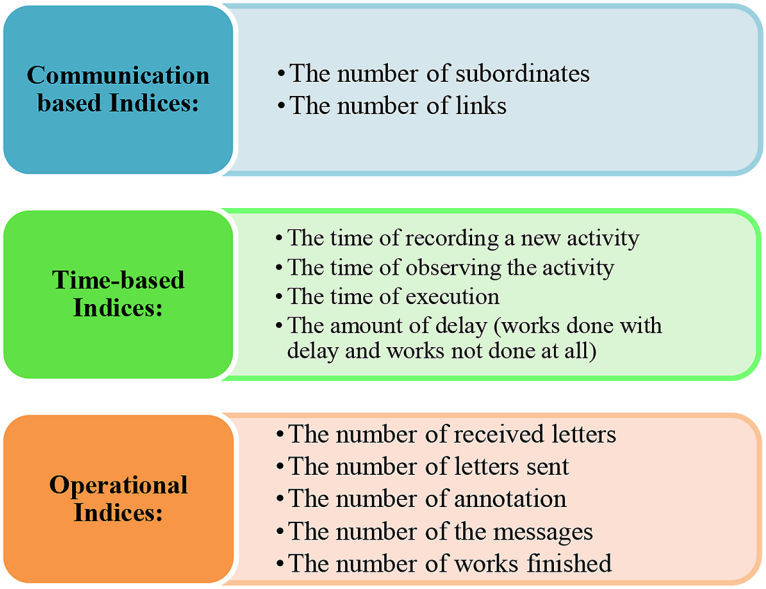
Literature	Method	Research Focus	Decision Making	Data Collection	Heterogeneous
Sepehrirad (2012)	Distance function mathematical model & SAW	Developing a hybrid mathematical model for 360-degree performance evaluation	by 360-degree	Questionaries'	-
Xu (2004)	ULHA/ ULOWA	Develop an uncertain linguistic approach to MAGDM	by GDM	Questionaries'	-
Yue (2014a)	IVIFN	aggregating interval data into interval-valued intuitionistic fuzzy information	by GDM	Questionaries'	-
Yue (2014b)	An extended TOPSIS method	Developing a new methodology for GDM problems in an intuitionistic fuzzy environment	by GDM	Questionaries'	-

Additional, the problem of assigning weights to performance evaluation factors as an unstructured and multi-attributed issue (Golec & Kahya, 2007) is important. So some studies have applied scientific approaches like AHP (Lan and Li, 2010), FAHP (Manoharan et al, 2011, Sepehrirad, Azar, & Sadeghi, 2012) and FQFD (Manoharan et al., 2011). The striking point in applying FAHP and FQFD is the restriction of the main factors to seven ones as to the limitation in the size of the pairwise comparison matrix (Manoharan, et al., 2011) and the restriction of sub-factors to 30 criteria. Among all current studies, only three methods have considered dependence and interaction among the criteria in their framework.

Generally these authors believe their methods have adequately covered huge number of employees and indicators (Yue, 2014a). Due to the expansion and complexity of tasks, evaluators would not be able to have enough knowledge about all subjects assessed. Thus, it is essential to implement the methods and techniques which are capable of correctly analyzing individuals' working procedure and professional relationships among staff in daily activities.

On the contrary, systematic methods with considering the fact that conventional evaluation processes are costly and time-consuming for both evaluators and individual being evaluated, and lack of accurate, real and objective data about the working situation of individuals, have proposed methods relying on automatic data collection from working processes and professional relationships established by employees and recording routine activities. They attempted to provide evaluation results with a higher degree of accuracy by applying data warehouse techniques, data collection algorithms, and appropriate data analysis. In this type of research, human evaluators are almost deleted or used in a limited number of criteria and the work basis is the developed algorithms. Hence, Lan and Li (2010) have designed a web-based performance evaluation system for R&D staff in a medicine production factory using B/S pattern. By using analytical hierarchy process and combining assistant indicators, the researcher has overcome the default of the KPI analysis which sometimes neglects other fundamental criteria among key ones, also determined the weight value of system indicators, thus, providing a more comprehensive evaluation. Also, Rezaei, Çelik, and Baalousha (2011) have developed a web-based organizational automation system using data warehouse techniques to measure the performance factor of each employee as well as an activity performance factor in Civil projects. The key feature of this research is exploring the distinction between those individuals who have no subordinates, and those individuals who receive

Figure 1. Research variables



working reports from their subordinates. But it only relies on functional types of OBS operations and three indices of time, cost and quality.

In Table 1, an overview of the methods investigated in this chapter is provided.

THE PROPOSED APPROACH

As mentioned above, in most part of the literature, there is scant attention to the role of information systems (Garengo, et al., 2007). Besides, the employees of operational sectors are assessed, and no specific attention is paid to employees who are at a higher level in organization and indirectly play a role in some issues. Some authors like Aqel and Vadera (2010), Rezaei, et al. (2011), Wu and Hou (2010) show that considering the communication type in individuals' working activities in order to achieve better results is important in the evaluation process. Considering the actual operational data and business financial data, Wu and Hou (2010) presented a model for evaluating three levels of employees in a distribution center based on working hours and volume.

Accordingly, in this study, a new method is proposed for automatic quantitative assessment of employee performance in office automation system. This model is inspired by Wu model which is presented for industrial distribution center which is changed according to office automation system and Rezaei, et al. (2011) framework which is a model of evaluation in office automation systems in which individual performance is measured in two direct and indirect levels.

Furthermore, in order to follow up employee performance, some ideas are adopted from Xuan, Jiang, Ren and Zou (2012) method to solve developer prioritization in bug repositories. In this method, a graph is created out of the communications among the developers and the comments which are put in the system in order to remove bugs. A link is drawn among each two developers who write a comment

on others' opinions, and the number of the comments is considered as the weight of the link. To make this method applicable for performance evaluation system, some changes are done. The proposed model is explained in the following.

Research Variable

According to the structure of office automation and the investigations done, performance variables can be divided into three general groups as Operational, Time-based, and Communication based which can be seen in Figure 1.

- **Operational Variables:** includes all activities done in automation system. Among the indices considered here are: the number of the letters received, the number of the letters sent/returned, the number of annotation, the number of accomplished works. It is worth mentioning about "the messages sent" is that we had to omit this evaluation factor as to the non-existence of this factor in the collected data set. The reason to choose this index as an evaluation index is that in this way, it is possible to follow up to which extent the individuals have spent their time to other works in their working hours. As mentioned above, this index is not considered in this study.
- **Time Variables:** by the three defined time points, and considering the time period that is allocated for each work, the time it takes to get the job done is calculated and in case of delay, the amount of delay is also calculated.
- **Communication based Variables:** as mentioned above, the research background was mainly focused on directed employees, and few studies have paid attention to evaluation factors and weight factors of indirect employee performance (Lan and Li, 2010). As the performance of indirect individuals can be influenced by employees at lower levels, this can be considered as one of the most important indices. Though, it must be considered that the low number of links does not indicate lower importance. The working volume can be of importance according to the level of position.

The Evaluation Method

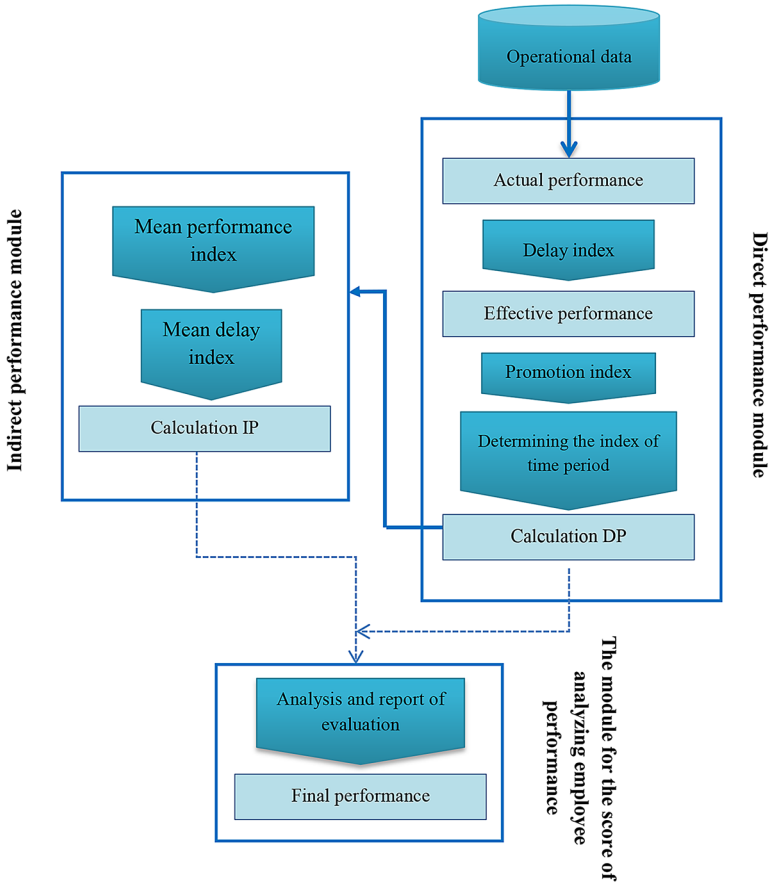
In this study, we intend to present a new approach for quantitative evaluation of employee performance in office automation systems. Our proposed model is inspired by Wu model which is adjusted in proportion with office automation systems. Individual performance is measured in two direct and indirect levels. In this model, the levels of employees and organizational units are entered to the system as input. See the hierarchy of the proposed model in Figure 2, as you can see, METKA evaluation framework comprises three modules.

Module 1: Specifying the direct performance: actual performance, effective performance and the growth of each employee performance are utilized to measure the performance of those employees who don't have any lower level employee.

Module 2: Specifying indirect performance: in order to measure the performance of directors and those individuals who have subordinates, indirect performance should be measured.

Module 3: Final analysis of performance score: employee performance ranking based on the results of Module 1 and 2 and analysis, conclusion and preparing the reports.

Figure 2. Employee performance evaluation procedure in METKA system



Specifying Direct Performance

In order to measure the direct performance, the actual performance and effective performance should firstly be identified. To do so, the amount of the individual's activity in the system and the possible delays existing at work are extracted from the system.

- **Actual Performance:** For each employee who is in the primary level, the amount of actual performance of the individual is firstly calculated through Equation 1.

$$RP(\mathrm{W}_{i,j,k}, \mathrm{T}) = \frac{N(\mathrm{W}_{i,j,k})}{TN} \tag{1}$$

In which $WR_{i,j,k}$ shows that employee k is in level i and department j. i=1 means that employee k doesn't have any lower level employee.

N($W_{i,j,k}$)= is the number of the individual activities in the system in time period T
TN= is the total activity done in system in time period T

- **Effective Performance:** As sometimes there is delay in executing the job, it can be considered as a negative coefficient in individual's performance. Also there might be some jobs that are left to others in that given time period that are delayed or are not done. Therefore, Negative Performance (NP) is calculated through Equation 4. Then accordingly, the effective performance is calculated.

    - **Calculating the Number of Delays**

D1($W_{i,j,k}$): is the total number of jobs done with delay
D1($W_{i,j,k}$): is the total number of jobs that are not done and facing delay

$$D1(\mathrm{w}_{i,j,k},\mathrm{T}) = \sum_{t=1}^{NUr_{tj}} Ur_t(\mathrm{w}_{i,j,k}) + \sum_{t=1}^{NDe_{tj}} De_t(\mathrm{w}_{i,j,k}) \tag{2}$$

$$D2(\mathrm{w}_{i,j,k},\mathrm{T}) = \sum_{t=1}^{NUr_{tj}} Ur_t(\mathrm{w}_{i,j,k}) + \sum_{t=1}^{NDe_{tj}} De_t(\mathrm{w}_{i,j,k}) \tag{3}$$

- **Calculating the Amount of Delay**

It should be considered that the length of individuals' working line can be different; therefore, in order to calculate the rate of delay, the proportion of working volume should be considered to measure individual ranking more precisely.

$$NP(\mathrm{W}_{i,j,k},\mathrm{T}) = \mathrm{D}1(\mathrm{W}_{i,j,k},\mathrm{T}) \,/\, \mathrm{N}(\mathrm{W}_{i,j,k}) \times \mathrm{TN} + \mathrm{D}2(\mathrm{W}_{i,j,k},\mathrm{T}) /\ number\,of\,recieved\,letters \tag{4}$$

- **Determining Effective Performance**

Based on Wu's model (2010), effective performance is calculated through Equation 5.

$$EP = RP(\mathrm{w}_{i,j,k}) \times (1 - \mathrm{NP}(\mathrm{w}_{i,j,k}, T)) \tag{5}$$

- **Final Performance (Direct Performance):** In order to calculate the direct performance, determining the time index and the amount of promotion index are two main elements. Time index is attained by the proportion of delay time to the time in which the job is done.

- **Determining the Confidence Interval in Performance**: In order to determine the promotion index, the existing historical data are used in system. By historical data, we mean the amount of effective performance attained in previous periods. To do so, the number of previous period should be determined. In Equation 6-8, n shows the number of previous periods.

In this way, the average and variance of effective performance of previous stages of evaluation are measured and confidence interval is determined for effective performance (Wu & Hou, 2010).

$$HEP(\mathrm{w}_{i,j,k},\mathrm{T}) = \sum_{l=1}^{n} HEP_l \Big/ n \quad , \; HEPV\left(w_{i,j,k},T\right) = \frac{\sum_{l=1}^{n}\left[HEP_l - HEP\right]^2}{n-1} \tag{6}$$

$$C_1\left(w_{i,j,k},T\right) = HEP\left(w_{i,j,k},T\right) + Z_{\alpha/2}\sqrt{\frac{HEPV\left(w_{i,j,k},T\right)}{n}} \tag{7}$$

$$C_2\left(w_{i,j,k},T\right) = HEP\left(w_{i,j,k},T\right) - Z_{\alpha/2}\sqrt{\frac{HEPV\left(w_{i,j,k},T\right)}{n}} \tag{8}$$

If the effective performance attained from Equation 5 is in this range, it shows that the individual hasn't had any significant change in his/her performance. But if it is more than the upper limits of confidence interval, it means that the individual has improvements (Trl = 1). On the contrary, lower than lower limits of confidence interval reflects weakening the working performance of individuals (TrL = -1) (Wu & Hou, 2010).

- **The Total Delay Time:** To calculate the total delay time, both categories of jobs that are done and those that are not done and are delayed should be considered. Equation 9 calculates the total delay time.

$$TDWT\left(w_{i,j,k}\right) = \sum_{t=1}^{NUr_{tj}} DTUr_t\left(w_{i,j,k}\right) + \sum_{t=1}^{NDe_{tj}} DTDe_t\left(w_{i,j,k}\right) \tag{9}$$

- **Working Time Index:** Working time index can reflect the required time to get things done by the individuals (Wu & Hou, 2010). In other words, by working time index, the amount of working time value of each individual is meant. According to this, based on the total of working hours recorded in the system from the individual's working hour, the amount of the times in which the work is done with delay is subtracted, and the proportion of this number is assumed as time index. Equation 10 and 11 specify working time index.

$$TDI = 1 - \frac{TDWT\left(w_{i,j,k}\right)}{Total\,hours\,workd\,by\,individual} \tag{10}$$

$$WTI = 1 - TDI\ \left(w_{i,j,k}\right) \tag{11}$$

- **Calculating Performance:** As explained in part A, in order to specify the amount of working improvement of each individual, the average of individual effective performance in previous periods is calculated. In order to determine the weight of direct employee improvement index in a specific job, (Wu & Hou, 2010) utilize Equation 12. According to this, direct performance is calculated with regard to the effective performance and the working time index (Wu & Hou, 2010).

$$\beta = \begin{cases} \dfrac{EP\left(w_{i,j,k},T\right) - C_1\left(w_{i,j,k},T\right)}{C_1\left(w_{i,j,k},T\right) - HEP\left(w_{i,j,k},T\right)} & if\ \ TrI\left(w_{i,j,k},T\right) = 1 \\ 0 & if\ \ TrI\left(w_{i,j,k},T\right) = 0 \\ \dfrac{C_2\left(w_{i,j,k},T\right) - EP\left(w_{i,j,k},T\right)}{HEP\left(w_{i,j,k},T\right) - C_2\left(w_{i,j,k},T\right)} & if\ \ TrI\left(w_{i,j,k},T\right) = -1 \end{cases} \tag{12}$$

$$FP\left(w_{i,j,k},T\right) = EP \times WTI \times \left(1 + TrI \times \beta\right) \tag{13}$$

Specifying Indirect Performance

Determining the amount of manager/director performance cannot be specified merely based on their own performance as they should be responsive about the job of their subordinates too. The performance of their subordinates should be influential in their performance score. To do so, the α coefficient of each position should be specified.

To discover the effective nodes in a social network, (Kempe, Kleinberg, & Tardos, 2003) have proposed Equation 14.

$$\alpha_l = p_{v,u} = 1 - \left(1 - \frac{1}{\deg ree\left(u\right)}\right)^{weight\left(v,u\right)} \tag{14}$$

With regard to the fact that the amount and quality of relations are influential in returned works and consequently in the quality and the type of performance, they are assumed as a dimension in evaluation. On the one hand, the kind of individual relations can be assumed as a graph, and the individual who has

more important and sensitive job can be considered a more important and more valuable node in the graph. As to this, in the current study, Equation 15 is used to calculate the effectiveness coefficient of each position which is the degree (u) of the total number of the letters that are sent and returned, also weight (v,u) is calculated from Equation 15.

$$weight\left(v,u\right)=\frac{number\,of\,work\,v\ to\,u}{TotalWork\,v} \tag{15}$$

Now the performance of those individuals who have subordinates, the total of FP and an average of subordinates' FP is attained through Equation 16 (Rezaei, et al., 2011).

$$IP=1/2(FP\left(w_{i=2,j,k},T\right)+1/n\sum_{l=1}^{n}\alpha\times FP_{l}) \tag{16}$$

In which n is the number of subordinates.

In addition, the average of the delays that are caused by the subordinates should be subtracted from the performance as a negative coefficient. Accordingly, the final score is attained from Equation 17.

$$FIP=IFP\left(w_{i=2,j,k},T\right)\times(1-1/n\sum_{l=1}^{n}\alpha\times D\left(w_{i=1,j,k},T\right)) \tag{17}$$

The Implementation of the System

In order to administer and implement the proposed model for automatic and quantitative evaluation of employee performance, a basic automation system is required. But as to the fact that the assumed companies don't let us have access to theirs, we had to design and administer a basic organizational automation per force.

To design METKA basic automation system, PHP object-oriented language is chosen for implementation. Furthermore, in order to design the required database MySQL5.5.24 is utilized. Then by adding some modules which are explained in Section 3, the mention system is implemented for a period of about two months in a small company of installing telecommunication pylons.

In this system, the users can perform all organizational tasks by sending their written exchanges. All activities and users' entrance and exits are recorded in in the system.

Data Collection

In order to collect the required data and also to analyze the performance, the time that is allocated to performance in this study, Xuan structure is utilized (Xuan, et al., 2012). With defining n users in METKA system for evaluation, each employee di is assumed as a vertex in the graph. All vertexes are divided into k attributes based on the departments. The three elements $(S_{ij},R_{ij,}E_{ij})$ show the number of

Table 2. Comparing evaluation outcomes

User	November	Rank	December	Rank	Expert	Rank
1	-	-	-	-	-	-
2	0.006328	11	0.00055	13	0.361667	10
3	0.003592	15	0.000666	12	0.331469	11
4	0.079078	1	0.110127	4	0.822819	5
5	0.048869	5	0.044615	7	0.913253	3
6	0.058655	2	0.13519	3	0.96631	2
7	0.051591	3	0.085604	5	0.672291	8
8	0.027931	7	0.159297	2	0.721249	6
9	0.009346	10	1.51E-07	15	0	14
10	0.050193	4	0.017688	9	0.060575	15
11	0.027513	8	0.045613	6	1	1
12	0.016557	9	0.178404	1	0.688717	7
13	0.006297	12	0	16	0.585348	9
14	0.02909	6	0.035264	8	0.898894	4
15	0.003105	16	1.26E-06	14	0.327371	12
16	0.006293	13	0.011143	10	0.229792	13
3	0.004505	14	0.009867	11	0.183506	16

letters sent, returned from employee i to employee j and the number of finished works of individual j that is depicted by a navigated link that is drawn from i to j. If there is no letter exchange between individual i and j, this value will be equal to zero. Each vertex saves values such as the allocated time for that given action, the time in which the work is done and the time and the number of delays. It is worth mentioning that there is no limitation on the type of the letters sent and the relations. In order to find a connective graph, an assumed employee d_0 is considered, and all individuals are connected to that. Then a bidirectional link is drawn between that employee and d_0.

This type of saving the individuals' activities in the system is advantageous because besides the data required for evaluation, other data like the volume of activities in each department and also the individuals who are more active as to the type of their position are firstly specified. In fact these vertexes can be considered as the separation points of the graph that by removing them, the graph would be disconnected. In this way, they key figures of the organizations are identified. Naturally, if this employee doesn't manifest pleasant performance, it brings about faults and weaknesses in other parts.

Evaluation in System

To evaluate, the director or the individual in charge of evaluation firstly chooses the allocated time range. After determining the range under evaluation and administering the evaluation algorithm, all information required for evaluation are extracted from the crude primary data which are saved in this period in the system.

Table 3. Results of variables analysis

	Sent	Received	Activity	Num_DD	Time_DD	Num_ND	Time_DN	Link	Subordinate
Sent		0.566*	0.783	-0.068	-0.192	0.616**	0.111	0.894**	0.655**
Received			0.818**	0.577**	0.004	0.519*	0.225	0.875**	0.540*
Activity				0.398	-.245	0.365	0.120	0.903**	0.422
Num_DD					-0.151	-0.050	0.122	0.271	0.126
Time_DD						0.96	-0.101	-0.112	-0.121
NumDN							0.329	0.651**	0.849**
Time_DN								0.183	0.064
Link									0.686**

*. Correlation is significant at the 0.05 level
**. Correlation is significant at the 0.01 level

For direct evaluation, Model 1 is implemented on the resulted data. In the next stage, Model 2 is applied for measuring the authorities' performance (indirect performance). See the data resulted from implementing the proposed approach in Table 2.

It is worth mentioning that comparison can be logical if the cases are similar and from the same classification. That's why here it is assumed that the working balance exists among the jobs. Moreover, as mentioned previously, for evaluation in each period, the results of the previous periods are required. Here, as there is only one period of background/history data to measure the performance in the second month of evaluation, instead of Equation 6, the EP of this period is contrasted with the last period, and the proportion of their difference is measured.

Result and Discussion

Factor analysis is a multivariate statistical method whose primarily purpose is to define the underlying structure in a data matrix. Therefore, in order to study the relationship between the variables, a correlation analysis has been conducted. Table 3 shows the corresponding results.

As mentioned before, the communication type in individuals' working activities is important in the evaluation process. As seen in Table 3, 0.686 in level 0.01 reflects high positive correlation among the variable "link" (communication) and "the number of subordinates". Also, given that the variable "activity" is defined based on number of sent and receive letters, obviously there is significant correlation between "link" and "activity".

On the other hand, Correlation between the number of works that has been delayed (Num_DN) and "subordinates" and "link" is 0.849 and 0.651 respectively. When the number of links increases it can be attributed to the importance of the individual (occupation), and his performance affects other performance.

In Equation 4, the number of delays is considered as a negative factor on performance. Correlation, 0.577 shows that getting more works (received letters) can leads to more delay. But insignificant correlation between "activity" and "delayed works" partially reflect the relative nature of this relationship.

Accordingly, there are strong evidences that validate the results of this experiment; High correlation coefficients between many variables, justifiability and logicality of the high correlations show the validity of the results and the variables cover different aspects and results of employees' work.

Table 4. Analyzing the correlation of the results

	December	Expert
November	0.519*	0.537**
December		0.592**

*. Correlation is significant at the 0.05 level (1-tailed)

**. Correlation is significant at the 0.01 level (1-tailed)

Table 5. Mean and standard deviation of performance score

	Mean	Std. Deviation	N
November	0.0268	0.024	16
December	0.0521	0.0628	16
Expert	0.5477	0.3347	16

In addition, in order to check the accuracy of the results achieved from the proposed evaluation model, a questionnaire is provided to assess individuals' efficiency and performance during these two months. To do so, a model named 360 degree model is applied. According to this model, each individual is assessed from four dimensions of supervisor, peer, subordinate employees and the customers/clients. Table 2 shows the results of professionals' assessment after the normalizing the data. As it can be seen in the table, user 3 is repeated two times in the table as that given individual occupies two positions for each of which the performance is assessed discretely.

SPSS is utilized to analyze the outcome of the proposed evaluation model. As seen in Table 4, 0.592 in level 0.01 reflects high positive correlation among the results by the system and professionals' assessment. On the other hand, the numbers are in such a way that it's not possible to put traditional evaluation absolutely aside. Table 5 also shows the mean and standard deviation of the results.

To have a better perspective of the results achieved, Figure 3-6 are presented. Figure 3 shows the comparison of the results in two month evaluation. Individual performance changes can be seen in

Figure 3. The comparison of November and December in METKA system

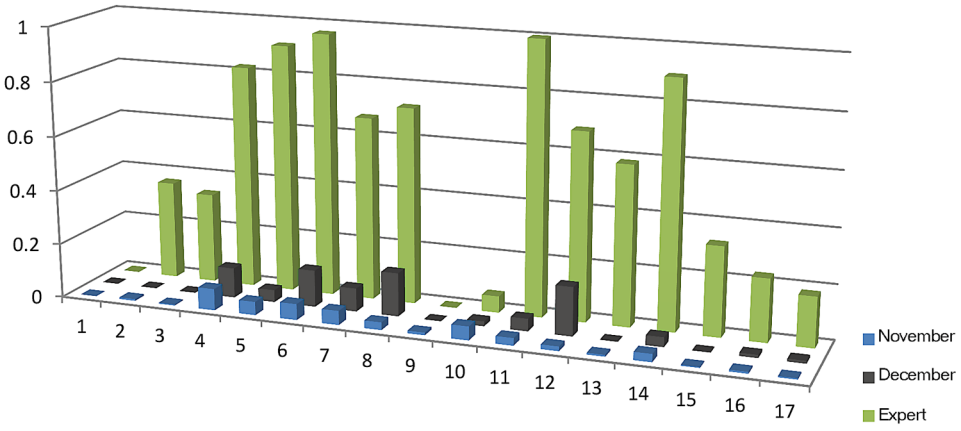
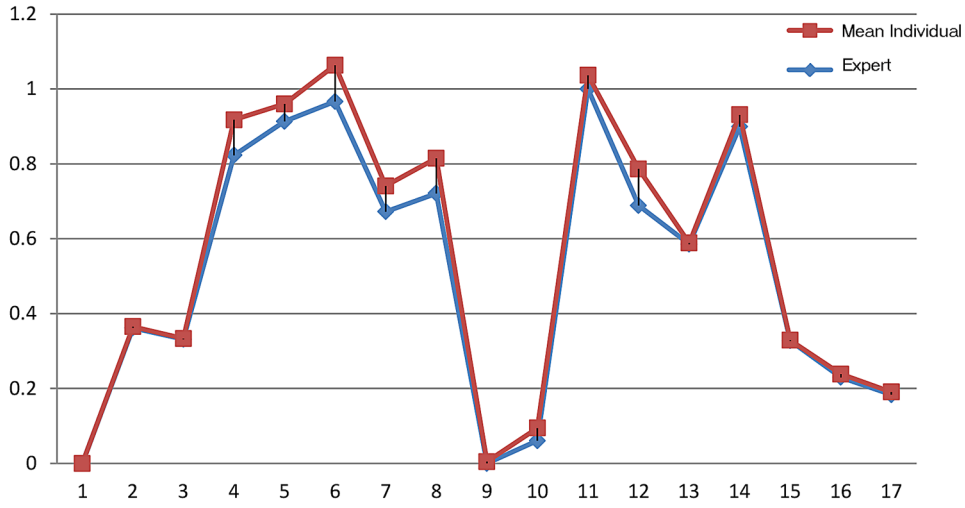


Figure 6. The mean of the evaluation of the professionals and METKA system



this graph. Employees 8 and 12 have had significant improvement, while employee 5 and 14 haven't manifested any change. Figure 4 shows change in performance from another perspective. Based on the determined indices, user 1, as to being the admin, has approximately zero activity, which is reasonable.

In Figure 5, there is a comparison of individuals' ranking during the two month evaluation of the proposed method with the professional's opinions. As it can be seen, those individuals who are given higher scores by professionals, also have a higher rank in the system, that shows the correlation of the results. User 9 has a mean of approximately 0, as in the first and second month has acquired rank 10 and 15, and is given rank 14 based on the professionals' opinion.

For better comparison of the results of the system in Figure 6, the mean of individuals' rank during the two month is presented beside the professionals' opinion. As it is clarified in the graph, the values are so close to each other. This indicates the correlation of the results as previously mentioned. This Graph clearly shows that the results achieved by the system are acceptable and can be used as an evaluation system.

Figure 4. Individuals' performance changes during the two months

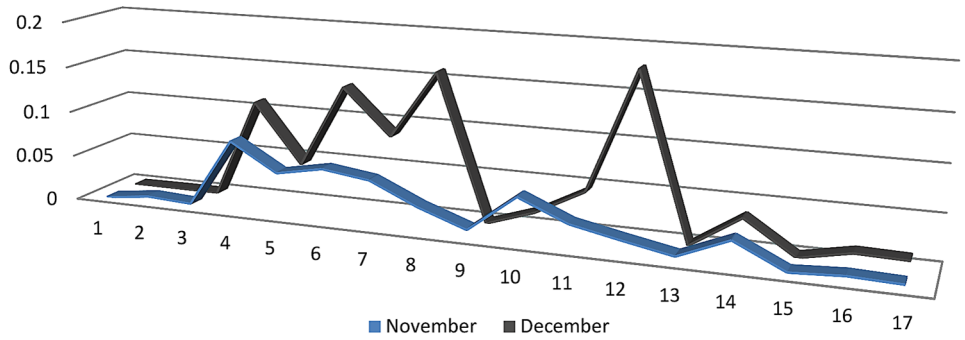
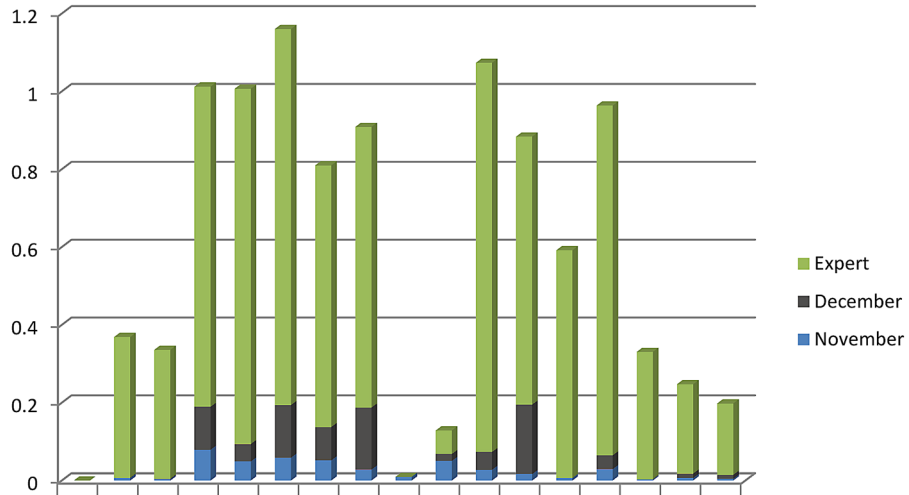


Figure 5. The comparison of the results of METKA system and the professionals



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Expert	0	0.36	0.33	0.82	0.91	0.97	0.67	0.72	0	0.06	1	0.69	0.59	0.9	0.33	0.23	0.18
December	0	0	0	0.11	0.04	0.14	0.09	0.16	1.51	0.02	0.05	0.18	0	0.04	1.26	0.01	0.01
November	0	0.01	0	0.08	0.05	0.06	0.05	0.03	0.01	0.05	0.03	0.02	0.01	0.03	0	0.01	0

FUTURE RESEARCH DIRECTIONS

Based on this chapter, developing dynamic systems and produce tools based on computer techniques in order to apply human resources effectively in organizations and provide better decision making opportunities for managers and release a more accurate evaluation output to improve decision support systems are required. In order to continue the body of research in the scope of quantitative employee performance evaluation, investigating other types of existing data such as unstructured data can reflect more accurate results. By unstructured data, the reports that are provided in the stream of work are meant that need the web mining techniques. In this way, other indices such as working quality can also be measured. In addition, as to the possibility of sending useless letters in the system so that the individual pretends to be highly active, some information can be achieved by investigating the content of the letters as to whether they include formal words or not. Moreover, administering data mining methods on the data can be used to analyze and extract knowledge. Moreover, determining the working balance among different jobs can lead to a better assessment results.

CONCLUSION

Despite of various tools and methodologies proposed for evaluating employees' performance, still several studies still attest the fact that there is no complete and accurate data on the employee performance because performance indicators are usually not measurable. On the other hand according to these literatures, evaluation methods are often based on the opinions of the evaluators and their mindsets. Therefore, some problems such biases and lack of accuracy will follow. In addition while speaking of the employee performance evaluation, all attention is directed to performance evaluation in business sector

and marketing, and the concentration is on the performance level of employees working in operational and physical departments of the organizations. In this regard, this study intends to eliminate the above problems by exploiting the capabilities of information systems. To do so, METKA system intended to evaluate individuals in two direct and indirect stages by using the relation. The results of evaluation showed that the achieved values based on the proposed approach are compatible with professionals' opinion and can be used as a discrete dimension for the evaluation of employee performance. Though, other evaluation methods cannot be set aside, as all indices cannot be measured quantitatively in the system, but can present a complete method together.

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KEY TERMS AND DEFINITIONS

Direct Performance: Determining the amount of performance individuals based on actual performance and effective performance.

Effective Performance: The performance that is calculated by the removal of the error and the delay of the actual performance.

Employees Ranking: A quantitative system to estimate contribution of each employee to achieve organizational goals and results during a period of time.

Indirect Performance: Determining the amount of manager performance based on their own performance and their subordinates as they are responsive about.

Information Systems: A complete system that is designed to produce, collection, organization, storage, retrieval and communication of information in an enterprise, organization or any other defined areas of society.

Non-Systematic Methods: Methods that evaluate relying on evaluators' opinions and calculating individuals' absolute performance score based on the mean of all opinions of evaluators or based on a proportion of input and output parameters.

Performance Measurement: A process that is used in organizations in order to evaluate employees' efficiency and productivity for planning Human Resource policies.

Systematic Methods: Web-based methods which, by using data warehouse and data collection algorithms, automatically collect detailed information on task completion, the portion of job content done, and professional inter-employee relationships in daily routine workplace activities through the designed systems.