

Preface

The interdisciplinary approach to strategic decision-making involves the combination of two or more approaches into one integrated and cohesive framework. Strategic management is more likely to benefit from interdisciplinary approaches because most strategic management problems tend to be unstructured, open-ended and difficult to model or structure with a single technique or method from any one discipline. In fact, strategic management has a long tradition of using a wide range of methods from a variety of disciplines such as economics, operations research, forecasting, information systems, finance, risk management, political science, law, philosophy, sociology and environmental science among others. It usually embraces all of the functional areas of the business in an integrated framework because it occurs at the highest level in organizations. Specific disciplines that can provide suitable theories or methodologies for solving problems in specific functional areas (such as marketing or finance) may not be robust enough to provide meaningful solutions for the larger strategic problems. This is particularly relevant in an increasingly global business environment where an increasing need for technical solutions is accompanied by the need to better understand the social, cultural, environmental, political and legal forces that influence many global organizations.

The theory and practice of interdisciplinary studies goes back as far as the Greek philosophers who considered the ideas of a unified science, general knowledge, synthesis and the integration of knowledge. Greek historians and dramatists often took elements from other realms of knowledge (such as medicine or philosophy) to further expand and enhance their understanding of specific phenomenon. Even in today's purely scientific fields, interdisciplinary considerations plays a central role in the development of new research fields such as nanotechnology which cannot be addressed without combining the approaches of two or more disciplines such as quantum information processing an amalgamation of quantum physics and computer science, and bioinformatics, combining molecular biology with computer science. Similarly, sustainable development as a research area deals with problems requiring analysis and synthesis across economic, social and environmental spheres often an integration of multiple social and natural science disciplines.

Strategic decision making considers the big picture and can be seen as a remedy to the problem of over compartmentalization. Managers and decision makers from specific departments or functional areas of a business are often trained in disciplines that are traditionally used in those areas. A marketing executive may feel more comfortable using a methodology that is based upon the field of communication whereas a production manager might choose a technique based upon operations research techniques. A strategic plan is more likely to utilize methodologies from different disciplines and the integration of these disciplines can reflect the coordination of the different departments in the strategic plan. Interdisciplinarity can be seen as a way to transcend disciplines since excessive specialization can be problematic

both epistemologically and politically. In the business world, this means to rely on decision makers with different skill sets and knowledge bases and not giving too much political power to one person or one department. This approach can increase the possibility of collaboration among different departments which can lead to new solutions and increase the overall effectiveness of the firm. Using an interdisciplinary approach can also strengthen the individual disciplines as much information is given back to the various disciplines involved. In an analogous way an integrated approach to strategic management can increase the effectiveness of each department as well as the overall organization as members from different departments learn to analyze each situation with different points of view.

In order to position an organization to be competitive over the long run, strategic planners must consider broader scope rather than more narrow approaches. For example, a long term investment strategy in a developing country may need to consider cultural aspects, requiring the application of theories of anthropology or sociology as well as financial theory. The decision to adopt certain technologies may require an understanding of the relevant technical fields, but also an application of human machine interaction which may require the use of cybernetics which is an interdisciplinary approach to study regulatory systems. Taking the long term view may require the mixing of different disciplines and approaches to increase the likelihood that the analysis will be relevant over a long period of time. Using a portfolio of different methodologies can also help reduce risk which is an important consideration in strategic planning.

This book is divided into three sections. In Section 1 we present five chapters on Organizational and Strategic Analytics.

In their chapter entitled “Implications and Philosophical Requirements of a Comprehensive Dialectical Inquiry System,” Acar and Druckenmiller outline the characteristics of information seeking and decision making systems to be used in conflict management situations, with a specific applicability to high-level and impactful strategic or political decision making. It starts by outlining the deficiencies of expert systems and the Delphi technique used in isolation and recommends the use of group-support systems and their extended variant, collaboration engineering. In order to bring together sound philosophical principles and advances in information technology, the chapter goes all the way back to the philosopher Hegel who is the source of the concept of dialectical inquiry used by modern American research theorists. Eminent among them is West Churchman, whose work provides a foundation for strategic and political decision making as well as the more general case of conflict management. So, after Hegel’s, Churchman’s main legacy is examined in the context of collaboration engineering.

As the chapter purports to provide a deeper understanding of collaboration engineering, it goes back to the sources of ambiguity in strategic theory, establishes a connection with the problem framing paradigm, and shows the need for dialectical inquiry in complex high-level strategic or political situations. It then moves on to its central contribution, which is the development of the general “design criteria” or conditions that desirable dialectical inquiry systems should satisfy in practice to reach and maintain the capability of improving decision making in awkward or conflicted situations. These seven criteria are useful for the design of easily used manual problem framing and analysis systems, yet also computerized ones for broader-scope or more inter-connected situations. A first benefit of this chapter is thus to make collaboration engineering developers aware of these design criteria for their own projects.

One dialectical inquiry system satisfying all seven requirements was developed by W. Acar in 1983 to assist in interactive planning as well as general collaboration engineering endeavors. In light of the many criteria it satisfies, Acar’s method has been called “Comprehensive Situation Mapping”. It is a powerful dialectical as well as computational method that can be used for analyzing situations, formu-

lating strategies and computing change scenarios. It has been computerized and usability-tested by D. Druckenmiller since 2004. A second benefit of the chapter is to inform its practitioner readers that, due to its contribution to strategic decision sciences generally and collaboration engineering specifically, comprehensive situation mapping has been devised with the capacity to equip its adherents in two tangible ways. First, it imparts a theoretical grasp of the way strategic or political uncertainty may affect high-level decision making and call for a dialectical inquiry-based intervention. Second, it directs decision makers to a powerful technique they can use in specific decision situations.

In their chapter entitled “Specialization vs. Diversification Decision Making: Driving Forces and Challenges,” Folinas and Althrawa explore the role of various economical, financial, and strategic forces influencing decision makers towards diversification and specialization strategies within the Saudi Arabian manufacturing industry. The study attempts to clarify the conditions and circumstances in which decision makers have considered either strategy. Moreover, identify the correlation between a basket of factors associated with the decision to diversify or specialize.

Surveying 100 decision makers in the industrial cities of Riyadh, Saudi Arabia, using questionnaires developed for both groups, the study initially attempts to identify the factors that had the greatest impact on firm performance based on firm returns on investment. Several factors were found significant; first, attempts of specialization were found associated with risk avoidance and managers craving to achieve industry dominant economic features, whilst results show an increased concern among diversified firm decision makers towards changes in import and export policies and regulations. Moreover, industry type was found effective in managerial responses as they weigh the role of the factors presented to the direction of the expansion made.

Firms diversifying in related fields of business were found concerned about achieving reductions in fixed cost per unit and diversifying in response to rivals offering entire product packages. Testing other factors to this effect revealed inconsistent behaviors among decision makers when industry type is statistically controlled. Specialized firms tended to achieve higher returns on their investments compared to those diversified. Firms that have been operating longer since the decision to specialize or diversify were also achieving higher returns on their investment. While several challenges were recorded, both specialized and diversified firms seem to be in a far better condition in the market to secure their position in face of world free trade and local and international competition.

Toyota is among the most successful companies in history. The Toyota production system has long been regarded as a source of its outstanding performance. The Toyota production system has been imitated by various companies all over the world and has also inspired thousands of publications in the business press. Many industries including electronics, metal working, mechanics, and foods supply have attempted to implement the Toyota production system. Even in service industries such as consumption, software, postal services, hospitals, airports, and government, Toyota production system is widely applied. However, these latter industries have their own characteristics that are different from the auto industry. Not every part of the Toyota production system – *kanban*, *andon*, and *heijunka*, for instance – can be easily transplanted without modifications. A fashion show dress might look glamorous on models, but it may not be appropriate for everyone. Similarly, Toyota’s Toyota production system might not perfectly fit other industries. Most companies, however, try to imitate Toyota production system without modification, achieving only limited benefits. Innovative companies, on the other hand, constantly change these lean tools to fit their systems. Some modifications become so successful that they produce huge impacts on industries.

One such innovation is *seru*. *Seru* has acquired a reputation as the *next generation of lean* in Japan for several years, but it is still largely unknown outside Japan. In the early 1990s, the Toyota production system was found not to work when it was applied to Japanese electronics companies. Toyota production system is fit for a stable, but not volatile, business environment such as that which the electronics industry belongs. This volatile environment can be described as one with short product life cycles, uncertain product types, and fluctuating production volumes (sometimes mass, sometimes batch, and sometimes very small volumes.)

Seru, a new production organization, was developed to cope with this environment. Many leading global companies such as Samsung, Sony, Canon, Panasonic, LG, and Fujitsu have adopted *seru*. *Seru* overcame a lot of disadvantages inherent in Toyota production system and brought amazing benefits to *seru* users. *Seru* is still largely unknown outside Asia. In their chapter entitled “Seru Production: An Extension of Just-in-Time Approach for Volatile Business Environments,” Stecke, Yin, and Kaku introduce *seru*’s history and defines various *seru* types. The evolutionary process of developing *serus* is described by using industry cases. A *seru* pyramid is constructed to compare *seru* with the Toyota production system. A just-in-time organization system is introduced. The authors show why applying it can bring great productivity, efficiency, and flexibility to a production organization.

Six Sigma is a quality management tool that focuses on linking the tactical and strategic levels of a company. An overriding emphasis is on reducing product variation in order to reduce defects. Six Sigma was developed by Motorola in the 1990s as a set of statistical tools for systematically analyzing processes to reduce process variation. Six Sigma has gained attention in the business field due to its potential financial impact and its potential to improve customer satisfaction. Several authors have investigated the key benefits of Six Sigma. Among the benefits cited in the literature are: (1) top management support and leadership; (2) focus on a disciplined approach for process improvement; (3) combining human elements and process elements; (4) distribution of responsibilities and authorities in a structured way by using the Belt system; (5) using several selected efficiency tools among quality methods; (6) innovative ideas and solutions from brainstorming sessions; (7) gains that are sustained; (8) cross-functional teamwork; (9) the focus on the problem-solving methods; (10) and placing value on decision making based on measurable indicators and data. Many researchers have attempted to define managers as effective quality leaders. Particularly following the 1920s, a great deal of research focused on worker motivation. Two distinct managerial approaches, labeling them Theory X and Y; theory X was introduced that was the more prevalent behavioral style identified among managers in the first half of the twentieth century. Successful implementation requires managerial commitment. This level of commitment will depend on the managers’ perceptions of their workers’ motivation. Although a great deal of research has been conducted on worker motivation, limited research exists that explores the possible connection between managers’ perception of workers’ motivation and Six Sigma commitment and success.

In their chapter entitled “Successful Implementation of Six Sigma Considering Management Styles,” Jenab and Staub explore this issue and find that the majority of participants in their study are Theory Y managers with the same level of interest in Six Sigma as Theory X managers. This conclusion has been derived from an anonymously surveyed middle and upper level managers in various types of industries. The survey consisted of 18 Likert style questions that captured characteristics of Theory X and Y behavior, Six Sigma adoption, and demographic/categorization data. The results indicate that although successful implementation of Six Sigma is independent from the management style (Theory X or Y), it requires management support and determination. Furthermore, the findings did not rule out other possible factors that could be influencing Six Sigma success, such as the dedication of Six Sigma champions or their skills in implementing Six Sigma.

Over the past few decades in the manufacturing industry, there has been a significant shift toward Lean Six Sigma initiatives that promote the philosophy of continuously identifying opportunities to improve performance. The main benefit of this strategy is that the manufacturing processes are constantly being monitored and improved with a focus on maximizing the ability to create value for the customer, which includes design, quality, function, cost, delivery, and other aspects of the product. Lean is used to eliminate the wastes or non-value added activities while Six Sigma is used to reduce the variation and make the system more consistent.

In their chapter entitled “Prioritizing Lean Six Sigma Efforts Using Bayesian Networks,” Li, Sawhney and Wilck provide an analytical method for continuous process improvement. This chapter provides a Bayesian Network model to aid in quantifying and prioritizing the improvement efforts of Lean Six Sigma, specifically within the manufacturing industry. The chapter provides a literature review for Lean Six Sigma and Bayesian Networks, and then describes the methodology of using the Bayesian Networks methods for prioritizing Lean Six Sigma efforts. The chapter includes a case study of a labor-intensive furniture manufacturing facility where this new methodology was implemented.

This work is relevant in today’s economy because U.S. manufacturers are facing great challenges in the rapidly expanding global marketplace. A principal concern of U.S. manufacturers is the cheap labor and other associated costs offered by abroad competitors. This chapter addresses via case study an example in the furniture industry. The furniture industry is still labor-intensive where the product is fabricated by employees manually with the assistance of various tools and equipment. The manufacturers of residential wood furniture are suffering an even greater challenge to stay competitive in comparison to other specific manufacturing industries. To further complicate matters, the nature of the furniture manufacturing process, which relies heavily on the people, makes it more fragile to the potential risks when Lean Six Sigma techniques are implemented. Removal of safety buffers requires interruption of the flow due to issues related to materials and equipment. Another example is the imbalanced flow, which is typical when most of work is done by people. It has long been recognized that human performance has a substantial impact on the reliability of complex systems.

The transition of process improvement is normally a major undertaking that requires great resources and aims at potentially changing all aspects of the business. The benefits include not only cost savings and process improvements, but also fostering organizational culture that makes the business more successful. A well-planned program can alleviate unnecessary problems during the implementation; however, a great range of risks can impact the implementation of process improvement initiatives. Therefore, there is a need to develop a model to identify the possible risks, evaluate their impacts, and subsequently develop risk treatment strategies to ensure the success of process improvement implementation.

In Section 2 we present five chapters on Sales and Financial Analytics.

Prior research has shown that when making high-tech purchase decisions, consumers consider not only the relative advantage afforded by currently available products but also the relative advantage expected from future generation products. Additionally, recent empirical evidence shows that prices for high-tech products often decline faster than the technology advances.

In his chapter entitled “Consumer Preference for the Latest Technological Offering: The Impact of Chasing Technology on Consumer Purchase Behavior,” Boone takes both these findings into account and investigates high-tech consumer purchase decisions under asymmetrical rates of technological advance and price decline. He proposes and tests a theoretical model of consumer purchase behavior that is based on four premises: (1) consumers are capable of forming expectations about future generation products based on a firm’s past product introductory strategies; (2) consumers use information about

current generation products and expectations about future generation products to form perceptions about a product's rate of technological advance, price decline, and time of introduction; (3) consumers consider a product's rate of technological advance, price decline, and time of introduction when making purchase decisions; and (4) the impact of technological advance, price decline, and time of introduction on purchase decisions is moderated by a product's level of technological sophistication.

In study one, Boone examines the antecedents of expectation formation and investigates how consumers use information about past product introductions to make predictions about the relative advantage and time of introduction of next generation products. His results suggest that consumer expectations of the intergenerational improvement in product features (relative advantage) and the intergenerational introductory time for a next generation product are linear extrapolations of consumer perceptions of the relative advantage and intergenerational improvement, respectively, of prior generation products. He also finds that the most recent product introductions have the biggest influence on expectation formation.

In study two, Boone further tests his model of consumer purchase behavior and finds that, all else being equal, consumers are more likely to purchase low-tech products than high-tech products because the former are inherently less risky. He also finds that consumers are more likely to purchase later generations of a product when the rate of technological advance is greater than the rate of price decline, and less likely to purchase later generations of a product when the rate of technological advance is less than the rate of price decline. Boone further finds that a product's level of technological sophistication moderates a consumer's decision to purchase the latest technological offering. That is, consumers are more likely to purchase later generations of high-tech products but are indifferent between purchasing later and earlier generations of low-tech products. Finally, Boone finds that as the salience of expectations of future product introductions increases, consumers are less likely to purchase high-tech products than low-tech products.

The managerial implications of Boone's research are important and may enable firms to increase the purchase likelihood of their products by managing consumer perceptions of rates of technological advance, price decline, and time of introduction. By adopting appropriate pricing and product release strategies, and using media communications (product introduction announcements) to increase the salience of next generation product introductions, firms can selectively increase sales across different generations of their product offerings.

In today's globalization era organizations, communities and supply chains operate in a value network wherein collaboration and group decision making are believed to be the core of long-term advantage. Involving all relevant policy makers, experts and stakeholders is acknowledged to be sufficient for consensus construction, implementation of selected practices and sustainable development). Supporting a supplier selection decision making process becomes intensely difficult due to the dynamic and ill-structured environment, as well as presence of conflicting groups of interests (such as shareholders, purchasing representatives, suppliers and ultimate customers) each with their own perceptions on the way the problem should be managed.

In their chapter entitled "A Multi-Criteria Vendor Selection and Order Allocation GDSS Using a Mixed Alternative and Value Focused Thinking Approach," Sodenkamp and Suhl present a comprehensive analytical framework for practical support of all types of supplier selection and order quantity assignment decisions. Hereby, the possible applications are not limited to typically discussed situations underlying the long-term supply contracts of manufacturing companies. The authors go beyond and analyze challenges in trading companies, whose survivability depends on constantly successful (daily) purchasing decisions. Independently on the type of commodity, trading decisions are affected by a large

number of extremely complex strategic, tactical and operational factors. Indeed, identification of all relevant criteria is a challenging practical task. Based on extensive interviews with trading representatives in Germany and literature reviews, the authors present a new combined alternative- and value-focused thinking approach that helps all concerned decision makers to derive a joint set of evaluation parameters. Moreover, the new formal way of decision group structuring implies, on the one hand, drawing clear distinctions among the decision makers' professional expertise domains, e.g., financial, political, social, technological, legal, etc.; and, on the other hand, articulating individuals' responsibilities and tasks in terms of establishing value systems or detecting characteristics of candidate vendors. As a result, the group is structured and participant competences are formalized.

In order to tackle diverse problem perspectives, quantitative and qualitative performance measures as well as priorities of supply chain participants in an accurate analytical way, the authors describe a comprehensive and flexible step-by-step decision support procedure. The approach contributes to the achievement of the following goals: (1) to derive consensus-based rankings of vendors based on their value to the stakeholders; (2) to classify vendors into similarity groups reflecting their relative competitive advantages and disadvantages; and (3) to support daily purchasing decisions based on market-rate prices and taking into consideration compound strategic importance weights of vendors. Furthermore, the authors exemplify applicability and usefulness of their approach with two real-world case studies of fuel oils and cereals vendor selection and order allocation in one of the largest agricultural corporation in Germany, Raiffeisen. In summary, the authors have achieved their objectives very well. They promote a sustainability-driven analytical group decision support perspective regarding the choice of methods for the elicitation, representation and quantification of supply chain participants' judgments, assessment of the estimates reliability and finally, for finding collaborative supplier selection solutions.

When a firm sells goods to foreign customers in countries with currencies that are different from their own, the price that these customers pay will depend on the foreign exchange rate. An appreciation of the firm's currency relative to the customer's currency will make the goods more expensive in foreign markets. If there are substitutes for the goods in the foreign market or other foreign competitors supply the goods at a cheaper price, then the foreign customer will more likely switch to new suppliers. Of course, the firm can reduce the price of its goods to its foreign customers by the amount of the foreign exchange rate change thereby absorbing the amount of the increase in price in its profit margin. The extent to which this can be done depends on the current level of the firm's profit margin. Alternatively, if the firm's foreign exchange rate depreciates relative to the currency of the foreign customer, then the foreign good becomes cheaper to the foreign customer. The foreign customer is unlikely to switch suppliers in this situation. However, the firm can choose to increase the export price thereby not allowing the foreign customer to benefit from the depreciation. Firms are likely to adopt this strategy especially when their imports become more expensive due to foreign exchange rate changes or cost increases. Studies on pricing-to-market therefore examine the extent to which firms alter their foreign prices in response to foreign exchange rate changes.

In their chapter entitled "Modeling Foreign Exchange Rate Pass-Through Using the Exponential GARCH," Lai and Joseph explore these issues for UK firms using a methodology that is line with the nature of the data. They find that UK firms adjust their export prices in line with changes in foreign exchange rates. The amount of price adjustment depends on the type of export sector. As such, they find that the price adjustments are more substantial for the Fuels sector and smaller for the Textiles sector. This reflects the degree of competition in those markets with competition likely to be greater in the Fuels sector. Of course, UK firms will price-to-market more if they wish to retain their foreign markets.

However, the price adjustments do not strongly depend on the size of the foreign exchange rate change. So the extent of asymmetric pricing, e.g., lowering prices following large currency appreciations, is not substantial. It is possible that UK firms attempt to retain foreign market share and do not change the foreign price of their good in a substantial way in response to foreign exchange rate changes.

The vim of any nation is reliant upon the sound and effective banking system. There has been a significant change in the business outline of banks in the developing countries i.e., from traditional banking to other non-traditional banking activities such as insurance, mutual funds etc. Banks are adding more and more products and services to their product lines to satisfy the customers effectively and efficiently. The banking system should not only be hassle free but it should be able to meet new challenges posed by the latest technologies and other factors as well. The banking system in the developing countries has changed significantly from the traditional setup to the advanced technological setup. It is no longer confined only to cities but has reached even the remotest corners. Internet has changed the face of banking system in the developing economies by reducing the costs of banking and transactions. Internet has been proved to be the cheapest delivery channel for doing all kinds of e-commerce transactions. The advancements in technology and communications have forced banks to diversify their products and services for comforting the customers as well to compete in the market. Banks are concerned only about the convenience and comfort to the customer. Many banks are striving hard to provide the best internet banking services to their customers. It is important for bank managers to frame their problems appropriately and address them in a proper manner. Otherwise, the problems poorly addressed may create more problems and take longer time to fix in the long run. Hence, it is of prime importance for bank managers to identify the factors that influence the adoption of these services.

In their chapter entitled “Customers’ Perspectives of Internet Banking Adoption in Developing Economies,” Varaprasad, Sridharan, and Unnithan determine the significant factors which influence the consumer’s adoption of internet banking services. People use internet banking services motivated by their desire to comfort themselves. There are individual differences in the adoption of these internet banking services and this study identifies to find the reasons for adoption or non-adoption of these services. This study investigates the factors which drive the customers to adopt internet banking services. The results of this study show that perceived usefulness, perceived ease of use, perceived risk, relative advantage, and conspicuousness are the important determinants of internet banking adoption. Perceived usefulness, relative advantage and conspicuousness have been found to have a strong relationship with intention to adopt internet banking. In general, the findings indicate that income levels and education play an important role in the adoption of internet banking. The findings of this study are particularly important for banks to concentrate on the problem areas to attract more customers and to help decide how to allocate resources to retain and expand their customer base. Banks also need to concentrate on those factors which are really influencing the bank users in adopting internet banking. With an increase in the penetration rate of internet banking, the work force required in the banks and transaction costs can be reduced significantly. This research article provides valuable insights into the underlying contextual factors of internet banking behavior for researchers and practitioners. The outcome of the study can be used to formulate new marketing strategies to increase the customer base of internet banking market. Hence, banks should consider the importance of the factors for designing, implementing, maintaining and promoting their products and services.

Computers are pervasive in all areas of business activities; including business data storing, management, and analysis. Indeed, computers are essential to control information within the firm and also to improve the business performance. One of the most applications of computers in business is the use of machine learning techniques to model and predict stock market to better manage portfolio, evaluate

risk, and make profits. For instance, machine learning focuses on construction and study of systems that can learn from data. As a result, based on known properties learned from the training data predictions and classifications can be performed. For instance, data is the basic form of information that needs to be collected, processed, and analyzed to create knowledge which is in turn useful information used for appropriate financial modeling and prediction.

In his chapter entitled “Practical Machine Learning in Financial Market Trend Prediction,” Lahmiri presents three machine learning algorithms or classifiers, namely the support vector machine, probabilistic neural networks, and the statistical k nearest neighbor and their application to stock market trend modeling and prediction based on wavelet transform coefficients, macroeconomic variables, and technical analysis indicators. In one hand, economic theory states that asset prices are related to macroeconomic changes. On the other hand, technical analysis is recognized by most of traders as one of the most popular approaches to analyze price movements. And, the wavelet transform is a multi-resolution analysis technique which is receiving a growing interest in financial prediction because of its ability to analyze non-stationary time series in frequency domain. Usually, a dimension reduction technique is employed to discover and isolate the patterns and trends in the initial large data set composed of various macroeconomic variables and technical indicators used as predictive variables. Indeed, a particular attention should be given to the choice of the macroeconomic variables and technical analysis indicators considered as inputs to the machine learning algorithms since they may significantly affect the global accuracy of the classifiers. In this work, starting from a large set of predictive inputs, a feature selection procedure is adopted to choose the most informative and non-redundant inputs. Lahmiri compares the previous machine learning techniques and demonstrate their applicability to efficient stock market trend prediction depending on wavelet transform coefficients, macroeconomic variables, and technical analysis indicators used as predictors. The performances of these approaches are compared with the aim of assessing which approach is more suited for stock market future trend change prediction depending on the strategy of the portfolio manager.

In Section 3 we present seven chapters in Production and Operations Analytics.

Optimum decision making is essential for reducing material and energy requirements. The area has received enormous attention in the recent years, primarily due to rapid development in computer technology, which includes development and availability of user-friendly software, high-speed and parallel processors etc. In the real-life problems, many times there is lack of information about a system or conflict in the information/data available. So, the decision making becomes difficult. Accordingly to degree of information available, if the complete information about a system is available it can be known as a white system, and if no information is available the system can be named as black system. Systems with limited information or fuzziness in the available information can be named as grey systems and accordingly the systems may have a variety of available solutions. The grey relation analysis is an important approach of grey system theory in the application of decision making.

Taguchi is an optimization technique used for solving the problems in the field of science, engineering and management. The method utilizes a well-balanced experimental design (with reduced number of experiments) called orthogonal array design. Signal-to-noise ratios are also evaluated, which are logarithmic functions of the desired output, serve as objective functions for optimization within experimental domain. However, the traditional Taguchi method is not useful for solving multi-objective optimization problems. The optimal process parameters obtained from the Taguchi method are intensive to the variation of environment conditions and other noise factors. Optimization of multiple performance characteristics is much more complicated than of single performance characteristics.

In recent years, various new approaches to optimization have been proposed. Many researchers have used combinations of available techniques to solve multi performance characteristic problems depending upon the situation and accuracy desired in the results, to make the results more reliable. In their chapter entitled “Grey-Based Taguchi Analysis Approach for Optimization of Multi-Objective Problem,” Kalsi, Sehgal and Sharma discuss a combination of grey relation and Taguchi based analysis for optimization, which can be effectively adapted for solving the complicated interrelationships among the designated performance characteristics of Multi-objective problems. Gray relation analysis is known for multi-objective problem solving by reducing number of factors into one coded factor, whereas Taguchi is well accepted method solve the problem by reducing number of experiments. To accomplish the goal, the authors include comprehensive theories and simplified methods of this combination useful for various processes, and consider it particularly for machining processes. They select orthogonal array to analyze the effect of cutting speed, feed rate and depth of cut using cryogenically treated and untreated tungsten carbide cutting tool inserts. They evaluate the performance of the model in terms of main cutting force, power consumption, tool wear and material removal rate using main effect plots of signal to noise ratios. This study indicates that the grey based Taguchi technique is not only a novel, efficient and reliable method of optimization, but also contributes to satisfactory solution for multi machining objectives in turning process. This method is expected to be very useful to the engineers, designers and managers as it make their tasks easier, logical and effective.

Additive manufacturing is the process of making a three-dimensional solid object of virtually any shape from a digital model that can be used for both prototyping and distributed manufacturing. It is also suitable for tissue engineering, which employs constructs with complex shapes and microstructures and which has a high level of automation and accuracy. However, additive manufacturing processes also involve several primary areas of complexity that may not be measured precisely, due to uncertain situations. This is exactly what the analytical model reported in this study was designed to control. Furthermore, the model is able to rank additive manufacturing processes based on their relative complexities.

Complexity of an additive manufacturing process can be defined through two major aspects: technical design and processes. These aspects of the additive manufacturing technique encompass a lot of information that may not be measured precisely because of uncertain situations. As a result, additive manufacturing project failures are numerous in actual practice. As complexity measures become an efficient yardstick for managing a group of additive manufacturing techniques, having a quantitative model for analyzing relative complexity under uncertain situations is a must.

In their chapter entitled “Complexity Analysis in Additive Manufacturing for the Production of Tissue Engineering Constructs,” Jenab and Weinsier develop a model based on a fuzzy analytic hierarchy process and triangular fuzzy numbers to express the comparative judgments of the additive manufacturing process analyst. An additional aim of their study is to develop a fuzzy model that could rank the additive manufacturing processes for a tissue engineering construct based on their relative complexity. Methodological considerations become important when we consider additive manufacturing complexity problems under uncertain situations. Therefore, the evaluation process must be improved by robust techniques such as fuzzy analytic hierarchy process in order to come close to reality and human cognitive behavior. Jenab and Weinsier propose fuzzy analytic hierarchy process to handle the fuzzy problems that have a hierarchical form. In the fuzzy analytic hierarchy process approach, the values in the pairwise comparison matrix are fuzzy numbers, where they can be modified according to the product analyst’s preference.

Manufacturing processes are based on the building of a solid object from three-dimensional model data by joining materials, usually layer upon layer in order to enhance the production of the tissue engineering constructs. This may have an impact on the design and manufacturing of additive manufacturing products. Therefore, measuring the complexity becomes an important task for management. However, lack of information and uncertain situations can create obstacles. This study shows that fuzzy analytic hierarchy process is a good method, because it eliminates inconsistencies due to personal feelings or judgments of the process analyst. Without applying fuzzy analytic hierarchy process, the overlooked inconsistencies can lead to misunderstandings of the complexity of the additive manufacturing processes. As a result, insufficient budgetary support and resources may not be allocated to the processes.

In their chapter entitled “Performance Analysis of a Markovian Working Vacations Queue with Impatient Customers,” Laxmi, Goswami and Jyothsna present a finite buffer working vacations queue wherein the customers can balk or renege. Working vacation is an extension to the regular vacation model, where the server is switched off during the vacation. During working vacations, instead of completely stopping the service, the server continues serving the customers with a different service rate. In practice the service rate during working vacations is lower than the one during service period, but it is not a modeling restriction. These models are suitable to describe practical system features like the effect of a lower intensity administrative task of the server, e.g. a safeguard service, following an active period. The regular vacation model is a special case of the working vacation model with zero service rates and the analytical complexity of working vacation models is higher than the one of the regular vacation model. Waiting for service is usually an unpleasant experience and represents the loss of valuable resources that translates into psychological as well as economic costs of waiting. Impatience is the most prominent characteristic as individuals always feel anxious and impatient during waiting for service in real life. Balking and reneging are two such impatient phenomena. Balking defined as deciding not to join the queue and reneging defined as joining the queue but leaving without being served. The study of balking and reneging in queueing systems with working vacations appears to be a recent endeavor. The contribution of this chapter is the queueing theoretic analysis and the results for the $M/M/1$ working vacation queueing model with balking and reneging. The service times during regular busy periods are assumed to be exponential. The server takes working vacations whenever the system becomes empty at service completion instants. During working vacations the service is provided to customers generally with a slower rate than the regular service rate. The service times during working vacation and vacation times are exponentially distributed. The framework of the model with working vacations, balking and reneging under steady-state is set. The steady-state equations are re-written in matrix form and using the blocked matrix method, the authors have obtained the steady-state probability vector in terms of inverse of two matrices and the computations of these inverse matrices are discussed. The major interest of the chapter is in studying the effect of balking and reneging on various performance measures of the model. A cost optimization problem through direct search method is considered with an objective to obtain the optimum service rate during regular busy period. Further, the authors have also presented excellent numerical results in the form of tables and graphs and discussed the impact of model parameters on various performance measures of the system.

Most of the existing inventory models in the literature are developed under the assumption that “all the parameters are either known with certainty or follow some well-defined probability distribution,” i.e., in crisp environment. However, in practice, this type of assumption is unrealistic as it is rare to predict the parameters or to define their exact distribution with certainty due to several factors. In their chapter

entitled “EOQ Model with Permissible Delay in Payments under Fuzzy Environment,” Jaggi, Sharma and Jain introduce the concept of fuzziness in inventory management. Further, in the traditional economic order quantity model, it is assumed that the retailer must pay for the items when he receives the lot. However, in real practice, due to the globalization of market economy and also to the fierce competition among the suppliers, they are bound to offer trade credit to the retailers to promote their business. From the retailer’s point of view, generally, trade credit is considered as the most flexible sources of short term financing and during this free credit period, neither capital nor interest is payable to the supplier but as for the expiring credit period interest is payable under the term and condition agreed upon. Therefore, economically, the retailer should wait to settle the account up to the last day of the credit period allowed by the supplier.

Jaggi, Sharma and Jain present an inventory model under the condition of permissible delay in payments in highly fuzzy environment whereas all the parameters (viz. demand rate, ordering cost, holding cost, purchase cost, selling price, interest earned and interest paid) of the model, excluding permissible delay period and cycle length, are assumed to be trapezoidal fuzzy numbers. The arithmetic operations are defined by using the function principle and the cost function and economic order quantity have been defuzzified using signed distance method. The purposed model determines the cycle length and economic order quantity by optimized the total cost function. Besides the numerical illustration, a comprehensive sensitivity analysis is also conducted to explore the effects of changes of the key parameters (viz. permissible delay period, and interest payable rate earned) on the optimal results. This model seems to be more realistic on the behavior of the parameters. The findings of the proposed work provide very important managerial insights to the decision makers to decide the appropriate ordering policy in today’s uncertain environment.

The large and complex real-life problems are often transformed into mathematical models to get the optimum solutions because it becomes difficult to take optimum decisions based on established theories, intuition and experience for such kind of complex problems. In their chapter entitled “An Economic Order Quantity Model for New Products When Demand Follows Dynamic Innovation Process,” Aggarwal and Kumar propose a mathematical model in inventory management which deals with economic ordering policies. The first and foremost task of any economic order quantity model is when to order and how much to order which is necessary to meet its requirement and to avoid over or under inventory that can impact the financial figures. The authors have considered an inventory model where demand varies with time and based on innovation diffusion criterion. The innovation diffusion theory is concerned with the diffusion of new products and has been extensively used in the field of marketing. Diffusion is defined as the process by which an innovation is communicated through certain channels over time among members of a social system. There are various marketing models showing different behavior of diffusion of new products by incorporating the innovation diffusion concept. The innovation diffusion theory plays an important role when the diffusion patterns of new products are taken into account.

The model developed here is based on dynamic demand pattern of the system influenced by innovation diffusion theory where it has been considered that the diffusion of new product takes place in the environment of dynamic innovation process having dynamic potential market size. The dynamic innovation process has been considered in the form of coefficient of innovation, which varies with time and has direct link with external influence such as mass media whereas the dynamic potential market size deals with expanding customer base. The model has been solved with a simple solution procedure by taking different numerical values. A comprehensive sensitivity analysis has been performed with respect

to different parameters that give the different economic ordering policies for different situations. On the basis of the relationship between the nature of parameters and the optimum solutions, the authors have clearly mentioned the applicability of the model in the observations section that how to take optimum decisions under different scenarios for certain defined conditions. The unique contribution of the article can be inferred from the Literature Review section. The special cases considered in the article shows behavior of the model in particular situations. The overall utility of the model is how to take optimum decisions regarding economic ordering policies when a new product is introduced into the market in a dynamic innovation diffusion environment.

In their chapter entitled “Ordering Policy in a Two-Warehouse Environment for Deteriorating Items under Inflationary Conditions,” Jaggi, Pareek, Khanna and Sharma determine the inventory policy which minimizes the present worth of the total cost. A comprehensive sensitivity analysis is conducted to explore the effects of changes of the key parameters (viz. holding costs, deterioration rates and inflation rate) on the optimal results. Finally the findings of the present study serve as a ready reckoner to the decision maker to adopt the appropriate policy under the different circumstances.

Automation and higher precision manufacturing are two major thrusts in the development of manufacturing technologies. Precision manufacturing refers to dimensional precision, angular precision, form precision, surface roughness, kinematic precision and surface layer alternations. Precision manufacturing is a challenging process due to sources of error which are associated with assignable causes. Assignable causes include geometrical cause, cutting cause, drive cause, and environmental cause. Although these sources have been studied in literature pertaining to precision manufacturing, there is no analytical model to study the errors. In their chapter entitled “Failure Analysis in Precision Manufacturing,” Jenab and Moslehpour develop a state diagram and a Markovian model to assess the sources of the error in precision manufacturing. They use the result obtained from the Markovian model for maintenance activities. The Markovian model presents generic state transition diagrams for a precision manufacturing machine with repair and restore possibilities. They classify the errors into geometrical, cutting, drive, and environmental errors. Upon occurrence of each, the maintenance crew travels to the site for repair. They also develop a macro in Excel to solve the state diagram that shows the probability of being in each state.

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