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Analytics and Data Science

Advances in Research and Pedagogy

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Contents

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Chapter 1
Exploring the Analytics Frontiers Through Research and Pedagogy

Amit V. Deokar, Ashish Gupta, Lakshmi S. Iyer, and Mary C. Jones

Abstract The 2015 Business Analytics Congress (BAC) brought together academic professionals and industry representatives who share a common passion for research and education innovation in the field of analytics. This event was organized by the Association for Information System's (AIS) Special Interest Group on Decision Support and Analytics (SIGDSA) and Teradata University Network (TUN) and held in conjunction with the International Conference on Information Systems (ICIS 2015) in Ft. Worth, Texas from December 12 to 16, 2015. The theme of BAC 2015 was *Exploring the Analytics Frontier* and was kept in alignment with the ICIS 2015 theme of *Exploring the Information Frontier.* In the spirit of open innovation, the goal of BAC 2015 was for the attendees to contribute their scientific and pedagogical contributions to the field of business analytics while brainstorming with the key industry and academic leaders for understanding latest innovation in business analytics as well as bridge industry-academic gap. This volume in the Annals of Information Systems reports the work originally reviewed for BAC 2015 and subsequently revised as chapters for this book.

Keywords Decision support • Business analytics • Congress • Business intelligence • Panels • Research • Pedagogy

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It has been a tradition for the AIS Special Interest Group on Decision Support and Analytics (SIGDSA) to organize the pre-International Conference on Information Systems (pre-ICIS) analytics workshop with the title of "Congress" when the event is held in the North American region. This "Congress" was the fourth such in its series that began in 2009. Planning for Business Analytics Congress held in December 2015 in Ft. Worth, Texas began in Fall 2014. The theme of Business Analytics Congress (BAC 2015) was decided as *Exploring the Analytics Frontiers* and was kept in alignment with the ICIS 2015 theme of *Exploring the Information Frontier*.

A major purpose of the Congress was to bring together a core group of leading researchers in the field to discuss the trends and future of business analytics in practice and education. This included discussion of the role of academicians in investigating and creating knowledge about applications of business analytics and its dissemination. This volume contributes to this purpose by striking a balance between investigating and disseminating what we know and helping to facilitate and catalyze movement forward in the field. This volume in the Annals of Information Systems includes papers that were originally reviewed for BAC 2015. These chapters were presented at BAC 2015 and subsequently revised for inclusion as chapters for this book.

BAC 2015 was sponsored by both industry and academia. The two main industry sponsors were Teradata University Network (TUN) and SAS, which in addition to providing financial support for the Congress, helped with bringing in distinguished speakers from industry. TUN also sponsored a reception for attendees the first evening of the event. Teradata University Network is a free, web-based portal that provides teaching and learning tools used by over 54,000 students and educators world-wide. These include majors as diverse as information systems, management, business analytics, data science, computer science, finance, accounting and marketing. The content provided by TUN supports instruction ranging from introductory information systems courses at the undergraduate level to graduate and executive level big data and business analytics classes. A key element of TUN success is that it is "led by academics to ensure the content will meet the needs of today's classrooms." SAS is a corporate leader in the provision of statistical and analytical software, services and support. SAS supports customers at over 80,000 sites around the world and provides several resources (www.sas.com/academic) for academics in support of their education needs. Academic sponsors included the University of Arkansas, University of North Carolina at Greensboro, University of North Texas, and University of Tennessee Chattanooga.

The day and a half BAC2015 event began on Saturday December 12th with several workshops. The first workshop was sponsored by SAS and focused on SAS® Visual Analytics and SAS® Visual Statistics. The workshop presented by Dr. Tom Bohannon focused on the basics of how to explore data and build reports using SAS Visual Analytics. It also covered topics on building predictive models in SAS Visual Statistics, such as decision tree, regression and general linear models.

The next workshop was sponsored by TUN and illustrated the vast academic resources available on TUN. It was presented by Drs. Barbara Wixom and Paul Cronan. The presenters discussed the rich repertoire of resources for faculty and students covering topics related to BI/Data Warehouse, database and analytics. Further, the talk session showcased software resources available from TUN and partnership

with BI and Analytics companies such as MicroStrategy, SAS and Tableau that provide excellent resources to support analytics and visualization topics. The University of Arkansas is also a TUN partner and their resources were also discussed.

A workshop organized by Prof. Ramesh Sharda included Prof. Daniel Asamoah, Amir Hassan Zadeh, and Pankush Kalgotra and focused on pedagogical innovations related to delivering a Big Data Analytics course for MIS Programs. This session covered their experiences in offering a semester long course on Big Data technologies and included some hands-on demonstrations that they have used in their courses. Discussions also included the course outline and learning objectives followed by a description of various teaching modules, case studies, and exercises that they have developed or adapted.

The last session on Saturday was a panel on *Innovations in Healthcare: Actionable Insights from Analytics*. It was moderated and organized by Dr. Ashish Gupta. Panelists included Ms. Sherri Zink from BlueCross BlueShield of Tennessee, Ramesh Sharda from Oklahoma State University, David Lary from University of Texas Dallas and Ashish Gupta from Auburn University. This panel shared insights that have been derived using big data approaches, and how they have led to transformations in areas related to health. Example include analytics in insurance from consumer's perspective, sports, pollution and allergy management, utilizing disparate data using new data science paradigms such as deep learning framework and other enabling technologies.

The Sunday session began with an industry keynote by Ms. Sherri Zink, Senior VP, Chief Data and Engagement Officer, BlueCross BlueShield of Tennessee. The keynote address provided detailed insight into applications of analytics for empowering consumers, reducing redundant consumer touch points, optimal treatment plan based on information shared between provider and payer, informed decision making. Her talk provided an overview of how analytics could be used to develop a 360-degree view of consumers with the help of various approaches that foster the data integration, transformation & prediction, and eventually towards actionable insights. Key takeaways from the keynote address included a description of how clinical, life style and psychographic data could help develop a better understanding about consumer for stratification purposes using segmentation and clustering approaches. Such insights could help in developing better wellness programs and creating continuous feedback.

The keynote was followed by a panel entitled *AACSB Resources for Building a Business Analytics Program*. The panel was moderated by Dr. David Douglas and panelists included Drs. David Ahuja, Paul Cronan, Michael Goul, Eli Jones, Dan LeClair and Tom McDonald. The panel discussed AACSB's analytics initiative designed to help schools develop programs by providing a mix of curriculum content, pedagogy, and structure resources for schools contemplating development of or enhancement of Business Analytics. Panelists who were members of the AACSB Analytics Curriculum Advisory Group shared resources and encouraged interactive attendee discussion. Consistent with AACSB's goal of providing services to member schools across the globe, they shared information on initial analytics curriculum development seminars that are being be offered in the three cities that house AACSB's regional offices: Tampa (USA), Singapore, and Amsterdam.

Lunch and afternoon sessions focused on research presentations, both complete and research-in-progress, prototype and tutorials. The BAC 2015 event, for the first time, included a prototype presentation that highlighted various aspects of the prototype such as novelty, architecture, functioning, ongoing and future work, etc. Prototypes presented related to both teaching and research applications. Examples of such prototypes included original web applications, mobile apps, functional analytics models, devices (such as IoT) connected to data science applications, and teaching games that have an integrated study or analytics component. A report on one such prototype, *Say It Right: IS Prototype to Enable Evidence-Based Communication Using Big Data*, by Simon Alfano is included as a chapter in the book.

In keeping with the *Exploring the Analytics Frontier* theme of BAC 2015, the research track sought forward-thinking research in the areas of analytics and business intelligence, with special focus on the role of business intelligence and analytics in the creation, spread, and use of information. The research track was co-chaired by Drs. Barbara Dinter, Babita Gupta, and Anna Sidorova.

Likewise, the teaching track also aligned their call with the theme of the congress and sought pedagogical research contributions, teaching materials, and pedagogical practices/cases that address acquisition, application, and continued development of the knowledge and skills required in the usage of business analytics in the classroom, with emphasis on business intelligence, social media analytics, big data analytics, high performance analytics, data science, visualization, and other emerging analytic technologies. The teaching track was co-chaired by Drs. Sule Balkan, Joseph Clark, and Nick Evangelopoulos.

The later chapters in the book provide many of the research and teaching track papers, along with a prototype report, and a tutorial report.

Biographies

Amit V. Deokar is an Assistant Professor of Management Information Systems in the Robert J. Manning School of Business at the University of Massachusetts Lowell. Dr. Deokar received his Ph.D. in Management Information Systems from the University of Arizona. He also earned a M.S. in Industrial Engineering from the University of Arizona and a B.E. in Mechanical Engineering from VJTI, University of Mumbai. His research interests include data analytics, enterprise data management, business intelligence, business process management, and collaboration processes. His work has been published in journals such as *Journal of Management Information Systems*, *Decision Support Systems* (*DSS*), *The DATA BASE for Advances in Information Systems*, *Information Systems Frontiers* (*ISF*), *Business Process Management Journal* (*BPMJ*) and *IEEE Transactions*. He is currently a member of the editorial board of DSS, ISF, and BPMJ journals. He has been serving as the *Decision Support and Analytics* Track Chair at the international AMCIS 2014–17 conferences, and is currently the Chair of the AIS Special Interest Group on Decision Support and Analytics (*SIGDSA*). He was recognized with the 2014 IBM Faculty Award for his research and teaching in the areas of analytics and big data.

Ashish Gupta is an Associate Professor of Analytics in Raymond J. Harbert College of Business at the Auburn University. Prior to this, he served as the (founding) director of Analytics Research Center and an Associate Professor of Analytics & IS in the College of Business at the University of Tennessee Chattanooga. He has been a Visiting Research Scientist at the Mayo Clinic Rochester, Visiting Associate Professor in Biomedical Informatics at the Arizona State University and research affiliate with University of Tennessee Health Science Center in Memphis. He has a Ph.D. in MSIS from Spears School of Business at Oklahoma State University. Dr. Gupta's research interests are in the areas of data analytics, healthcare informatics, sports analytics, organizational and individual performance. His recent articles have appeared in journals such as *MIT Sloan Management Review*, *Journal of Biomedical Informatics*, *IEEE Transactions*, *Information Systems Journal*, *European Journal of Information Systems*, *Decision Support Systems*, *Information Systems Frontiers*, and *Communications of the Association for Information Systems*. His research has been funded by several agencies and private enterprises. He has published four edited books.

Lakshmi S. Iyer is Professor of Information Systems and Director of the Master's in Applied Data Analytics Graduate Programs at the Walker College of Business, Appalachian State University. Her research interests are in the area of business analytics, knowledge management, emerging technologies & its impact on organizations and users, and social inclusion in computing. Her research work has been published in or forthcoming in *Communications of the AIS*, *Journal of Association for Information Systems*, *European Journal of Information Systems*, *Communications of the ACM*, *Decision Support Systems*, *eService Journal*, *Journal of Electronic Commerce Research*, *International Journal of Business Intelligence Research*, *Information Systems Management*, *Journal of Global Information Technology and Management*, and others. She is a Board member of Teradata University Network, recent past-chair of the Special Interest Group in Decision Support and Analytics (*SIGDSA*, formerly *SIGDSS*). She has served as a Guest Editor for *Communications of the ACM*, and the *Journal of Electronic Commerce Research*. She is also co-editor of *Annals of Information Systems* Special Issue on "Reshaping Society through Analytics, Collaboration, and Decision Support: Role of BI and Social Media," from the 2013 pre-ICIS workshop in Milan, Italy.

Mary C. Jones is Professor of information systems and Chair of the Information Technology and Decision Sciences Department at the University of North Texas. She received her doctorate from the University of Oklahoma in 1990. Her work appears in numerous journals including *MIS Quarterly*, *European Journal of Information Systems*, *Behavioral Science*, *Decision Support Systems*, *System Dynamics Review*, and *Information and Management*. Her research interests are primarily in the impact on organizations of large scale, organizational spanning information systems such as ERP or business intelligence systems. She teaches a variety of courses including Enterprise Applications of Business Intelligence, IT Project Management, and a doctoral seminar in General Systems Theory.

Chapter 2
Introduction: Research and Research-in-Progress

Anna Sidorova, Babita Gupta, and Barbara Dinter

Abstract Inspired by the theme "Exploring the Information Frontier" of the ICIS 2015 conference, the Pre-ICIS Business Analytics Congress workshop sought forward-thinking research in the areas of data science, business intelligence, analytics, and decision support with a special focus on the state of business analytics from the perspectives of organizations, faculty, and students. The research track aimed to promote comprehensive research or research-in-progress on the role of business intelligence and analytics in the creation, spread, and use of information. This work has been summarized in this chapter.

Keywords Business intelligence • Analytics • Data science • Big data • Social media analytics • Decision support systems • Curriculum design • Pedagogy

2.1 Introduction

Business Intelligence and Analytics (BI&A) have become core to many businesses as they try to derive value from data. Although addressed by research in the past few years, these domains are still evolving. For instance, the explosive growth in big data and social media analytics requires examination of the impact of these

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technologies and applications on business and society. As organizations in various sectors formulate IT strategies and investments, it is imperative to understand how various technologies and applications under the BI&A umbrella such as business intelligence, data warehousing, big data and big data analytics, decision support, and data visualization contribute to organizational information processing, and ultimately organizational success.

In the rest of this editorial we introduce the papers included in this chapter. The papers address three broad issues: (1) business intelligence and analytics capabilities and organizational impact, (2) social media analytics, and (3) individual, organizational and societal implications of big data. The remainder of this editorial is structured around these themes.

2.2 Organizational Use and Impact of Business Intelligence and Analytics

As organizations invest heavily in BI&A in hopes to improve their competitive stance, researchers seek to develop theoretical frameworks that explain the strategic role of BI&A, and help better understand the key factors associated with successful organizational implementation and usage of BI&A. The papers presented here build on several theoretical perspectives, including the capabilities view of the firm, value chain model, and the IS success model.

A paper titled *Business Intelligence Capabilities* (Ramakrishnan et al. 2018) proposes a theoretical framework for understanding core business intelligence capabilities. As BI systems become an integral part of value delivery in modern organizations, organizations need to go beyond the view of BI as a tool or artifact, and focus on developing BI capabilities. The authors draw on the IT capabilities framework and propose three categories of BI capabilities, BI innovation infrastructure capability, BI process capability and BI integration capability, which contribute to the organizational success. The proposed taxonomy can be used to inform practitioners engaged in building BI capabilities in their organizations. It also represents an important step in developing comprehensive nomological network of BI capabilities.

A (RIP) paper titled *Big Data Capabilities: An Organizational Information Processing Perspective* (Isik 2018) presents a theoretical model of big data capabilities that is inspired by the organizational information processing perspective. The paper argues that the realization of value from big data depends on an adequate fit between big data processing requirements and big data processing capabilities. Another (RIP) paper titled *Business Analytics Capabilities and Use: A Value Chain Perspective* (Bedeley et al. 2018) proposes a value chain based approach for analyzing business analytics (BA) capabilities of a firm. The authors analyze extant academic and practitioner literature and identify and describe how descriptive, predictive, and prescriptive analytics is used in primary and supporting activities of Porter's (2001) value chain. The literature analysis suggests that organizations focus on building BA capabilities in value chain activities where they measure the outcome of BA use in terms of the firm value.

Building on the IS success model, a paper titled *Critical Value Factors in Business Intelligence Systems Implementations* (Dooley et al. 2018), proposes and empirically tests a theoretical model on business intelligence system success. The paper extends Delone and McLean's model of IS success (Delone and McLean 2003) by relating critical success factors identified in extant BI&A research perceived information quality and perceived system quality. Through the use of survey methodology, the study finds empirical support for the relationships among critical success factors, perceived information quality, perceived system quality and user satisfaction with the system and with the information provided by the system.

Song et al. (2018) present in their paper *Business Intelligence Systems Use in Chinese Organizations* an international perspective on BI&A systems by investigating the impact of natural culture, in particular of Guanxi, a universal and unique Chinese cultural form. The authors have conducted a series of interviews in two indigenous Chinese organizations (including Alibaba) in order to test previously identified research constructs. Based on the results five propositions of BI systems use in Chinese organizations have been formulated, introducing a Guanxi perspective in BI use theories. Their results confirm that national culture has a significant impact on BI&A usage in China. Future research should be guided by these insights given the high relevance and influence of Chinese firms worldwide.

2.3 Social Media Analytics

Web 2.0 and social media facilitate the creation of vast amounts of digital content that represents a valuable data source for researchers and companies alike. Social media analytics relies on new and established statistical and machine learning techniques to derive meaning from large amounts of textual and numeric data. In this section we present several papers that seek to advance social media analytics methods and to demonstrate how social media analytics can be applied in a variety of contexts to deliver useful insight.

The first paper in this category, titled *The Impact of Customer Reviews on Product Innovation: Empirical Evidence in Mobile Apps* (Qiao et al. 2018) addresses a research field with promising opportunities—analyzing Web 2.0 data to foster innovation. The article examines the role played by customer reviews in influencing product innovations in the context of mobile applications. In particular, the authors verify the impact of online mobile app reviews on developers´ product innovation decisions and identify the characteristics of such reviews that increase the likelihood of future app updates. The findings suggest that it is important to explore user generated reviews in the context of customer-centered product innovation.

The paper *Whispering on Social Media* (Zhang 2018) examines the role of information circulated on social media in influencing stock performance during the so-called "quiet period" before an initial public offering (IPO). During such quiet periods organizations are not allowed to disclose any information that might influence investors´ decisions. Nevertheless, people discuss and comment about

upcoming IPS's in social media. The author finds in her research that the number of IPO-related tweets (and re-tweets) have significant positive correlation with the IPO's first-day return, liquidity and volatility.

The next contribution in this category presents another interesting use case for social media analytics. The paper titled *Does Social Media Reflect Metropolitan Attractiveness? Behavioral Information from Twitter Activity in Urban Areas* (Bendler et al. 2018) describes how the analysis of social media activities can generate insights for urban planning. When tweets are combined with other data such as the temporal information, spatial coordinates, appended images, videos, or linked places, a variety of applications can be supported, for example city planning, city safety, and investment decisions. For these purposes, the paper presents methods and measures for identifying the places of interest.

The paper titled *The Competitive Landscape of Mobile Communications Industry in Canada—Predictive Analytic Modeling with Google Trends and Twitter* (Szczech and Turetken 2018) describes how social media and Google Trends can be analyzed to predict competitive performance. Their predictive model builds on the previous studies that use Google Trends for predicting economic and consumer behavior trends in a particular business or industry. The authors improve these existing models by adding competition variables and incorporate Twitter Sentiment scores into their models to discover if Twitter sentiment scores modify some of the variance in the dependent variable that is not already explained by Google Trends data.

The research-in-progress paper titled *Scale Development Using Twitter Data: Applying Contemporary Natural Language Processing Methods in IS Research* (Agogo and Hess 2018) illustrates the use of Twitter data analytics for scale development. With the rise in social media communication, these data are becoming an important source to understand consumer behavior. However, challenges abound in transitioning the traditional measurement scales into social media data such as tweets. This paper uses natural language processing methods to develop measurement scales using big data such as tweets. They present a new scale called the technology hassles and delights scale (THDS) to show how the content validity of the scale can be improved by using a syntax aware filtering process that identifies relevant information from analyzing 146 million tweets.

2.4 Individual, Organizational and Societal Implications of Big Data

The rise of big data and associated analytical techniques has important implication not only for organizational, but for the society in general.

The research-in-progress paper titled *Information Privacy on Online Social Networks: Illusion-in-Progress in the Age of Big Data?* (Sharma and Gupta 2018) focusses on the issues of privacy and information disclosure on social media. They present a research model that draws together concepts from behavioral economic theory, the prospect theory which is an extension of expected utility hypothesis, and

the rational apathy theory, which is derived from the public choice theory in social psychology. The research methodology investigates why people choose to disclose vast amounts of personal information voluntarily on Online Social Networks (OSN). The proposed research model considers the effect of situational factors such as the information control, ownership of personal information, and apathy towards privacy concern of users on OSN. The article proposes value to practitioners in many different ways, the OSN providers and third parties could better understand how consumer's information disclosure behavior works and we could better understand why people tend to disclose too much of their personal information on OSN.

The research article, titled *Online Information Processing of Scent-Related Words and Implications for Decision Making* (Lin et al. 2018) takes a broader view of human information processing by examining the role of olfactory information in decision making. The authors propose a methodology to examine emotions triggered by olfactory-related information and how these could be simulated using visual cues in the context of consumer decision-making online. The methodology combines approaches from neuroscience with behavioral experiments. Their work studies the effectiveness of triggering olfactory emotions using sensory congruent brand names in online ads and also examines the influence on the consumers' attitudes and intentions towards brand and purchases. Results show that individual differences in olfactory sensitivity moderate the effects on cognitive and emotional processes. This work has implications for online advertising and marketing decisions made by the consumers.

2.5 Conclusion

The research work presented at the Special Interest Group on Decision Support and Analytics (SIGDSA) Workshop held on Dec 12, 2015, Fort Worth, TX was of considerable variety in addressing the issues facing the researchers in the business intelligence and analytics area. The research work included here represents some of the innovations taking place in the analytics, combining theories from not only information systems but also diverse fields such as neuroscience, psychology, behavioral economics, and social sciences. Future research promises to exciting with opportunities to extend literature and methodologies presented here to further the field of decision support systems in the context of business intelligence.

Biographies

Anna Sidorova is an Associate Professor in the Department of Information Technology and Decision Sciences at the University of North Texas. She received his Ph.D. in information systems from Washington State University. Her current research interests include strategic use of business intelligence and analytics, business process management, information sharing on social media, and adoption and

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Chapter 3
Business Intelligence Capabilities

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Abstract Business intelligence (BI) is emerging as a critical area of expertise for firms' value proposition. Firms are trying to leverage BI as an inherent capability to create value. Considering an organizational systems view, BI extends beyond a tool or artifact to include a number of capabilities. We draw on IT capabilities and prior research on BI to uncover potential capabilities that BI bestows to an organization. A three category BI capability classification is suggested: BI innovation infrastructure capability, BI process capability and BI integration capability. We discuss the attributes of these three BI capabilities to provide insights into how the capabilities help organizations. This taxonomy will help decision-makers take informed decisions on how to effectively implement BI within their organization to improve performance.

Keywords BI capabilities • BI innovation infrastructure capability • BI process capability • BI integration capability • IT capability

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3.1 Introduction

Business Intelligence (BI) is referred to the techniques, technologies, systems, practices, methodologies, and applications that analyze critical business data to help an enterprise better understand its business and market and make timely business decisions (Ramakrishnan et al. 2012). BI helps transform large amount of data from disparate sources into meaningful information to support decision making. BI investment is estimated to grow from $54.5 billion in the year 2012 to $96.9 billion in the year 2016 (Tabbitt 2013). BI is being used in almost all industry sectors and is a top priority for organizations (Isik et al. 2013). The opportunities associated with business analytics in different organizations have helped generate significant interest in BI. In addition to the underlying data processing and analytical technologies, BI includes business-centric practices and methodologies that can be applied to various high-impact applications such as e-commerce, market intelligence, e-government, healthcare, and security applications.

The evolution of business intelligence has its roots in artificial intelligence and business analytics, and has entered into mainstream business and IT communities since the 2000s (Davenport 2006). Further, the database related technologies advanced avenues for data collection, extraction, and analysis in the business intelligence areas (Chaudhuri et al. 2011; Turban et al. 2008; Watson and Wixom 2007). Currently, BI involves both structured and unstructured (big) data analysis and intelligence gleaning. Very large (from terabytes to exabytes), real time (feeds and tweets) and complex (from sensor to social media) data is emerging central tenet to recent BI developments. In addition, BI involves analytical techniques in applications that require advanced and unique data storage, management, analysis, and visualization technologies.

Recent developments in the internet, web, social media and mobile systems have offered unique data collection and analytical abilities to BI area. Large amounts of company, industry, product, and customer information can be gathered from the web and organized and visualized through various text and web mining techniques. Web analytics tools can gather customer clickstream data logs. Social media data analytics presents a unique opportunity for businesses to treat markets as avenues of business-customer relationship based co-creation (Lusch et al. 2010). Furthermore, mobile applications ranging from information advisories and ecommerce infomediaries and aggregators to gaming systems, often with billions of users, are changing the way intelligence and analytics fields are helping businesses and societal developments. It is noteworthy to mention that along with businesses, sectors such as healthcare, education, and governments have been benefitted a lot from business intelligence area. Emerging technologies and developments regarding Internet of Things (sensors, RFIDs, barcodes, tags), or drone based surveillance or monitoring systems are providing conduits for highly mobile, location-aware, person-centered, and context-relevant operations and transaction data. Indeed, many agree that both practice and academic communities face unique challenges and opportunities in understanding, developing, researching and educating the next generation BI students, researchers and professionals (Chen 2011).

Notwithstanding the increasing trend in BI adoption and implementation, the return on investments from BI remains a complex puzzle for many organizations. Some practitioners note that only around 20% firms have been able to convert BI to tangible benefits (Henshen 2008). Although it sounds simple, but initiation, implementation and development of a set of capabilities that can leverage on BI is not an easy task, and often needs integration of a set of distinctly different capabilities, ranging from information infrastructure to analytical mindsets. Once developed and used to its best extent, BI can be influential in organizations, and helpful in decision making or efficiency enhancements (Popovic et al. 2012; Wixom and Watson 2001). Furthermore, some even suggest that BI capabilities can be an important strategy within organizations forming their position in a competitive landscape (Thamir and Poulis 2015). Thus, given the wide applications and understanding of BI, it is important that BI capabilities be explicated in a simple yet holistic manner. In addition, given a firm wants to move towards BI implementations, managers should have an understanding on what capabilities need to be developed, or which directions need to be taken with an integrated perspective of BI capabilities.

The goal of this chapter is to highlight a typology of BI capabilities in organizations. We provide three categories of classification for BI capability in organizations: (1) *BI innovation infrastructure* consists of the foundational ability to mobilize and deploy BI functionalities to support innovation in the organization through infrastructure, culture and technological improvements; (2) *BI process capability* is the penetration of BI into the firm's customer centric and business-to-business (B2B) centric processes, and (3) *BI integration capability* refers to how the organization builds and integrates such capability and develops ways to acquire and convert business intelligence towards organizational improvement. Salient features and components of each type of BI capability are suggested to help in understanding in practice and further research prospects. The next section focuses on the understanding of BI capability, followed by the approach to develop the taxonomy and detailed description of each type of capability. Finally, suggestions on how to use the taxonomy, including managerial and research implications are discussed.

3.2 What is BI?

Several definitions of BI reflecting on different perspectives have been suggested. Moss and Atre (2007) define BI from a technological perspective as "an architecture and a collection of integrated operational as well as decision support applications and databases that provide the business community easy access to business data." However, Olszak and Ziemba (2003) define BI from an organizational perspective as "a set of concepts, methods and processes that aim at not only improving business decisions but also at supporting realization of an enterprises' strategy."

The effectiveness of BI is situated in its ability to support decision-making within an organization and providing decision-makers with timely and relevant information (Buchanan and O'Connell 2006; Massa and Testa 2005; Ramakrishnan et al. 2012).

Researchers have examined the benefits of implementing BI (Cooper et al. 2000; Watson et al. 2004), implementation factors (Hwang et al. 2004), and decision making (Park 2006). Organizations are struggling to make sense of the growing variety, velocity, and volume of data; demanding development of BI capabilities to deal with the data produced by internal and external sources, and leverage it to improve performance. Prior work on BI capabilities focuses mainly on the technical and organizational aspects of BI. For example, Sukumaran and Sureka (2006) examine BI capability as the ability of BI to manage quantitative and qualitative data. Similarly, BI capability has been seen in terms of a tool that can manage internal and external data (Harding 2003; Hostmann et al. 2007; Isik et al. 2013). From an organizational perspective BI capability has been examined as the ability of BI to provide support for decision making under conditions of uncertainty (Harding 2003; Gebauer and Schober 2006; Isik et al. 2013). An overarching view of the capabilities that BI endows in organizations in terms of supporting innovation, integration, and different process is still a gap in the BI literature; this chapter tries to fill in this gap.

3.3 Classification of BI Capabilities

We draw on prior work of IT capability and BI capability to propose that BI capabilities help orient a firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments; using business intelligence as a tool, artifact, and process level integrative capabilities. IT capability has its roots in the resource-based view that suggests that organizations' gain competitive advantage through the application of a combination of resources that are non-substitutable, scarce, difficult to imitate, and economically valuable (Barney 1991). Bharadwaj (2000) define IT capability as a firms' "ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities," (p. 171). Early studies with regards to IT capability started with viewing IT capability within single dimension in terms of either technological capability (Sabherwal and Kirs 1994) or managerial capability (Sambamurthy and Zmud 1997) and has now evolved to comprise three dimensions: technological dimension, human dimension, and organizational dimension (Kim et al. 2011; Schaefferling 2013). The technological dimension refers to the configuration and structure of all the technological elements in a firm such as hardware, software, networking and telecommunications, and different applications; the human dimension of IT capability discusses the knowledge and skill sets of the IT worker in a firm to manage and leverage IT to achieve a competitive advantage for the firms. Similarly, the organizational dimension examines the influence of organizational resources and the IT/business partnership that can provide the organization with a competitive advantage (Melville et al. 2004; Bhatt and Grover 2005; Rockmann et al. 2014).

BI as a capability is more so justified as a process or operational capability (Isik et al. 2013). Following prior work we conceptualize that BI capability overall is a culmination of different process or operational capabilities, and in addition, provides

a second layer or integrative capability in the organization. This integrative capability is manifested through the three underlying three dimensions: (1) integrate BI within the organization (integration of data and intelligence), (2) align BI towards innovation (infrastructure frontier), and (3) use BI to improve customer centric and business partner centric processes (process orientation) (see Table 3.1). These three dimensions translate to the three BI capabilities: BI innovation infrastructure capability, BI process capability (consisting of customer centric and B2B centric process capabilities) and BI integration capability. We elaborate on these three dimensions further in the next sub-sections.

3.3.1 BI Innovation Infrastructure Capability

BI Innovation capability is the ability to marshal and use the functionalities of BI to sustain innovation in organizations through technological, cultural, and infrastructure improvements. In order to support BI technology the proper infrastructure and the right data collections strategy for BI is needed (Ramakrishnan et al. 2012). Further, in order to leverage BI technology, it is imperative to have the appropriate organizational structure that can facilitate sharing and collaboration. Along, the same lines, culture also plays an important role in facilitating sharing and leveraging of information generated by BI. BI technology plays a crucial role in supporting decision-making within any organization (Isik et al. 2013).

BI innovation infrastructure capability constitutes technical, structural and cultural elements. First, BI technology refers to the degree and extent of technological readiness to adopt BI in the organization. The technology dimension may also include business intelligence, collaboration, distributed learning, discovery, mapping, opportunity recognition and generation as well as aspects related to security and privacy of the data and analytics. The structural element of BI innovation infrastructure refers to the modular organizational design that helps facilitate the technical architecture and subsequent functions and innovations relevant to BI. BI culture facilitates a firm's ability to manage data, knowledge and intelligence; and espouses interaction between individuals and groups is a basis of the creation of new ideas and innovation.

Technical, structural and cultural elements associated with BI innovation infrastructure provide the abilities to a firm that help in managing data, knowledge and intelligence through embedded routines and processes of the organization. Technology plays an important role in the structural dimension needed to capture, store, and analyzed data in a firm. The various communication systems and information systems can be linked in an organization to integrate the previously fragmented flow of data and information (Teece et al. 1997). These linkages can eradicate the hurdle to communication between different business units and enable collaboration among them. Further, BI technology can endow firms with the ability to engender information and knowledge regarding their external fiscal environment and their competition (Gold et al. 2001). Effective utilization of BI technology can help organizations deal with competitive and institutional pressures that firms face within an industry (Ramakrishnan et al. 2012).

Table 3.1 Conceptualization of BI capabilities and dimensions

Category	Core	Description	References
Infrastructure Frontier	Codification, connectivity and flow of data and information to derive intelligence	• Codification of specialized data and information from different organizational elements to be used by qualified staff or personnel • Detection, classification and planning of organizational data and information to be accessed by others • Provider formal access and provision to staff and employees to contextually use the data and information • Creating a culture or practice of intelligence based decision making.	Sukumaran and Sureka (2006), Parikh and Haddad (2008), Hostmann et al. (2007), Harding (2003).
Process Orientation	Exploitation of infrastructure and integration for crating organizational value through workflow and process coordination levels	• Conceptualize and execute BI as essential dimensions at each and every process and workflow levels • Realization that the actions related to BI can be used to create and facilitate economic and strategic values for the organization • Exploitation of BI as a capability-asset to produce income and maximize profit	Li et al. (2008), Sahay and Ranjan (2008), Elbashir et al. (2008), Isik et al. (2013), Wixom et al. (2011)
Integration of Data and Intelligence	Design and integration of spaces, practices and connectivity to foster the activities around data, information and intelligence gathering and conversion	• Design and use of organizational structures or networks • to acquire expertise and skills for intelligence generation • to acquire data and information from external sources • to convert the data and information to intelligence by using the gathered expertise and skills • seamless integration of the acquisition and conversion process within the organization	White (2005), Hostmann et al. (2007), Gebauer and Schober (2006), Petrini and Pozzebon (2009)

BI structure establishes an organizational framework and readiness to accommodate and leverage this foundation, while BI technology provides the foundation. Structure examines the distribution of tasks, coordination, flow of information, and decision-making rights within an organization (Pugh 1990). Further, firms with rigid structure may have the unintended effect of inhibiting the sharing of information and knowledge across internal boundaries (Gold et al. 2001), rather than enabling communication and collaboration. Therefore, we argue that in order to leverage BI technology it is important to have BI structure in place that encourages the sharing and exchange of information and intelligence. Organizations need to promote collective intelligence rather than individualistic acumen. Firms need to facilitate the transfer of intelligence across internal boundaries. Thus, BI structure plays an important role in supporting BI technology, and hence, is an important element in BI capabilities taxonomy.

Finally, BI culture espouses interactions between individuals and groups as a basis of the creation of new ideas and innovation. Thus, a more interactive and collaborative culture is a precursor for converting the data or fact based tacit information to more explicit intelligence, and move it from an individual to an organizational level. Employees in such a cultural glue within the organization can develop an ability to self-organize their knowledge and practices to facilitate solutions to new or existing problems.

To establish the value proposition of BI innovation infrastructure capability, we suggest that a firm can foster innovation using the technical, structural and cultural elements of BI capabilities. Structural element of innovation infrastructure will allow data and information to be exchanged seamlessly between different business units, thus improving the effectiveness of BI towards higher performance. Further, having a culture that will facilitate interaction between individuals and groups to exchange information and intelligence generated by BI to come up with new innovative ideas will make the BI more effective.

3.3.2 BI Process Capabilities

BI process capabilities is the ability of BI to penetrate into the firms' business processes. This capability examines the functionalities of BI that can sustain both B2B centric and customer centric activities. We argue that BI helps organizations by supporting the business processes that give a firm a competitive advantage. Business processes in a firm help orient its activities towards value creation. To create value, a firm needs to do at least three activities; first, operations that can convert goods to products or services (i.e., operations); second, relationship with other firms who supply materials and products to the firm (e.g., firms in the supply chain), and third, orienting its operations to deliver products and services to the customers (i.e., customer oriented activities). As noted previously in this paper, the operational BI capabilities are embedded within infrastructural development related to BI, or, in other words, the infrastructural BI development caters to the operations. On the

contrary, supply chain and customer oriented BI activities need to be explicitly developed; and included in the firm's value chains as two sets of capabilities to cater to the two ends of the value chain, i.e., supply chain partners and customers. Based on these concepts in the existing literature, we propose that for an organization to achieve competitive advantage, two explicit BI capabilities need to either exist or be developed—the customer centric and a business to business (B2B) process related BI capabilities elements. Although BI adoption and implementation is oriented predominantly towards customer centric data-information-knowledge-intelligence paradigm, similar process oriented approach of BI can also be found in leveraging B2B relationships or supply chain visibility areas. For example, BI in the B2B or supply chain can eliminate waste by providing demand aggregation or reducing the 'bullwhip effect' associated with distribution.

Because processes are not unilateral directives in an organization, and often consist of a multitude of orientations, we conceptualize the two dimensions of BI process oriented capabilities as multi-dimensional constructs. For example, customer centric BI process capability consists of the way BI is oriented to meet the firms' customer needs and serve them, elements that enhance customer satisfaction and loyalty by providing insights regarding customers' long term goals and requirements, and ability to absorb customer oriented information/intelligence into the organization using BI. Similarly, B2B centric BI process capability consists of BI applications related to supply chain integration, engage new partners and improve coordination with existing partners, and using BI for process coordination and operational improvements. Inherently, these dimensions relate to and influence organizational performance due to responsiveness to customer needs, awareness of customer goals and the ability to learn from information generated during customer interactions. Furthermore, B2B centric BI process capability aids activities with B2B partners due to insights through visibility of goods and information, business level integration, and process-level coordination across channels. Together, BI process capabilities provide firms with the capacity to derive analytical insights in its business processes which in turn enhance organizational effectiveness.

3.3.3 BI Integration Capability

Prior studies recognize BI integration to be very important and critical for the successful utilization of BI (Isik et al. 2013). Integration refers to combining different types of explicit data and information into novel patterns and relations (Herschel and Jones 2005). Based on the existing literature, we posit that organizations need to develop ways to acquire and convert business intelligence towards organizational performance.

We argue that BI integration capability has two dimensions that are effective towards organizational performance, albeit in an interconnected manner. First, BI acquisition consists of gathering data from different types of sources across the organization and beyond, in addition to data aggregation, rollup and partitioning. Data extracted from operational systems need to be cleansed and transformed in

order to make it suitable for use without errors (Ramakrishnan et al. 2012). Second, the data need to be converted to usable patterns and schemas to help an organization to glean more insights from the data. Thus, BI Integration consists of the acquisition of data from various sources, followed by the conversion of data to the right format and quality in order to be used effectively in the organization.

As much as the acquisition and integration of business intelligence from various sources is a prerequisite for the utilization BI capabilities; the outcome of the acquisition and conversion through integration helps to achieve higher organizational performance. For instance, customer centric activities require acquisition of business intelligence regarding customer behavior and experience, which in turn provide insights regarding goals and requirements. Second, the gathering and aggregation of data from different types of sources across the organization and beyond enables the organization to leverage BI to adequately respond to market and environmental changes. Hence BI can provide insights regarding the nature of change to which the organization needs to adapt, as well as the internal changes required to do so. Third, aggregation, cleansing and transformation of this data can make this data more substantive and insightful, thereby making subsequent decisions faster and more effective. Thus, integration capability of BI that facilitates the gathering and cleaning of data from disparate data sources and providing the decision-makers with timely and usable information will make the BI more effective.

3.4 Using the Taxonomy

With the advent of business intelligence, organizations are somewhat moved by a 'fad' effect around this tool. In practice, while the buzz around BI is very high, BI perspectives and viewpoints vary across firms, with differing concepts, definitions and applications. While eliminating the differences would be a herculean task, integrating BI perspectives into holistic models can certainly be a fruitful approach. The intention of this chapter is to provide such a holistic view around BI integration in an organization, albeit with a bias towards a capability perspective. Taking the capabilities perspective helps to highlight the fact the BI is 'not just a fad' or buzz' in the practice and academic discourse, but it can be helpful in garnering higher organizational performance. Indeed, the theoretical concepts and model developed in this chapter are oriented towards establishing the relationships between different dimensions of BI capabilities, their integrated schema, and the influence of these dimensions on organizational performance.

The classification schema can be helpful in further research. A line of research that can be pursued is relating the BI capabilities in a causal way. For example, a relationship model can test whether a BI innovation infrastructure capability can lead to a higher BI integration capability, and a higher BI integration capacity can lead to a higher process capability as suggested in a conceptual diagram in Fig. 3.1. Further research can explore relationships between capability types and organizational performance or BI effectiveness.

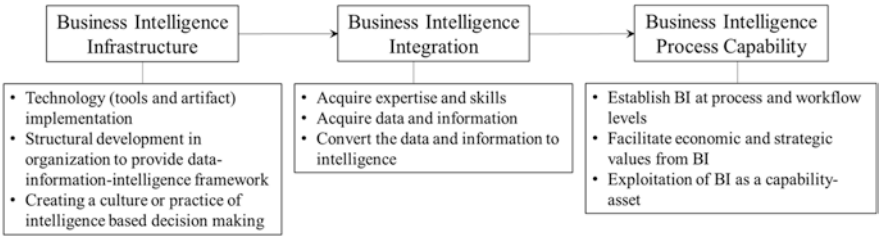

Fig. 3.1 A suggested relationship model between types of BI capabilities

The integrative model provides two theoretical contributions. Although existing studies note that BI helps in improving organizational decision making, the proposed model goes a step beyond to disentangle various dimensions of BI enabled capabilities. As a result, granular insights into BI orientation in a firm in relation to improving its capabilities are drawn. In addition, it is suggested here that BI is not a single directional or unilateral tool or perspective that just helps in siloed decision making; instead BI can be taken as a process-integrative organization wide framework that helps in improving firm performance.

The BI integrative model and dimensions have implications for managerial practice. The model provides directions to a step wise approach starting from acquisition to conversion and process integration for BI tools and applications. Furthermore, focusing on BI capabilities and integrating them into the functionalities of the organization may help in improving performance.

A number of factors might be unintentionally missing in the integrative model discussed here. For example, different industrial sectors might be leveraging on BI differently; indicating a variance in the model. In addition, early adopters and laggards may show variations with respect to BI capability and performance relationships. Additional research is warranted to extend this body of knowledge and related relationships. Future studies may focus on extending the model to other contexts by developing specific testable hypothesis on particular settings.

In conclusion, this chapter takes an integrative approach to BI. The central tenet of the chapter focusses on three dimensions of BI capability and relates it to organizational performance. The concepts proposed here are expected to provide a capability-integrative framework for BI implementation and motivate managers to see BI from organizational performance improvement perspective.

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