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A Computational Framework for Vaccine Selection: Comparing MEREC and CRITIC Weighting Techniques

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Abstract

The COVID-19 pandemic highlighted the importance of proper vaccine selection in controlling virus transmission and saving lives. Vaccine selection is a complex process that impacts public health, economic recovery, and global equity, requiring equitable decision-making. This study explores the use of multi-criteria decision-making (MCDM) methods—MEREC (Method Based on the Removal Effects of Criteria) and CRITIC (Criteria Importance Through Intercriteria Correlation)—to determine objective weights for evaluating vaccine selection. Computational analyses are conducted to compare the weights derived from both methods, highlighting their strengths and limitations. The WASPAS (Weighted Aggregated Sum Product Assessment) method is also applied to compare vaccine selection scenarios using the criteria weights obtained from MEREC and CRITIC. The study concludes with a practical application of these methods to a vaccine selection problem, demonstrating their effectiveness in supporting informed decision-making. This research contributes to optimizing vaccine selection strategies by integrating theoretical and computational analysis, ensuring preparedness for future pandemics while promoting global health equity.

Keywords
Vaccine Selection, Merec, MCDM, Critic, Waspas

Biographies
S. S. Appadoo is a professor, and the institutional head of the Department of Supply Chain Management at the University of Manitoba, Canada. In addition to teaching undergraduate and graduate courses, he is a prolific researcher, with his work continually being published in esteemed journals (both national and international) and referred proceedings. His tenacious and innovative research has garnered global acclaim –frequently cited by academics both domestically and internationally. Professor Appadoo has published in journals such as the *European*

Journal of Operational Research(EJOR), Annals of Operational Research (AOR), Fuzzy Optimization and Decision Making (FODM), International Journal of Production Economics(IJPE), and *Information Science*, among others. Professor Appadoo's work spans interdisciplinary horizons, exemplified by his partaking in collaborative projects - including working with over fifty researchers from around the world in various academic disciplines. Having published over one hundred and fifty articles in international journals and proceedings, his publications have appeared in internationally revered journals - specializing in management science and supply chain management. His articles were included in the 'Top 25 Hottest Articles' list for Science Direct, published by Elsevier, and were among the most cited articles on Elsevier. Professor Appadoo also serves on the editorial review boards for many international Journals.Dr. Appadoo is primarily interested in developing analytics techniques and Decision-Making Systems. He is currently working on quantitative and fuzzy decision-making models, as well as multi-criteria and group decision-making. He has presented his work at prestigious conferences and research workshops, such as INFORMS Annual Meeting, ASAC, CORS Annual Meeting, IEEE, and DSI Annual Conference. He co-authored a book titled, More-for-Less Solutions in Fuzzy Transportation Problems (Studies in Fuzziness and Soft Computing).His research is funded by the National Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant as a Principal Investigator. The Discovery Grants Program promotes and maintains a diverse base of high-quality research capabilities in Natural Science and Engineering in Canadian universities, fostering research excellence and providing a stimulating environment for dynamic research training. Professor Appadoo is a recipient of the Associates' Achievement Award, the Joint UM/UMFA Committees on Merit Award, and several best paper awards at some national and international conferences. In addition to his academic prowess, professor Appadoo is known for his capabilities as an educator. Students commend Professor Appadoo's teaching methodology and consistently rank his classes and instruction as exceptional. He serves on departmental, faculty, and university committees and contributes extensively to the professional community through review processes – operating as a conference chair and academic reviewer.Owing to Professor Appadoo's significantly contribution and efforts in creating the Ph.D. program in the Department of Supply Chain Management, the Asper School of Business is one of the limited institutions offering a Ph.D. program in SCM.

Yuvraj Gajpal is an Associate Professor of Supply Chain Management at Asper School of Business, University of Manitoba Winnipeg, Canada. He holds a PhD in Management Science from DeGroote School of Business at McMaster University Hamilton, Canada and Master in Industrial Management from Indian Institute of Technology (IIT) Madras, India. Prior to joining University of Manitoba, he worked as an assistant professor at King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia. He also taught courses at McMaster University as a sessional lecture. He has worked as a postdoctoral fellow at Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), University of Ontario Institute of Technology (UOIT) and McMaster University. He is a member of Institute for Operations Research and the Management Sciences (INFORMS) and Canadian Operational Research Society (CORS). His research interests mainly lie on application of heuristics and meta-heuristics on transportation and logistics management. His current research is focused on retail supply chain management where he is exploring the issue of contract between retailer and manufacturer and the effect of different inventory policy on their relationship. He has published papers in leading research journals such as Computers and Operations Research, European Journal of Operations Research, International journal of Production Economics, and Journal of the Operational Research Society. He is a reviewer of many international journals such as Computers and Operations Research, European Journal of Operations Research, Journal of Heuristics, Transportation Research Part E, Journal of Scientia Iranica and Annual Symposium on Supply Chain Management. He has collaborative research work with Dr. Ashraf Elazouni from KFUPM in the area of finance based project management and with Dr. Mustapha Nourelfath from University of Laval in the area of manufacturing production plan. He has received Junior Faculty Research Grant (JFRG) from KFUPM in the amount of SAR 50,000. He was an academic advisor for 6 students for their 9 month Industrial Co-op work. He has co-supervised many senior design projects for undergraduate students. He was the chair for work and process measurement lab design committee and a member of various departmental committees at system engineering department of KFUPM. He has taught courses in Operations Management, Simulation, Statistics, Global Supply Chain Management, Engineering Economics, Cost accounting and Methods engineering at KFUPM and McMaster University. At Asper School of Business, he teaches Management Science Simulation for Business Analysis.