

Can Range in Information Technology Boost Innovation in a Mature Industry?

A case study of a Work-Oriented Social Media platform for innovative ideas and solutions in a large upstream Oil & Gas enterprise

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ABSTRACT

This work explores the potential for enterprises in mature industries to employ the construct of *Range*, through its embodiment in software and processes that enable domain-crossing, to boost innovation. It builds on a theoretical framework proposed by Nobbay (2015), *the Five Rs of IT-Enabled Innovation*, which distinguishes *Range* as a separate concept in information science. *Range* involves the enablement of human networks across functional domains and socio-cultural boundaries. Work-Oriented Social Media (WOSM) platforms are prime examples of applications embodying *Range*.

In a case study presented in this Doc 5 paper, a single WOSM platform, focused on innovation, is analysed from the perspective of features influencing adoption. The features are examined using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework (Venkatesh et al., 2003), which built on the Technology Acceptance Model (Davis, 1989) and other theoretical lenses of technology adoption.

Primary research was conducted in two phases, both using mixed methods. In the first phase, 55 professionals from multiple organizations were surveyed on expectations of IT service delivery in the Oil and Gas industry. Separately, six expert practitioners were interviewed in depth. The construct of *Range* was developed and explored in the context of domain-crossing potential. Detailed results of this first phase were presented in Docs 3 and 4, and are summarized and referenced in this paper. The second phase was a study on the use of a WOSM platform called BrightIdea to promote crowdsourced innovation. The work included investigation of features that influenced adoption and usage of the platform. Additionally, the potential for domain-crossing innovation was explored through data analysis of ideas on the platform. The study was built on data collected from a survey of 144 employees of Empco¹, a large company in the Oil and Gas (O&G) sector. The study also included interviews with Empco staff tasked with promoting innovation.

Key findings were: (a) Social media features such as Likes and Comments favour platform participation, (b) Graphics and Statistics are desirable features of the platform, (c) Senior leadership encouragement was observed, but the platform was not boosted by Empco's middle and lower management, and (d) There was evidence of domain-crossing ideas, but technical disciplines had limited crossing.

This work contributes to theory in the fields of Information Strategy and Organisation and Innovation Management through the development of the Five Rs conceptual framework and examination of the potential for *Range* to promote innovation. It extends the UTAUT model to WOSM platforms. The case study of the BrightIdea platform also informs professional practice, through analysis of factors that promote participation. Both platform-intrinsic and enterprise-determined factors are covered.

¹ Empco is a pseudonym

CONTENTS

1.	Introduction and Background.....	5
	Theoretical Framework – The 5Rs	7
	Range	9
	The Oil and Gas Industry.....	13
	Prior Research on Range and the 5Rs Framework – Docs 3 and 4	15
	Work Oriented Social Media (WOSM) Platforms	17
	Doc 5 Focus – Study of a WOSM Platform for Innovation	20
2.	Literature Review	21
	IT-based Collaboration	23
	Connecting Collaboration to Innovation.....	25
	Work-Oriented Social Media and Technology Acceptance	28
	Innovation and Transformation in the O&G industry?	32
	Section Summary	35
3.	Research Objectives and Questions	36
	Ontological, Epistemological and Axiological Grounding	38
	Developing the Research Questions	41
	Research Questions	42
	Section Summary	45
4.	Research Methodology.....	47
	Methods	50
	Pilot Survey.....	51
	Validity and Reliability.....	52
	Section Summary	56
5.	Case study – A WOSM Platform to Promote Innovation.....	57
	Organizational Context	57
	Analysis of Expert Viewpoints	58
	Analysis of Alternative WOSM Platforms	60
	BrightIdea Platform Results at Other Organizations	62
	Salient Features of the BrightIdea Platform.....	64
	Section Summary	71
6.	Findings	72
	Do Key Features of the BrightIdea Platform Promote Network Adoption?	73
	Management Action and Influence in Network Adoption.....	76
	Were Performance Expectations Generally Met?	78
	Did BrightIdea Promote Crossing of Functional Domains?	80
	Variances in Engagement from Different Categories of Adopters	84
	Section Summary	89

7.	Discussion and Conclusions.....	90
	New Knowledge	91
	Contributions to Theory and Practice	92
	Limitations.....	93
	Recommendations for Future Research.....	94
8.	Appendices	96
	Appendix 1: Illustrating the differences between Reach and Range.....	96
	Appendix 2: Applying the 5Rs in Evaluating Solutions.....	97
	Appendix 3: Summaries of Interviews with Innovation Experts at Empco	98
	Appendix 4: Survey Questions	101
	Appendix 5: Examples of Graphic Displays of Ideas and Categories	103
	Appendix 6: Link to External O&G Innovation Showcase	104
9.	References	105

1. INTRODUCTION AND BACKGROUND

This work is primarily in the field of Information Science in business, particularly in Information Strategy and Organisation. The relationships between Information Science (IS), Information Systems (ISY) and Information Technology (IT) may be illustrated by these simplified conceptual formulae:

IT* + Business Processes + Data + Business Rules = *ISY

ISY* + Contextual Knowledge + Domain Expertise = *IS

The domain of Information Science encompasses technology, processes, data, structures, contextual knowledge and expertise in applying information systems to solve business problems. However, in common usage the terms Information Technology and Information Systems often signify a broader scope than their direct linguistic and academically constructed meanings (Gartner Group, 2013). In the interests of simplicity and expedience, the terms IT, ISY and IS are not differentiated elsewhere in this paper and are used interchangeably.

The concept of strategy precedes the development of modern business organizations, having been used in the context of military planning and analysis. While tactical planning was used for a single battle, wars were fought based on a broader strategy. In business, strategy definitions may be centered on responses to external environment, responses to competition, and positioning of the business in its chosen market. Henderson (1989) focuses on the inputs to strategy, suggesting that logical and imaginative responses to environmental factors are the key elements in the process. Taking a broader perspective, Porter (1980, 2008) advocates the development of a holistic picture of the competitive environment in strategy formulation. The landscape includes competitors, customers, suppliers and alternate products. The formulation and articulation of strategy is a key responsibility of top management, and it is incumbent upon top management to ensure that the strategy is designed to achieve outcomes consistent with the mission and goals of the organization (Wright, Kroll, & Parnell, 1997). More specifically in the context of Information Strategy, Applegate et al. (2002) address some of the strategic opportunities and challenges presented by the growth of networked systems while Peppard and Ward (2016) present a framework to align IT strategy with business objectives and a portfolio of IT projects that are managed concurrently with dynamic organizational structures. Other research has focused on the application of strategic vision and strategic models to specific information-critical areas including customer management, marketing and electronic commerce (Park & Kim, 2003; Rodrigues & Fonseca, 2015; Barnes et al., 2003).

It is not an exaggeration to claim that Information Science pervades every function of the enterprise, covering technical groups, support functions and governance (Porter & Millar, 1985; Keyes, 2005). When narrowing the scope of study to understand the role of IT in innovation and business transformation, a fundamental question could be framed as whether the IT strategy is to *lead* change or merely *enable* change through provision of infrastructure and tools to other functional areas of the organization (McKinsey & Company, 2015). However, such a question could be viewed as being overly simplistic, as IT is woven so deeply into the fabric of critical organization processes that the boundaries are not clearly distinguishable. Even if the boundaries between IT and operational groups were clearly distinguishable, one could challenge the usefulness of functional segregation when considering broad strategic change. As knowledge has become increasingly specialized over the last century, and expert knowledge in any field narrows as the field develops, there is a snowballing need to articulate knowledge across domains. Understanding the central themes, theories, insights, challenges and limitations of a range of specializations becomes critical to the realization of the value and the further development of subject-matter experts across the enterprise (Drucker, 1993).

The concept of thematic clarity of organizational specialization in the context of IT strategy underpins the development of numerous frameworks and models over the past three to four decades. This work builds on the large body of knowledge in IT Strategy and organisation in two significant ways:

First, a simple new conceptual framework is proposed – the Five Rs of IT-Enabled Innovation. The Five Rs are Richness, Reach, Range, Reliability and Repeatability. The Five Rs framework can be applied to many strategic initiatives, but innovation was selected as it is considered a critical area in most organisations, particularly those in mature sectors like the energy sector. The concept of Range is developed as a basis for a new class of drink in an organisation's strategic liquor cabinet.² In the context of innovation, Range may be more desirable and effective than Richness or Reach, and it effectively harnesses the power of social media and the Internet to include actors from a broad spectrum of disciplines and capabilities. Range is also consonant with a new era of corporate governance, wherein even the stodgiest old enterprises are compelled to deliver social and environmental benefits to community stakeholders and not just financial returns.

Second, it incorporates a case study of a Work Oriented Social Media WOSM platform, a practical example of Range, which was used to promote innovation in a mature organisation. The case study uses mixed methods and includes investigation of survey data from users of the WOSM platform (n=144), analysis of data collected directly from the WOSM platform itself, analysis of alternative

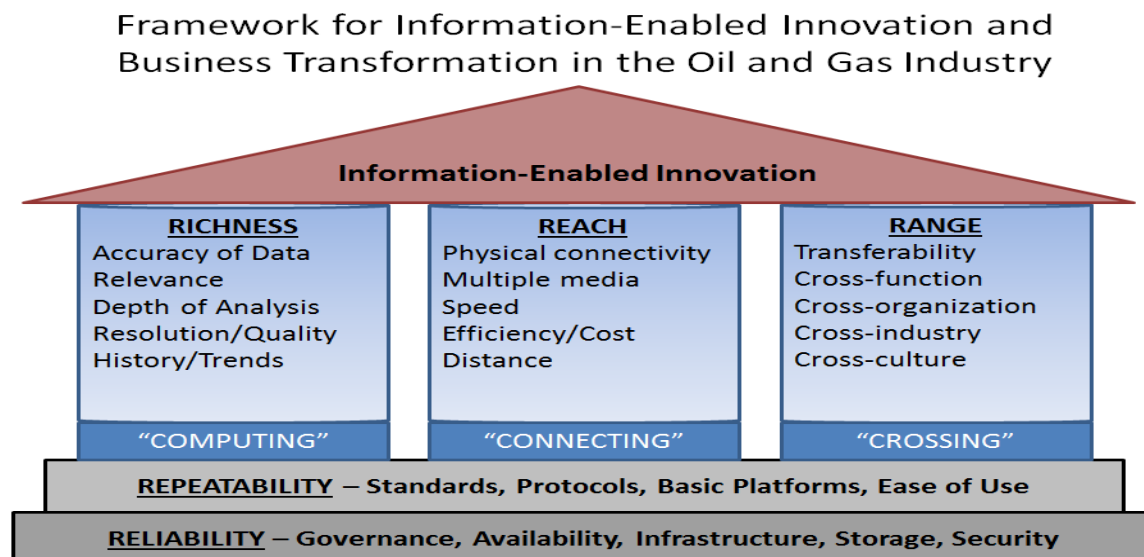
² The metaphor of a 'strategic weapon in an organisation's arsenal' seemed outdated and rather violent

platforms with similar functionality, ethnographical observation and interviews with members of the functional department tasked with promoting innovation across the enterprise.

Theoretical Framework – The 5Rs

It was recognized that the development of the ‘5Rs’ mnemonic and the somewhat clichéd visual of a house foundation and pillars may not be considered typical in a doctoral-level paper. The use of an atypical, somewhat provocative, writing style is not an attempt to create an ostentatious Derrida-esque product with novel literary devices (Garvey & Stangroom, 2012); on the contrary, it may be viewed as a pedestrian display of pragmatism. The pragmatic intent is to first create a lasting impression and draw attention and interest to the broad ideas before elaborating on the research results and conclusions. An idea that is easy to grasp and easy to remember has a higher chance of being influential or ‘sticky’ (Heath & Heath, 2007). The power of visualization, engaging both left-brain and right-brain orientation when presenting ideas or data, is evident from some of history’s most influential papers, including Maslow’s theory of the hierarchy of human needs (1943), Porter’s Five Forces model of competitive strategy (Porter, 1979; Porter, 2008), and the US government’s balanced nutrition pyramid (Welsh, 1992). When thinking strategically, visual representations and acronyms for mental models can help the brain to engage more fully (Krogerus & Tschappeler, 2008). While the student-researcher’s aspirations are undoubtedly far more modest than references to Maslow or Porter might imply, the simple graphic is expected to be an important part of the overall contribution of the work.

A depiction of the basic 5Rs Framework is presented below:



This conceptual framework is designed to categorize multiple aspects of effective information systems support, with earlier analysis by Nobbay (2016) examining their relevance to change in the O&G sector. The visualization and categorization through labeling and description of the “Five Rs” is summarized as follows:

Richness - a combination of computing power and data quality

Reach – a combination of communications capability and physical media quality

Range - the facilitation of cross-functional, cross-industry and cross- cultural interaction

Repeatability - an established platform of common basic processes, standards and features, and

Reliability – 24/7 information availability, anywhere, with secure access and strong governance

The Foundations: Repeatability and Reliability

With the massive proliferation of computers and the Web, the importance of **Reliability** has grown exponentially. There is an increased need for service availability on a continuous basis. There is also a growing need to protect organizational data from criminal elements. Customers increasingly provide personal financial data to organizations via secure web-based applications, necessitating strong governance and controls from organizations to protect this data. Failure to protect customer data can result in very significant loss of credibility and business value to organizations, as evident from a number of highly publicized cases in the last few years, including Target and Equifax in the US (McCoy, 2017; Schneider & Arnold, 2019). Service availability is critical to organizations of all forms and sizes, but even more so, to global competitive businesses that can see significant impacts from even short-lived outages. Service availability and security are closely linked, as security measures including firewalls, dual-authentication systems and whitelisting protocols both constrain and enable service delivery in most organizations.

Repeatability, represented by a set of common processes, protocols and standards, is critical to the core service delivery of the IT function. Gershenfeld (1999) observes that the history of computing is littered with unsuccessful standards that sought repeatability through advance specification instead of relevant industry experience. Automobile manufacturers in the 1980s devised their own standards for computing and networks, believing they were more advanced than other industries. Today’s auto industry uses open standards for networking since they discovered that good standards arise from a diverse community working collaboratively on developing and deploying the networks instead of one organization or group controlling the design. The differences between TV standards and video standards led to races for dominance that did not result in the best technology. Established protocols of the internet, widely accepted across organizational and geographical domains, now help to

eliminate divisions of technical standards. Within organizations of different sizes and structures, IT strategies have morphed toward the use of standardized hardware and software to replace 'legacy' systems that were often designed and maintained by in-house personnel, particularly in larger organizations (McAfee, 2006; Bresnahan & Trajtenberg, 1995; Gershenfeld, 1999).

Richness and Reach

The concepts of Richness and Reach are common in marketing, communications and sales in general. **Richness**, which is about the depth and quality of information and the speed at which it is made available, has been viewed as something to be balanced against **Reach**, which is related to the number of views, target audience and viability of the media over time and distance. These concepts influence strategy and decisions across a wide range of business areas including product design, service delivery, consumer contact and information-gathering (Wells & Gobeli, 2003). Choices related to Richness versus Reach remain relevant in many industries. In entertainment, for instance, the choice to perform live music or theatre translates into smaller audiences, with a richer experience and considerably higher admission fees; this often involves forgoing a studio recording release to a large audience who can be reached anywhere in the world at any time.

Both Richness and Reach depend on human agency to deliver enterprise value. Richness is appropriately viewed as a primary service concept within the IT function. However, the concept of GIGO (garbage in, garbage out), first articulated in the early days of computing and data analysis, is still valid today. While better tools and analysis enable quick validation and verification of results, it is still primarily humans that must determine what data to collect, how frequently to collect it and how best to utilize it to improve business decisions. Similarly, while advances in Reach have enabled co-workers and business partners to connect anywhere at any time, the effectiveness of those communications depends on factors outside the control of the IT function. The technology only facilitates the connection.

In today's O&G industry, it can be argued that both Richness and Reach have reached very high levels. Further improving computing speed, richer data and greater mobile access all provide business value, but are not viewed as critical to solving key issues in the industry (Nobbay, 2016).

Range

The theoretical framework, particularly the construct of Range in IT, builds on concepts of collaboration in innovation developed by Prahalad & Krishnan (2008), Chesbrough (2006) and

McKinsey (2015). Broader work on socialized innovation in the field of behavioral science, including Surowiecki (2005), Johnson (2010) and Berger (2016), also influenced the Range construct.

The concept of Range is common in marketing, where it denotes a seller's expansion of product lines to capture more of established customers' needs or add new markets without adding locations. Range in this traditional, limited sense can also be observed in the O&G industry, with companies like Schlumberger, Halliburton and Baker offering a range of products and services including fluid pumping, wireline logging and fishing; the combination of services is also known in the industry as an 'integrated services' offering. In the context of innovation activity, a construct similar to Range - 'external search breadth' – was defined and analyzed by Laursen and Salter (2006). They used the UK Innovation Survey as a primary source in measuring the number of external sources and channels that firms used in innovation activities. A key difference between the concepts of 'external search breadth' and Range would appear to be the contextual definition of Range as aspect of IT functional service delivery. Another significant difference would be that Range is not, by definition, limited to the facilitation of crossing outside the organization or industry; it also enables cross-discipline, cross-department and cross-location sharing *within* the organization.

In this thesis, Range is reborn as an IT concept, the facilitation of interaction and learning across traditional boundaries of industry, organization and function. However, even in this context Range maintains its semantic roots; one could view Range as a conceptual expansion of the IT dimensions beyond computing and communication. Such non-accidental association is also observed by Fodor and Pylyshyn (2015) in a much broader philosophical context; they argue that concepts are constituents of propositions just as words are constituents of sentences. This association may *seem* accidental; yet, when sentences are viewed as formal expressions of propositions, with relevant syntax and content, the connection is clarified.

While Range is conceptualized here as an IT service construct, it is differentiated from other constructs by its critical dependence on human agency. It is recognized that IT solutions focused around Richness or Reach typically do involve important elements of human agency in design, in form and in function. However, it would be feasible for machines and web-enabled devices to communicate with each other, exchange and process information, and perform actions based on pre-defined and/or iteratively developed algorithms. In solutions enabling Range, the core functionality is the exchange of ideas and knowledge amongst human participants, using machines, physical infrastructure, conceptual structures and contextualized information to promote shared objectives. This centralization around, and dependence on, human agency could have broader social and

technological implications in a world where humans are trying to predict and understand *when*, not *if*, machines will surpass human intelligence (Vinge, 1993; Chalmers, 2010).

Range-enabling IT solutions appear to have some common characteristics with Reach-enabling IT solutions, primarily in enabling communication. However, the construct of Range is distinguishable from Reach in both form and function. This is clearly illustrated by comparing an e-mail server (eg. Gmail) to a WOSM (eg. Kaggle). See Appendix 1 for this comparison.

How Range Supports Radical vs. Incremental Change

In the context of innovative change and growth, Richness and Reach tend to support incremental improvements, enabling efficiencies and routine efforts. Radical innovation is more likely to come from Range, due to the influences of cross-learning and the collision of ideas across functional domains and industries. The collision of ideas across organizations, disciplines, industries and cultures is what is most likely to result in radical innovation. The constructs of incremental and radical innovations can be viewed as the extreme ends of the innovation spectrum, and a number of researchers and business consultants have attempted to interpolate the gap through categorization and conceptualization of intermediate levels on the spectrum. Terms such as ‘radically incremental innovation’, ‘architectural innovation’ and ‘component innovation’ may be used to describe levels that are neither incremental nor radical, but fall in-between these extremes based on the research lens, the industry and the context (Henderson & Clark, 1990; Le Masson, Weil, & Hatchuel, 2010).

World-changing or even industry-transforming ideas rarely occur in isolation or without some form of a supportive environment. Johnson (2010) conceptualizes “the adjacent possible” which he describes as the connection of new ideas to existing devices or ideas.³ Johnson also discusses the ‘*slow hunch*’, which he describes as an idea that develops over a long period and can be quite different from the original spark of inspiration; he describes the creation of the World Wide Web by Tim Berners-Lee as a striking example of the slow hunch.⁴

This concept of some innovations enabling larger ones is consonant with general theories around socialization of ideas, which has grown significantly in the past two decades with the proliferation of the Web and social media. IT platforms and applications that enable accumulation, storage and

³ Johnson provides the example of Lee de Forest’s invention of the vacuum tube, enabled by a device called a ‘spark gap transmitter’. The vacuum tube would in turn enable the electron switch, which would enable logic gates that the first digital computers used in the 1940s. Johnson posits that de Forest is the inventor who opened up the ‘adjacent possible’ for Babbage’s Analytical Engine, which was conceived 60 years earlier.

⁴ The Web was a major departure from the original conception of the Internet, which was devised as a means for scientists to share documents in a closed group of identified individuals. The open architecture of the Web allowed for millions of nodes to be inter-connected through shared basic protocols.

access to a range of employees across an enterprise are beginning to mature. McAfee (2006) coined the term 'Enterprise 2.0' to refer to organizations' use of emergent social platforms; these platforms don't impose a fixed set of workflows, structures and roles but instead allow a free flow of information within broad ranges of multiple topics. This freeing of information flow is a profound shift. It lets people create and refine content as equals and with very few rules. It opens up innovation processes to more people, using the wisdom of crowds to tackle difficult issues. In addition, information becomes more quickly accessible and a culture of interaction and collaboration is created (McAfee, 2006; Surowiecki, 2005; McAfee, 2009).

McDermott and Archibald's (2010) analysis of communities of practice (CoPs) also lends support to this theme. Working with a number of organizations, they contrast CoPs with traditional work teams. Unlike traditional work teams, there is not usually a pre-defined success metric in a CoP – it simply morphs to fit the dynamic needs and development of its members. CoPs may be cross-functional within an organization, or they may be cross-organization within an industry; in emerging areas such as AI (Artificial Intelligence), Data Science and the Internet of Things (IoT), there are CoPs that are cross-sector as well. These communities may also coalesce informally through MeetUp groups (meetup.com) and other internet-based interest groups. Taking the 'flow' concept to the next level, Adler et al. (2007) advocate for a complete obliteration of traditional silos and replacement with new structures based on customer segmentation and customer service.⁵ The cross-functional interaction is not just a means of making routine business more effective; it promotes creative problem solving and innovation. Nathan Meehan, President of the Society of Petroleum Engineers, an O&G industry group with over 150,000 members, articulates this in his first public interview: "Innovation comes about by thinking differently and creatively, by connecting seemingly unrelated ideas, and putting them together in unrelated ways to produce something novel or original. This requires collaboration among diverse and disparate groups of people" (Donnelly, 2015).

How Range Helps Foster New Attitudes to Thinking

The mining industry, like the manufacturing sector, has traditionally been dominated by 'left-brain' thinkers – engineers and other professionals who succeeded through mastery of specialized knowledge and measurable skills in their fields. Through the Agricultural and Industrial Ages, while infrastructure was being built across the world and there was significant value to be gained by finding ways to get things done faster and more economically, left-brain thinking naturally was favored over the artistic and social thinking style of right-brain dominance. However, there is growing recognition

⁵ McDermott and Archibald acknowledge that functional and geographical silos can deliver value from expertise as well as contextual knowledge. When these silos cannot be effectively supplanted, they can be augmented by layering on 'boundary-spanning' roles or teams over existing organisational structures.

of the limitations to this type of thinking, especially in the context of transformational change in society and business. Contemporary thought leaders – including Pink (2005), Johnson (2010) and Koulopolous (2012) forecast a change in societal emphasis from speed and efficiency to quality, artistry and diversity of interaction.⁶

Pink (2005) categorizes ages, starting with the Agricultural age in the 18th century followed by the Industrial age of the 19th century and the Information age of the 20th century. He theorizes that the 21st century will be the Conceptual age. He outlines important senses that he considers are most relevant to the Conceptual age, including: *Design* – combining beauty, emotions and the senses; *Story* –personalized narrative; *Symphony* – synthesizing ideas, and; *Meaning* – creating richly contextualized exchanges. These concepts all require interpersonal relationships that go beyond traditional business structures and communication. When Google issued its initial public offering (IPO), its prospectus was highly atypical. A typical one has risk factors and dry descriptions about the company’s operations. Google’s prospectus, on the other hand, was essentially a personal letter to potential investors explaining why Google was special. Larry Page’s letter said “We aspire to make Google an institution that makes the world a better place” (Levy S., 2011). Google was signaling that it was not going to be like a traditional company. This re-humanization of technological advancement provides the background and impetus for Range. The social benefits of innovation and technology are increasingly factored into decision-making and analysis of value delivery (Candi & Melia, 2019).

Conceptually, Range in IT may be viewed primarily as one of the ‘right-brain’ aspects of customer service delivery, comprising the elements that are harder to quantify and more human-centric. Enabling social media, promoting broader networks, incorporating engaging design features and facilitating greater human connection are some of the facets of Range. When combined with the concepts of Richness, Reach, Reliability and Repeatability as part of the 5Rs framework, the construct of Range can help IT executives and managers to create a nurturing environment for innovation through engagement of personnel across the organization.

The Oil and Gas Industry

Products from mineral oil and gas pervade modern life worldwide, through use in transportation, power and the ubiquitous use of plastics, which are derived from petroleum. The broader industry

⁶ Pink makes a stirring opening statement: “Lawyers. Accountants. Software engineers. That’s what Mom and Dad encouraged us to become. They were wrong. Gone is the age of left-brain dominance. The future belongs to a different kind of person with a different kind of mind: designers, inventors, teachers, storytellers – creative and emphatic ‘right-brain’ thinkers whose abilities mark the fault line between who gets ahead and who doesn’t.” It would be reasonable to criticize Pink for being overly dramatic, but his arguments for a more balanced approach to knowledge seem consistent with societal evolution.

activities include extraction, refining, distribution and marketing. This research focuses on the extraction sector, which is also known as Exploration and Production (E&P), Upstream Oil and Gas (Upstream), or simply Oil and Gas (O&G). In this paper, the terms Upstream, E&P and O&G are used synonymously. Globally, the industry produces over 80 million barrels of petroleum every day, with the US accounting for over 10% of that quantity. Russia and Saudi Arabia are the other countries forming the top three petroleum producers, who together account for close to half of worldwide production (Source: US Energy Administration, 2019).

In the decade from 2005-2015 the US oil and gas (O&G) industry was transformed, with US oil production increasing over 80% from 5.2 million barrels of oil per day (mmb/d) in 2005 to 9.4 mmb/d in 2015. (Source: US Energy Administration). In value terms, assuming a commodity price of \$50 per barrel, this increase represents a revenue increase of over \$75 Billion annually for crude oil alone. Crude oil and natural gas, which drive transportation, power, and other industries, have been extracted for over 100 years. However, until recently, an oilfield had to have the right combination of porosity, permeability and geological structure to allow oil and gas to be 'trapped', accumulating in producible reservoirs. Dramatic improvements in production technologies and techniques in the last decade, especially in production from source rocks, also known as 'shale' or 'unconventional' production, fundamentally changed the industry and shook world markets. The US, with both mineral ownership and producer/operator ownership in private hands, was at the forefront of the technological breakthroughs. The key technologies that drove the change are advanced rock-fracturing ("fracking") and precision drilling of horizontal wells enabled by automated rigs. While neither of these are new inventions, it is their *widespread* use in *combination* with advances in 'smart' drilling that has been transformative. The concept of smart drilling, in turn, is a combination of several developments. From a *mechanical* perspective, the use of advanced remote-controlled equipment and directional drilling tools have significantly decreased the time required to drill a well and increased the accuracy of reaching geological targets. *Process* developments include the use of 'batch' drilling - where different rig equipment is used for different sections of work, 'pad' drilling - where a single surface location serves as the base pad for several wells, and advances in rig safety procedures.

These technological developments were not attributable to information technology, social media or WOSM networks. However, renewed interest in O&G was amplified and promoted by a number of new innovative ventures in the industry; most of these new ventures have used social media and the Web to spread their influence and build awareness of their product offerings. Additionally, newer entrants into the O&G workforce have the skills and desire to effectively use technology in their workplaces, and usually have access to the latest computing and mobile technology in their personal

lives. Many companies, including Empco, have implemented BYOD (Bring Your Own Device) policies that mandate the use of personal mobile phones for work as well as the use of personal computing tablets – such as iPads – for company work.

Prior Research on Range and the 5Rs Framework – Docs 3 and 4

In Document 3, an apprentice piece, Nobbay (2015) concluded that the 5R framework presented might be useful to understand and articulate the role of IT in business transformation. While he made no claims regarding wide applicability of the results, the work was expected to assist in positioning IT to enable creativity and innovation in the upstream oil and gas sector. The application of the concept of Range, in particular, appeared to be an area where organizations can optimize their internal and external resources. From a strategic viewpoint, the marginal benefits from investment in Range may exceed those of investments in Richness and Reach. The research indicated that computing power, computing speed and communications systems are effective in delivering value to users. In general, users did not feel that there were significant gaps between their computing and communication needs and the available IT resources. This suggests that, given a limited pool of resources, more time, effort and funds could be allocated to Range-enabling solutions. Additionally, Range could be incorporated into organisational and strategic planning. With an increasing number of tools and applications that promote Range becoming popular over the past few years, the questions for organisations are likely to be related to the pace of adoption, the staying power and the width of acceptance of Range-enabling platforms, and the ability of the organisation to integrate the applications with its overall architecture and systems.

Nobbay (2015) suggests a practical use of the concepts through the deployment of a template to facilitate choices between IT projects and solutions.⁷ The intent was not to create some variation of a *Balanced Scorecard* or a formal structure for analyzing alternatives; the table is simply created to illustrate how the concepts may be applied in practice as part of a broader toolbox of decision-aids. The template is provided as Appendix 2.

In Document 4, another apprentice piece, Nobbay (2016) concluded that radical innovation and transformative changes in the O&G industry are not likely to come from improvements in the Richness and Reach aspects of information technology. Aspects of IT that are encompassed in the

⁷ The template is suggested as merely a tool and not the deciding factor. An analogy would be the use of econometrics in an investment decision – an investor or corporate manager may consider Payback, Rate of Return (RoR), Net Present Value (NPV) and Discounted Profit Index (DPI) calculations to facilitate the investment decision, but no single measure is sufficient. Even when all are used in combination, other factors would be relevant, including strategic fit, market conditions and competitive landscape.

construct of Range are more likely to facilitate transformative change by enabling crossing of knowledge across boundaries. Multiple avenues of knowledge crossing – across disciplines, across entities, across regions/language and across industry sectors – offer opportunities to drive transformational thinking. Improving knowledge transfer between functional disciplines and between business entities in the O&G sector was seen as a relatively easy initial approach for organizations and teams that were in the early stages of promoting innovation. While these two aspects were not investigated in depth in the research, they appeared to be significant in the pursuit of information-enabled change.

Crossing lingua-cultural boundaries was expected to provide a rich source of transformational opportunities. While the crude oil market is global, there appear to be gaps in knowledge transfer across language and geo-political borders. The O&G sector in the US could benefit from interacting more with Europe, the MidEast, Canada and Mexico as well as areas where the business and technical environment is substantially different like the Far East, S. America and W. Africa. Cultural differences that result in contrasting thinking and working styles can stimulate transformational change. There also appear to be significant opportunities for cross-industry knowledge transfer into the O&G industry. While it is relatively easier to see linkages with sectors that are closely related such as manufacturing and logistics, it was argued that truly transformative ideas could potentially migrate from more distant sectors like defense, aerospace, healthcare and retail. While this document (Doc 5) includes some references to cross-sector innovation opportunities between O&G and aerospace as well as between O&G and healthcare, the focus of this paper is on cross-disciplinary innovation and its facilitation through a WOSM platform.

The construct of Range is expected to be useful as an element in developing a broad theoretical foundation for IT service strategy. Its employment in developing a comprehensive service delivery strategy would tend to promote knowledge-sharing and foster a culture of innovation. The promotion of cross-discipline, cross-organization and cross-industry engagement creates the basis for radical innovation as opposed to incremental innovation. In mature industries such as the oil and gas industry, radical innovation can deliver significant gains in financial, environmental and social arenas, what is known as a Triple Bottom Line, a term coined by John Elkington in the mid-1990s (Slaper & Hall, 2011). The ‘socialization’ of innovation helps promote the notion of shared ownership in both inputs and outcomes.

Work Oriented Social Media (WOSM) Platforms

The WOSM Platform as a General Purpose Technology

The concept of a 'general purpose technology' was promulgated by Bresnahan and Trajtenberg (1995) as a technology that enabled the creation or growth of related technologies, through enabling a new technology to overcome the difficulties of combining vertical integration and horizontal integration. Vertical integration, which is essentially the issue of getting upstream and downstream actors to use compatible technology, is often challenging due to scale – Walmart's automation of key elements of their supply chain, for example would be almost impossible to accomplish if they did not have the benefit of their massive buying power (Friedman, 2005). Horizontal integration, which relates to the cross-sector application of the technology, enables the technology to overcome user resistance and also enables improvement and growth in the technology as it becomes 'mainstream' or even a dominant technology across multiple sectors (Ott, Papillod, & Zulsdorf, 2009). This horizontal integration is clearly identifiable in IT devices and applications, including the PCs of the 90s, enterprise resource planning (ERP) systems, and modern digital advertising and the e-commerce systems. Today's largest online seller, Amazon, took 20 years to become profitable.

The general purpose technology (GPT) concept was extended and applied to the proliferation of nanotechnology by Ott et al. (2009), and may be generally viewed as well suited to a wide range of industrial technologies; it is arguably also relevant to the use of social media at work. Bresnahan and Trajtenberg (1995) offer this high-level view:

"Most GPTs play the role of enabling technologies, opening up new opportunities rather than offering complete, final solution. For example, the productivity gains associated with the introduction of electric motors in manufacturing were not limited to a reduction in energy costs. The new energy sources fostered the more efficient design of factories, taking advantage of the newfound flexibility of electric power. Similarly, the users of microelectronics benefit from the surging power of silicon by wrapping around the integrated circuits their own technological advantages. This phenomenon involves what we call 'innovational complementarities' (IC), that is, the productivity of R&D in a downstream sector increases as a consequence of innovation in the GPT." Bresnahan & Trajtenberg, 1995, pg. 84

In the case of WOSM platforms, taking a vertical integration perspective, the formation and articulation of ideas may be viewed as 'upstream', and the adaptation, implementation and further nuancing in practice may be viewed as 'downstream'. The enabling technology, the WOSM platform, is then identifiable as the product itself. At first this may seem like a stretch; however, this conceptual adjustment is central to the concept of Range. If the WOSM platform were merely designed as an

instrument to communicate ideas, or if its use was limited to communication, it would not be distinguishable from Reach. Alternatively, if it were merely utilized as a tool to capture, store, categorize and manage ideas, perhaps with drawings and document attachments, it would be a knowledge management tool, conceptually indistinguishable from Richness. It is the combination of a range of platform-intrinsic features with human agency, social norming, strategic management intent and enterprise-level initiatives that has the potential to deliver Range through the adoption of a WOSM platform.

It is limiting to look at internet search and online collaboration platforms simply as tools to solve a given problem. A large number of users, particularly amongst the generation of Millennials, participate in Range-enabling software and platforms, including WOSM platforms, not only to improve their general learning and situational-specific knowledge, but also to practice their functional skills in open-innovation, collaborative settings (Rader, 2019). Competing platforms – whether crowdsourcing solutions, sharing designs and code, or connecting participants across functional and organizational domains – tend to seek differentiation through size or market-share, creativity and/or focus in a particular domain. Technology-enabled crowdsourcing – whether focused on soliciting new ideas to solve problems, raising financial capital or simply getting work done faster and cheaper, represents a fundamental shift in human advancement (Surowiecki, 2005; Friedman, 2005).

Comparing WOSM Platforms to predecessor tools

In the table below, two WOSM platforms, LinkedIn and BrightIdea, are compared and contrasted with their pre-WOSM equivalents. This comparison is not intended to compare functionality or efficacy of the platforms, but to illustrate how technology has transformed individual and organizational capabilities. The 5Rs framework is relevant in this comparison; it is also relevant to note that these platforms are relatively recent, lagging developments such as personal computers, themselves transforming innovations, by as long as two decades. The LinkedIn platform was launched in 2002 and the BrightIdea platform in 2005.

WOSM Platform Name	LinkedIn	BrightIdea
Base Functionality	Build and Maintain Professional and Business Contact Details	Gather and Develop Ideas
Pre-WOSM equivalent (tools in use prior to pre-2002)	Business cards, Rolodex (well-known brand name for a desktop business-card filing system)	Suggestion Box(es), suggestion cards and management review of ideas and change recommendations from subordinates
Primary Physical Medium	Paper/cardboard replaced by Internet, accessed by computers/smartphones	Paper and wooden boxes replaced by Internet, accessed by computers/smartphones
Improved Access to Historical Records	Simplified and accelerated Search functionality	Simplified and accelerated Search functionality
Change in Reliability – Positive	Securable by means of password and ID management. Will not be lost to fire or theft.	Securable by means of password and ID management. Will not be lost to fire or theft.
Change in Reliability – Negative	May be accessed remotely by identity thieves or competitors	None. Stealing undeveloped employee ideas is of little value to competitors or thieves
Improvements in Richness	<p>Photographs (recent), experience, education all available and editable. Also posts and activity on site.</p> <p>Data can be sorted and manipulated to optimize effort.</p>	<p>Platform facilitates attachments of documents, pictures and diagrams. Records are editable and can be copied for reuse or further enhancement.</p> <p>Data can be sorted and analyzed in multiple ways to gather broad insight on trends and issues.</p>
Improvements in Reach	<p>Accessible at convenience of user – not tied to specific location or working hours</p> <p>With some investment of time and effort, a user may maintain contact with hundreds of business associates. Private messages and public posts enable breadth of communication that would not be practical using business cards combined with telephone/e-mail</p>	<p>Accessible at convenience of user – not tied to specific location or working hours</p> <p>Ideas can be collected from multiple locations without the need for gathering and compilation. Thousands of people can access the data contemporaneously or at preferred times.</p>
Improvements in Repeatability	<p>Standard format and structure for data fields – experience, education, community involvement</p> <p>Permanent record enables duplication and revisiting of contacts</p>	<p>Standard format and structure for categorizing ideas, estimating level of difficulty, posting attachments</p> <p>Permanent record enables review of older ideas that could be connected to newer ones.</p>
Improvements in Range	Ease of interaction with other users of LinkedIn enables crossing of domain boundaries – organization, region/country and functional domain	<p>Ease of interaction with other adopters enables crossing of domain boundaries – immediate work unit, region/country and functional domain.</p> <p>Peer-to-peer interaction as opposed to employee-management communication.</p>

Doc 5 Focus – Study of a WOSM Platform for Innovation

Work Oriented Social Media (WOSM) platforms are examples of the employment of Range in business. Other examples include automated language translation software and generic social media platforms that are part-recreation, part work. The study of WOSM platforms can help in understanding the value of Range in IT strategy and organisation. Improving knowledge of factors promoting wider use of WOSM platforms can help inform management practice.

In this Doc 5 paper, a single WOSM platform, focused on innovation, is analyzed from the perspective of salient features influencing adoption. The platform, called BrightIdea, was deployed by Empco⁸, a large corporation operating in the Oil and Gas (O&G) industry sector. The features include both application-intrinsic and enterprise-determined features, and are examined using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework (Venkatesh et al., 2003), which built on the Technology Acceptance Model (Davis, 1989) and other theoretical lenses of technology adoption.

Section 2 of this paper comprises a broad **literature review**, connecting IT strategy and organisation around two central and related themes – collaboration and innovation. The literature review also covers WOSMs and the acceptance of new technology as part of business transformation and more broadly as part of societal evolution. This is followed by a focused literature review of O&G industry challenges and the value of innovation in this context.

Research objectives and **research questions** (RQs) are laid out in **Section 3**. This section also covers the development of the RQs, connecting them to research objectives. **Research methodology and methods** are discussed in detail in **Section 4**.

Section 5 covers the **organisational context** for the Empco case study, which includes background and analysis from interviews with functional experts. Details of the BrightIdea platform, its features and its use at other organizations are also included in this section.

Research findings are presented in **Section 6**, followed by **conclusions and recommendations** for future research in **Section 7**.

⁸ Empco is a pseudonym

2. LITERATURE REVIEW

The development of IT as a broad functional discipline and later into sub-disciplines and further specializations creates the need within organizations to structure and concentrate efforts around the core mission and goals. In industrial and commercial enterprises, this generally translates into channeling investments into the most promising areas and projects. Farbey et al. (1994) use a pragmatic approach to focus on the need for a comprehensive review of benefits of IT investments and present three models of benefits analysis - strategic, organizational and technological. They reason that these benefits need to be analyzed within the broad direction of business strategy and management intentions. Expanding on their work and building on its pragmatic aspects, in a later publication Farbey et al. (1995) theorize that different types of applications have varied levels of amenability to measurement as well as degree of certainty to which the estimated cost and benefits will be realized. They modeled a 'benefits ladder' with eight distinct 'rungs', wherein higher rungs signify increased complexity of evaluation and increased uncertainty, but also offer higher potential returns.⁹ While this approach is useful in categorizing projects planned or undertaken by the IT department, it is limited in its application to structuring the IT organization around central knowledge-based groups or functions that address execution of the IT mission.

Other conceptual lenses to analyze the functional role of IT include a simplified framework proposed by Tucker (2016). Tucker categorized the IT function, in increasing levels of significance, as 'Expense Center' (the most basic level), 'Service Provider' (a customer-driven actor), 'Value Partner' (a key function working alongside the business) and 'Business Driver' (a critical function leading the organization or some portion of it). This classification may be criticized as overly simplistic, and is arguably more relevant to execution analysis while being of limited value in defining broad, long-term information strategy. However, it can be very useful in building a balanced portfolio of projects with multiple time-frames (eg. short, medium-term and long term) as well as multiple functional roles, and can therefore be valuable in IT project planning as well as in building effective work-teams in the IT department. Some research has taken a limited, tactical view of information strategy. Ahmadinia et al. (2015) for example, treat "information strategy" simply as the determination of the mode and frequency of data-gathering and analysis.

⁹ Farbey's Benefits Ladder has conceptual rungs range from legally mandated changes, at Level 1, to complete business transformation at Level 8. This framework is also useful in thinking about the *role* of IT, as it recognizes that the impact of a particular technology is inherently project-based. One project – relatively low on the 'benefits ladder' - might simply enable more efficient interpersonal communications, while another at a higher level could speed up a critical business process and have a transformational impact.

After a study using mixed methods in the early nineties, Earl (1993) published the results of data gathering, analysis and interviews with general managers, line managers and IT managers in twenty-seven companies. He identified five approaches to strategic information systems planning: business-led, method-driven, administrative, technological and organizational approaches, concluding empirically that the 'organizational' approach had the most success. This approach integrates the IT function as a full member of the organization, not a technical support group or an administrative resource. When compared to Tucker's functional role categories, Earl's 'organizational' approach could be seen to fall somewhere between 'Value Partner' and 'Business Driver'. However, Earl's construct of an organizational approach to strategic planning appears more relevant and more impactful than Tucker's casting of the functional role of the IT department as the lead concept. Tucker's categorization is pragmatic but does not adequately account for dynamic organizational power structures and unexpected events which are common in business. Under the organizational approach, priorities are not pre-set but emerge as the business grows and changes. In this strategic mode, *interactive learning* and *process improvement* are emphasized over structure and control-and-command style decision-making. Earl proposed a diagnostic tool for evaluating the approach taken by an entity. These various approaches have a common theme of focusing thinking around strategic intent of information systems operations and management. They advocate viewing the IT function not just as a support function but also as a key element of overall business strategy.

IT strategy is not just about technology; it could be argued that the technology piece is the easiest – changing people and organization culture is the hardest part. An important aspect of human development has surfaced, or at least become more pronounced, in the past two decades; it is the blurring of lines between business and personal lives across a range of daily activities. Additionally, cultural changes have combined with social media platforms and tools to promote the virtues of openness, sharing of personal information and cross-cultural inclusivity. Large numbers of virtual communities have flourished, creating multiple opportunities for learning, personal growth and collaborative activities. Platforms like Yammer and Slack have built customer markets in both business and personal applications, allowing users to create both multiple accounts (work, home, community) and multiple groups within those accounts. The proliferation of mobile technology, particularly high-speed mobile video and data, has been at the forefront of these developments. This could be expected to get even more traction based on improvements in user-centric design and improved data speeds. The newest generation of workers has been exposed to these trends from adolescence. A survey of MBA students enquiring about perceptions of the single most important new technology indicated that mobile (40%), cloud computing (13%) and social media (11%) were

the foremost, with others being clean energy (10%) and business analytics (9%) (Coleman, Gulati, & Segovia, 2012).

From a strategic viewpoint, an ongoing challenge for the IT function is to overcome the conventional organization of service delivery in distinct lines of 'hardware' and 'software'. These distinctions are convenient for managers and functional experts who specialize in one line or the other and have matured in an era only 2-3 decades removed from when 'computers' were room-sized metal boxes with hundreds of cables and a closely-guarded, temperature-controlled room in a separate building. However, this conventional industry perspective is arguably provider-centric instead of customer-centric. In successful mature technologies and systems, the traditional split between hardware and functional use is rendered inconsequential. The ballpoint writing pen is an example of such a technology. The underlying mechanism of a ball-pen and its user interface blend seamlessly to the point that they are seldom even considered as separate elements (Gershenfeld, 1999).

The '5Rs of Information Service Delivery' conceptual framework presented in this paper embraces this solution-centric approach, and the research on Range and WOSM platforms is focused on understanding user perceptions and improving user outcomes. While there is substantial discussion of the enabling technology, it is viewed from the customer's standpoint in direct reference to expectations of results, and from a research standpoint as part of a dynamic landscape of IT-related knowledge and tools to facilitate desired outcomes.

The detailed literature review comprises the following sections

- IT Based Collaboration
- Connecting Collaboration to Innovation
- Work-Oriented Social Media and Technology Acceptance
- The Oil and Gas Industry
- Innovation and Transformation in the O&G industry

IT-based Collaboration

Better tools and communication speeds enable faster communication between colleagues working on operational and innovation projects. Yet, it is not fully established as to whether the quality and effectiveness are improved. In a 10-month longitudinal study with an engineering innovation team that was using a collaborative tool, Majchrzak et al. (2000) used multiple methods including ethnographical observation, survey questionnaires, network logs and face-to-face interviews to test the effectiveness of the tool. Their work yielded unexpected results. The researchers expected that

not only would the tool be used more after an initial period of resistance, but that the study subjects would periodically return to the tool to re-use knowledge sources after finding the source useful and relevant. However, their hypotheses were not validated by this research. With regard to usage of the tool, they found a relatively consistent level of overall use at the outset and throughout the duration; there was a high degree of variance between individuals, but no overall pattern of increase. The more relevant finding was that the work teams tended not to rely on the tool even after initially establishing its usefulness.¹⁰ Working with a different team of researchers a few years later, Majchrzak found valuable results in a study on collaboration in *virtual* teams, concluding that the benefits of virtual collaboration were so high as to make the virtual format even preferable to co-location of teams. (Majchrzak et al, 2004)¹¹ The development of internal capabilities in networked collaboration has developed significantly over the last decade as the internet became ubiquitous, but organisations seeing innovation across enterprise boundaries need to develop capabilities in searching for the right partners and optimizing their own contributions to the network (Rehm, Goel, & Junglas, 2017).

The use of electronic networks and shared virtual spaces enable the identification and attribution of contributions by a large number of coworkers. Adler et al. (2011) identified the importance of recognizing individual contributions in achieving organizational goals. They argued that as more organizations develop matrix-like structures instead of traditional vertical hierarchies, it is both more difficult and more important to identify individual contributions to facilitate team spirit and incentivize collaborative work. Work-oriented social media, both structured and unstructured, enable individual association not only with the origination of creative and transformative ideas, but also with the promotion and socialization of such ideas. There is a significant body of literature on the societal and cultural factors involved in achieving the right balance between valuing individual contributions to outcomes versus collective efforts and achievements achieved at multiple levels of the organization. In very broad terms, 'Western' culture (generally understood to include the US, UK, Western Europe, Canada and Australia) tends to value individual effort and achievement more than other cultures (Trompenaars, 2007; Basabe & Ros, 2005). The question of individualism vs. collectivism in the ideation and adoption of innovative change is not one of the central research questions in this paper.

¹⁰ The researchers concluded that two specific situations around the underlying project, which was related to innovative rocket-engine design, were significant factors affecting the results; the first was that many engineers stopped categorizing and organizing input data effectively, believing it would not be useful to others. The second factor was that frequent design changes in the project specifications led to quick obsolescence of information and, consequently, reduction in reliability. Both factors are arguably quite common in any dynamic organization, particularly in the private sector in the Western hemisphere. However, it is worth emphasizing that this study covered a single team working on a single, albeit very large, engineering project. It could be inferred that other teams would be even less likely to rely on the information.

¹¹ The approach in this later study was mostly normative, covering team-building, structuring of inter-personal relationships and members' understanding of key elements of success. With respect to collaboration technology, the study found that the use of virtual workspaces for project execution was preferable to e-mail, videoconferencing and even in-person meetings. E-mail tended to create issues with organization of information, difficulty in copying team-members, and retrieving information. Video-conferencing and in-person meetings tended to distract members by taking them out of familiar surroundings, as well as creating sub-texts of voice-tone and body language that were difficult to articulate in meeting minutes. The use of virtual workspaces combined with regular phone conferencing allowed for organization of information by topic and date, and facilitated fast access to relevant information.

However, it is relevant to both Range in IT and to social-media platforms, as well as to certain features of the collaborative innovation platform covered in the case study.

Connecting Collaboration to Innovation

The study of innovation as a distinct research area, in terms of scholarly analysis of enabling factors, ongoing processes and social and economic outcomes has grown tremendously in recent years (Fagerberg, Fosaas, & Sapprasert, 2012). From a perspective of organizational and social mechanisms and structures promoting innovation, there is evidence that innovation benefits from increased knowledge sharing and collaboration. For enterprises that seek to derive value from knowledge sharing and innovation through broad technology-assisted networks, the applicability of Metcalfe's Law may be instructive. Robert Metcalfe, credited with inventing the Ethernet in the late seventies (von Berg, 2001), proposed a formulation of network value in terms of the network size, which later earned the moniker of Metcalfe's Law. The Law states that the value of a network is proportional to the *square* of the size of the network; it predicts an *exponential* increase in value of networks as they grow in number of nodes (or members or participants), as opposed to a linear increase. While there have been a number of competing formulas for the actual value-determinant equation (Briscoe, Odlyzko, & Tilly, 2006), Metcalfe's Law has been validated in practice in several situations, including the value of very large social networks like Facebook and China's Tencent (Xing-Zhou & Jing-Jie, 2015).

The growth in both content of social networks and number of participants in these networks can be attributed to three technology trends. First, the proliferation of affordable web-based services throughout the world has made the Web a common, standardized tool, comparable to the printed books and newspapers of the past few centuries. Second, most of the information on the Web is being created by a large number of dispersed participants in small portions at a cost near zero, which creates a significant advantage compared to large centralized newspapers and other publishers who employ permanent staff to produce information packages. Third, the Web enables people in multiple social and economic strata, across diverse geographies, languages and cultures, to create and collaborate in multiple fora to produce new and useful knowledge efficiently (Carr, 2008; Benkler, 2006). This third factor has implications beyond cost, speed, efficiency and quality. It enables the building of products and the creation of new markets where none existed or could have existed without the technology.

The linkage of collaboration and innovation through formal and informal networks and inter-personal interactions is further propounded by Johnson (2010) from a broader, trans-generational societal context. From a business-focused perspective, the positive effects of collaboration on innovation and innovative thinking has been effectively argued at the department or work-team level (Cash, Earl, & Morison, 2008; van den Berg, 2016), at the organizational level (Hammer, 2004), and even across organizations through open-innovation initiatives (Chesbrough, 2006; Von Hippel, 2003; Stengel, 2017). Many initiatives tend to promote involvement of players lacking domain expertise in the core disciplines being targeted for improvement, creating pathways for radical innovation. From a pragmatic standpoint, the engagement of non-experts to think about radical or unconventional solutions to problems that have baffled experts seems intuitive – the novice in a field is not constrained by years of learning and conditioning to look at issues in a particular way. The novice or outsider is more likely to ‘colour outside the lines’ or ‘think outside the box’; paradoxically, the absence of domain-specific knowledge could become an asset. Where coworkers or organizationally-linked cohorts, who are inherently ‘insiders’, act as ‘outsiders’ to help solve a problem, a high degree of trust may facilitate the free exchange of ideas and opinions, enabling radically new solutions. The concept of corporate entrepreneurial innovation has been analyzed through multiple modalities of roles, processes and internal marketing (Shaw, O’Loughlin, & McFadzean, 2005; Zampetakis & Moustakis, 2007; Datta & Jessup, 2013).

Drawing a clear distinction between technology and knowledge management, and arguing that traditional systems have had limited success, Mubarak (2019) advocates a people-centric approach:

“With the recent advancement of technologies, it has been frequently observed that technology is dominating the discussions about knowledge management. Knowledge management comes in many different forms. One needs to understand that in any of these forms, technology does not manage knowledge but simply facilitates the interactions between people who possess or need knowledge. ...In my opinion, knowledge management is directly associated with people and this is not technology-based or a software application...The most appropriate approach is to recognize the people who possess knowledge; those who are willing to use it and share it with others through a means of connecting them with others for only one purpose, a purpose to create bigger networks and stronger ties to make knowledge available, accessible and useable.” Mubarak, 2019, Pg. 1

This people-centric approach is critical to creating long-term business value, and is closely related to concepts of sustainable business models wherein enterprises are constantly evolving along with their society and environment. Sustainable models place value on developing people and preserving the physical environment, along with realizing a return on financial capital. These models are gaining

attention in academia and professional practice (Pedersen, Gwozdz, & Hvass, 2018; Yang, Chou and Chiu, 2014).

Opposing many of his peers of the 1990s by arguing for caution in knowledge-sharing, MacDonald (1994) expressed particular concern regarding *inter-organizational* knowledge-sharing agreements, proposing that formalizing such agreements tended to disrupt informal networks and hence could have a negative effect on innovation. However, it is worthwhile to note that MacDonald's concerns and reservations preceded the widespread use of social media, email and cellphone-texting in human communication. These developments in communication over the past two decades resulted in the blurring of boundaries between formal and informal interactions in business and even in society. It may still be argued, though, that building structure and discipline around ideas and innovation can be counter-productive. Excessive structure can reduce the spontaneity and serendipity often associated with the creation and sharing of new ideas.

Informed corporate leaders may therefore attempt to create an appropriate balance between these competing perspectives, seeking a position that fits both organizational culture and the range of strategic factors (Porter, 2008). Further, AOL's founder Steve Case (2016) argues that society tends to underestimate the role of large organizations in mature industries creating radically innovative solutions: "The conventional wisdom may be that startups are the future, while established corporations are all relics of another world. But many of the world's biggest companies are teeming with talent and resources, creating new and innovative products all the time. In 2014, for example, Johnson and Johnson spent more than Google on research and development. Though the most rapid growth in R&D is happening in the software and Internet industry, as of 2014, *less than 10% of total corporate R&D came from 'tech companies'*. Most of the world's biggest ideas are still hatching elsewhere." Case's perspective is helpful but misses an important point; companies can *combine* internal programs with external alliances. Stengel (2017) discusses how large companies like Toyota and IBM are forming partnerships with startups and early-stage businesses to innovate.

The relationship between collaboration and innovation is not limited to connecting threads of communication and simple knowledge-sharing. In identifying causal links between collaboration and its positive effects on innovation, Dance (2008) argued that collaboration not only enabled association of ideas across different individual and group perspectives, but also improved the speed at which the feedback loop was completed, facilitating the improvement, morphing or discarding of innovative ideas. Increased participation also tends to improve the energy and enthusiasm around innovative ideas; further, having a group collaborate on devising and articulating innovative ideas tends to increase the chance of implementation by providing early traction and dissemination.

Even organizations with relatively high levels of centralized decision-making and formal structures can use collaboration networks for feedback and validation, providing faster information to improve the quality of decisions. However, highly innovative large organizations must balance creative stimulation with a clear set of rules or guidelines to achieve multiple objectives. These goals include profitable growth (corporations), organization mission (e.g. education and healthcare) or technological advances of national impact (e.g. defense and aerospace). This balance is typically not achieved through following a formulaic approach but through tailoring rules and guidelines for the particular context, workforce and culture of the organization (Sull, 2015).

Work-Oriented Social Media and Technology Acceptance

Social media – the common term for multi-user communication platforms that are not primarily based on games or commercial transactions, experienced a massive surge in the decade from 2005-2015. Facebook, Twitter, Youtube and LinkedIn grew rapidly in this period. Pew Research (2015) estimated that the percentage of US adults using social networking sites grew nearly tenfold from 7% to 65% during this period. Information technology (IT) had focused, for decades earlier, on increasing computing speed and improving physical connectivity between devices. Only in this past decade has IT focused on accelerating the power of human networks; this has fundamentally changed marketing, advertising and service industries like hotels, restaurants and transportation.

The rapidly morphing value of IT, both theoretical and practical, can be seen as secular trends or 'waves'. The first wave in the 1990s saw America Online (AOL) and other providers connect millions of businesses and consumers to the Web, creating broad value for the personal computers that had become prolific in the 1980s. Following this was the second wave, with companies like Google creating powerful tools to search the Web for data on events, places and people and companies like MySpace and Facebook connecting people through online social networks. The third wave is arguably, where the greatest potential lies, where entrepreneurial people and organizations use the technology to transform areas of direct human experience and work, through 'core' sectors including healthcare, education and energy (Battelle, 2005; Case, 2016).

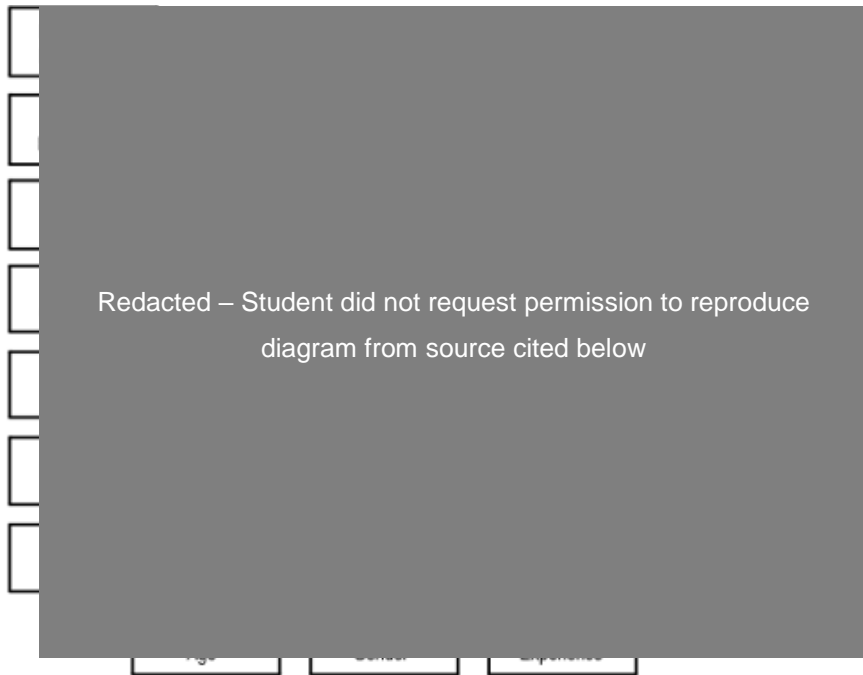
The construct of Work-Oriented Social Media (WOSM) is relatively new, and the first reference to the term itself appears to have been in a semantics-based study of collaboration on LinkedIn in 2012, several years after the term 'social media' was popularized (Danowski, 2012). LinkedIn, which was acquired by Microsoft in 2016, reached 500 million users in 2017 (Fortune, 2017) and is the most widely used WSOM platform today. Yammer, a loosely structured platform, started as a social-media

platform, but after widespread adoption by enterprises is now recognizable as a WOSM platform, albeit one that is more flexible, without tight boundaries between work and personal uses.¹² The value of networks like these grows with broader adoption; this leads to the growing importance of, and interest in, promoting wider engagement of all stakeholders. In analyzing the overall impact of WOSM, there are significant links to other fields in the social sciences, including sociology and psychology. Concepts such as trust between co-participants and empathy for other users that affect social media also affect work-oriented interactions. Detailed review and understanding of the expression of complex human emotions such as positivity and nuanced sentiment may be enabled by WOSMs. These emotions, as expressed through the choice of evaluative words, the choice of interaction method (for example, commenting on a post vs. 'liking' or 'sharing') and the choice of supporting graphics or attachments attached to posts, could yield useful data and insight about both the network and individual actors or groups of actors (Danowski, 2012; Hogan, 2010). However, organizations should also consider the potential drawbacks of having social-media-like applications in the workplace. One issue could be that participants are distracted from critical projects that are in the execution phase, spending more time on ideas and initiatives that are in the conceptual or planning stages. Another could be the potential for fatigue as participants get an overload of social media messages in their personal lives and start to lose the sense of pleasure and enjoyment they may have experienced from social media (Loiacono & McCoy, 2018).

As more organizations recognize the value of WOSM platforms, they need to persuade their workforce to join and actively participate in these media. This effort is inherently cross-functional, involving aspects of technology, aesthetics, psychology and statistics. Venkatesh et al. (2003) proposed a framework for categorizing and analyzing the factors involved in human adoption of new IT systems; they named it the Unified Theory of Acceptance and Use of Technology (UTAUT) framework. The UTAUT framework was developed from synthesis of the Technology Acceptance Model (TAM) first proposed by Davis (1989) and extensive further work on theoretical lenses of technology adoption. These perspectives include understanding and analyzing the impact of variances in the culture of technology adopters (Straub, 1994; Straub, Kreil, & Brenner, 1997) and the moderating effect of gender of technology adopters (Gefen & Straub, 1997). Additionally, from an organizational and workflow perspective, Dinshaw and Strong (1999) adapted the model to look at the impact of the fitness of the technology to the required functionality, while Goodhue and Thompson (1995) analyzed technology adoption through the lens of the individual user-product fit.

¹² Yammer, which was adopted by Empco as an entity-wide WOSM in 2017, is discussed in more detail later in this paper. Additionally, in the survey of user experience and attitudes with regard to the BrightIdea innovation platform, respondents' usage of LinkedIn and Yammer was used as a proxy for exposure to WOSM platforms.

A diagram of the UTAUT conceptual framework is presented below:



Source: (Venkatesh, Thong, & Xu, Unified Theory of Acceptance and Use of Technology: A Synthesis and the Road Ahead, 2016)

The UTAUT framework also drew from additional work by Venkatesh and Davis, dissecting pre-determinant factors affecting both perceived usefulness and perceived ease of use (Venkatesh & Davis, 2000). In creating a more nuanced framework while maintaining the flow and context of Davis' pragmatic original work, the UTAUT model appears to offer an effective response to criticism of the TAM as being overly simplistic. The TAM is unequivocally simple, yet instructive; Davis identified just *two* primary factors in adoption of technology – perceived ease of use and perceived utility. The model was widely criticized as being simplistic to the point of being tautological, and the basis for research that was essentially motivated by excessive parsimony (Lopes-Nicolas et al., 2008). However, it has proved enduring and useful, with the original article being cited more than 40,000 times and multiple strands of derivative research continuing today. It may be viewed as ironical that Davis' TAM framework was adopted, adapted, developed and cited by so many; it is both useful and easy to use (ie. the framework itself, when viewed as a tool, exemplifies its original assertions) making it a pragmatist's ideal response to critics.

The UTAUT framework expands Davis' original construct of 'usefulness' beyond work-centric definitions. It builds on concepts in the fields of sociology and psychology to understand human motivation beyond traditional work functions. It may be observed that hedonistic motivation and social

norming in business interactions, particularly in technology adoption, were less studied in management literature prior to the dawn of the internet in the nineties. Carr (2008) articulates this critical angle in referring to the intrinsic motivation of social media contributors:

“... the biggest reason people contribute to such sites is no different from the reason that they pursue hobbies or donate their time to charitable causes or community groups: because they enjoy it. It gives them satisfaction. People naturally like to create things, to show off their creations to others, to talk about themselves and their families, and to be a part of communal projects. It’s no different on the internet.” Carr, 2008, Pg. 139

In terms of functional value, the use of technology to enable and promote organizational knowledge-management appears to have expanded as a science in the late nineties, before social media and mass expansion of the Web but concurrent with the proliferation of electronic mail and computer-based collaboration systems (Von Krogh, Ichigo, & Nonaka, 2000). The significance of enterprise-wide adoption of KM-related systems arguably created a virtuous cycle. The promotion of knowledge management and extended learning became entwined with the more mundane imperative to increase adoption of the enabling technology, while increased adoption of the enabling technology expanded the spheres of domain experts and facilitated cross-domain interaction. Cross-domain knowledge transfer, which today is mostly enabled by IT, could be viewed as a critical service delivery of the IT function.

The adoption of WOSMs and other technology, whether to support innovation or other applications, can also be viewed through the lens of Diffusion of Innovation (DOI) theory (Rogers, 1983), which analyzes adoption from the aspect of the psychology and risk-tolerance of network actors. Identifying innovators and early adopters and engaging them in early networks facilitates broader adoption and provides a pathway for the majority to participate once the early-adoption risks are mitigated. However, this approach is arguably less relevant in situations like WOSM usage, where the initial time, effort to learn and apply the technology are not significant. Additionally, a phased approach as envisaged by DOI would tend to require a longer time horizon, which is more pertinent in situations where several rounds of development (or multiple versions or iterations of a product) are planned.

A useful framework for analyzing adoption of technological innovation is the Technology-Organization-Environment (TOE) framework originally proposed by Tornatzky and Fischer (1990), which has been used in a number of empirical studies. The TOE provides for analysis of the range of technologies available to the organization and their significance in advancing the entity’s mission and goals. The organizational aspect is viewed in terms of size, structure and qualitative dimensions of the entity’s human capital. Finally, the environmental aspect is an external lens, covering industry

landscape, competitors, government and supply chains. The TOE framework is particularly useful in analysis of the benefits and challenges related to new technologies, such as e-commerce and web security (Lippert & Govindarajulu, 2006, Zhu & Kramer, 2005).

In a more recent publication synthesizing literature and approaches related to the TAM and UTAUT frameworks over the past two decades, Venkatesh et al. (2016) recommend identification and analysis of specific features of new technology applications as useful extensions to the existing, extensive body of knowledge of the supporting factors in technology adoption. In the context of WOSM, this could apply to platform features including voting buttons, 'likes', video attachments, ability to tag articles and people, and ability to search for items of interest. The analysis of 'specific features' could also apply to organizational implementation features and processes, as in a business context these factors are integral to overall perceptions of utility. There is clear pragmatic value to analyzing features; the concept of 'perceived utility' at a platform level is extremely hard to measure objectively, making it impractical to employ in comparing alternatives. However, when broken into component elements – in this example, specific features of a WOSM platform, the results of detailed analyses can be used to compare platforms and relative strengths and flaws. The other technology adoption factor from the original TAM framework, Perceived Ease of Use, is relatively insignificant in this research as most of today's social-media platforms can be comfortably navigated by a ten-year-old child, primarily due to the proliferation of point-and-click user interfaces and drop-down menus.

Innovation and Transformation in the O&G industry?

The concept of transformation, or radical innovation, is clearly subjective, with many shades of meaning and context. In the E&P sector, the question could be framed around offshore versus onshore production, brown-field versus green-field¹³ or other categorizations. The discourse on transformation is more meaningful when boundaries are defined around the question of what is transformational change in the context of the organisation and peers being studied.

Once the industry context is set, the question arises as to the magnitude of change. This is also a highly subjective concept, one that is not only organization-specific but also varies based on functional divisions in the organization. The magnitude of change cannot always be categorized by monetary levels. For instance, a radical shift in drilling processes could yield a billion dollars of

¹³ In industry terminology, 'brown-field' means an oilfield in an area where infrastructure – roads, power and communications - is already developed. 'Green-field' means the oil producer would have to develop infrastructure, which can be very expensive.

savings annually in a single organisation, while transformational changes in maintenance might result in production gains and cost savings worth less than a hundred million dollars annually.

In any industry or sub-group, the categorizations of innovation into ‘radical’ and which are ‘incremental’ must be seen in the context of timing, execution practicalities, and the real or perceived limitations of what can or cannot be changed. Le Masson, et al. (2010) use the term “radically incremental” to describe a common situation in industry, wherein none of the individual innovations involved a fundamental change, but a succession of incremental steps built important changes when observed in retrospect. While the classifications this research group used were conventional - ‘minor adaptation’, ‘feasible technical change (incremental)’ and ‘problematic technical change (radical)’, the research found that a series of incremental changes that *built on prior incremental changes* could facilitate radical change. In practice, the use of innovation networks and collaboration-enabling technology has the potential to spur both *radically incremental* and *radical* change. Ideas flow in from groups and individuals outside of core functional groups. The daily routine of functional groups can lead to complacency and stagnation. Several functions of the O&G sector resemble manufacturing, which Singh et al. (2017) argue has suffered from a conventional view that innovation should be measured through R&D and patent activities. Instead, they advocate for a wide range of activities to be regarded as innovation, including design-based cost reduction, product life extension and the development of valuable product features.

Clayton Christensen discussed the critical differences between what he termed Sustaining Innovation and Market-Creating Innovation. Improving products, the primary goal of sustaining innovation, is important for economies, but the main driver of growth is the building of new factories, creation of jobs and development of new technologies. Christensen argues that most of these ‘building’ activities are driven by Market-Creating Innovation. This type of innovation creates value through providing new products and services, primarily to groups that did not previously have access to them, thus creating new markets (Dillon, 2020).

Establishing clear pragmatic value to IT strategic initiatives in the O&G industry, Mills (2013) argues that there is a very direct connection between technology and large oil and gas production increases. He insists that the productivity boom will continue, and that, in contrast to the *initiating* technology, the *sustaining* technology will be specifically *information* technology. He theorizes that the generation of massive data streams from advanced fiber-optic cables and the ensuing facilitation of analysis and learning will transform the industry.¹⁴ While Mills’ optimism about the industry should be tempered

¹⁴ Mills argues that it is not primarily horizontal drilling and fracking techniques that have driven productivity gains, since there have only been incremental improvements to what is essentially decades-old technology. Instead, he credits the big gains to ‘smart drilling’ – a combination of better mapping of underground reservoirs and more precise steering of the drill-bit. Even with advances to date, however, the success rates for fracking sections (also known

with a critical analysis of the broader social, political and market factors impacting the industry, such as the growth of alternative fuels (discussed later in this paper), there appears to be a strong case for improving IT in the industry. The growth of big-data and analytics is linked to the expansion of cloud-based computing. Cloud computing and the resulting scalability will be critical for small and mid-sized companies to have access to these data-heavy technologies. The extension of the benefits of large-scale technical computing to smaller companies is important to the industry in the US, as there are hundreds of smaller operators due to the historical development of the industry in the country through fragmented private ownership.

As with other industries, computer systems and applications are used to support production decisions in the E&P industry. Improving the speed and efficiency of the information flows and responses can yield progressively better results, but are less likely to be game-changers in the future. Wang (2003) notes that production optimization applications have been used in oil and gas production for several decades; applications include planning, well siting, well operations, well design and field facility design. The techniques include both linear and non-linear programming as well as integer programming. Sherwin et al. (2002) described an oilfield information system that encompassed instantaneous flow of information from remote devices to a central station, creating the opportunity for significant operating efficiencies. While variants of these applications have been deployed for over a decade at multiple organizations, developing them to their full potential requires not only transformative change in the IT functional support paradigm, but also radical improvements in the level and extent of collaboration between functions in an organization. There is enormous potential to reduce the 'time-to-market' for products through the shortening of multiple segments of the investment cycle – starting with lease acquisition and continuing through the processes of target identification, drilling, well completion, processing and transportation.

A strategic question that E&P companies face today is the level of attention to their emissions of greenhouse gases (carbon dioxide, methane and nitrous oxide). A significant increase in greenhouse gases in the last century has been conclusively linked to the likelihood that climate change and global warming on a massive scale will impact human life across every continent. The impacts are expected to come from a combination of the melting of polar ice caps, increases in floods and extreme weather events. In addition, further increases in temperature in regions that are already close to the limits for human habitation pose a risk of catastrophic outcomes without massive reliance on cooling systems, which in turn increase emissions of greenhouse gases into the atmosphere (Senge et al., 2010).

as 'stages') is still only about one in four. He says this is the big opportunity – to use sophisticated imaging combined with analytics to identify patterns that were not discernable with older technology.

The science of climate change from greenhouse gases has grown to a point where the continued use of fossil fuels over the longer term (20 – 30 years and more) comes into question. Coal, which is arguably the most polluting source of energy¹⁵, is likely to be the first fossil source to be significantly curtailed over the next decade or two. Crude oil is also likely to come under pressure from reduced demand from the transportation sector as road vehicles move to gas and electric drives. The demand for natural gas, however, is likely to grow over the medium term. Natural gas is the cleanest fossil fuel and is more economical to produce and distribute than solar and wind power. The enormous increase in US natural gas production enabled by fracking and advanced drilling techniques have also helped reduce the emissions of CO² in the USA by 14% between 2005 and 2017, as the replacement of coal-fired plants by natural gas feedstock results in lower CO² emissions (Murray W., 2019; Rhodium Group, 2019).

Section Summary

The literature review covered an important area of IT strategy: the creation of organisational frameworks around collaboration and innovation. The IT function can facilitate innovation by promoting networks and Work Oriented Social Media (WOSM) platforms. The context of large, mature organisations provides a basis for understanding how some of the concepts could be applied to the Oil and Gas (O&G) sector.

There is potential to build on the literature in two key areas. First, a new theoretical framework for IT organisation around service delivery could enhance attention to the value of people-centric networks in boosting innovation. Second, a case study on the use of a WOSM platform in a mature organisation would add to the body of knowledge on technology promotion in the context of innovation networks. This work builds on the UTAUT framework (Venkatesh, Thong, & Xu, 2016) through examination of salient features of a WOSM platform designed to promote crowdsourced innovation. The technology and organizational aspects of the TOE framework are also interwoven through the analysis; however, there is limited application of the environmental aspects as the case study approach is structured around the product features, internal implementation and level of discipline-crossing in a single mature organization.

¹⁵ Coal is significantly less polluting than wood-burning. However, wood-burning is only used as a primary source of energy in under-developed or primitive societies.

3. RESEARCH OBJECTIVES AND QUESTIONS

The overall objectives of the research project are to contribute to the body of knowledge in IT strategy and organisation and to develop professional practice in information management strategy in the O&G sector. Due to the common nature of many elements of IT strategy and systems, this knowledge and practice development may apply to other sectors, but no claims are made in this respect.

Why Innovate in the O&G Industry?

Despite clear environmental and societal impacts from the extraction and use of fossil fuels, the O&G industry has remained highly relevant. From the steam engine of the 18th century and the electric bulb of the 19th, to the jet engine and the computer of the 20th century and the Internet of Things of the 21st, technology has changed human life dramatically in the last 5% of recorded history. Underpinning these rapid developments has been an abundance of power generated by fossil fuels, hydroelectric sources and nuclear plants, as well as the development of rapid and convenient transportation. While individuals, business organizations and governments have started to drive towards cleaner and safer sources of power and fuel like solar and wind, these sources are expected to take between 20 to 30 years to replace current sources. In the US, about 80% of all energy produced - 88 quadrillion British Thermal Units - comes from fossil-fuel sources. Petroleum and natural gas make up over three-fourths of this and coal accounts for the rest (US Energy Information Administration, 2019). There is significant value in improving the business of oil and gas production today. Information science has the potential to facilitate improvements through the effective use of resources, enabling cross-domain knowledge exchange and boosting innovation.

Why Promote Range in IT?

Research on the concept of Range in IT, and its application in the use of WOSM platforms to promote idea-sharing and innovation, has the potential to broadly benefit practice in other mature industries as well. The oil and gas industry already has cross-industry collaboration and idea-exchange fora with the medical industry (including a popular partnership called 'Pumps and Pipes'¹⁶) and the aerospace industry (including interaction and joint initiatives with NASA) and these are likely to grow.

¹⁶ Pumps and Pipes is a collaborative organization whose motto is 'exploring your neighbor's toolkit'. They have a number of cross-sector initiatives between the medical industry, the oil and gas industry and the aerospace industry. These are the top three sectors in the Houston metro area. <https://pumpsandpipes.com/about-us/>

More narrowly, research on specific features in WOSM platforms has the potential to guide managers and software providers in optimizing the value of such platforms to users and organisations.

In the area of academic development, the concept of Range can potentially broaden the scope of the discipline of Knowledge Management (KM) and help build stronger bridges between the academic field of KM and the fields of Collaboration, Innovation and Information Strategy. While these fields are related and have both conceptual and practical overlaps, the Range construct, contextualized as a component of information science, can assist in integrating research on the overall information systems value proposition and value delivery as part of the 5Rs Framework.

Why a case study of a WOSM platform?

Research on specific features of information technology as moderating factors in their adoption was identified as an area for academic development by Venkatesh et al. (2016). Venkatesh, with over two decades of influential work in this area, argues that there are sufficient conceptual models and empirical work covering psychological and social factors in user adoption of technological solutions, but not enough analysis and literature relating to the qualities and features of the technology products themselves. Focused research and case studies, such as the one presented here, could help development of improved features in WOSM platforms serving a number of industrial sectors. Additionally, the introduction of the BrightIdea platform at Empco, with a specific focus on innovation, presented an opportunity for a contextualized case study with good access to a number of relevant sources.

The next section provides analysis and discussion of the development of specific research questions (RQs). A section on research methodology and methods follows the development of RQs.

Ontological, Epistemological and Axiological Grounding

This research is derived from an ontological position that would be generally recognized as Realist. Realism as an ontology broadly accords primacy to human agency as the basis of knowledge of reality, but recognizes that reality may exist outside of human perception. The physical and institutional structures that precede or enable human agency in linguistics, for example, are enabled by anatomical features (the larynx, tongue, lips and the auditory system) as well as institutional features, which in the case of linguistics is the development of language syntax, structure and hermeneutics. In analyzing organization research, Leca & Naccache (2006) connect the ontological underpinnings of Critical Realism to epistemological, methodological and even axiological considerations, opining:

“Institutional entrepreneurs are organized actors who skillfully use institutional logics to create or change institutions, in order to realize an interest that they value highly... (they) will select the structures depending on the context, to ensure that the causal powers of the structures that they intend to use will work. Critical realism also suggests a specific method to link the different domains.”

Leca & Naccache, 2006, Pg. 634

To the extent that a realist approach includes understanding and analysis of external structures, both physical and institutional, the epistemological implications are compatible with Baconian induction. Baconian epistemology can be somewhat simplistically understood through the analogy of repetitive human observation of the appearance of steam from a pot of water over a wood fire. Empirical data can support an initial causal understanding of the relationship between fire and steam, which may be true or at least partially true. A subsequent observation of water over an electric stove plate may then lead to a better understanding of the mechanism by which water turns into steam; this is not done through repudiation of the empirical data but by analyzing the common factors, (in this case, temperature and the physical properties of water) that led to steam conversion in different situations (Garvey & Stangroom, 2012).

In the field of information technology, claims that reality is constructed and interpreted through social interaction are less prevalent than in more typically ‘social’ fields, for example, international relations or cultural studies (Dusek, 2006). With a critical realist outlook, the underlying topic simply helps guide the research to an appropriate point on a ‘greyscale’ or continuum, neither completely empirical nor completely constructivist. Even in the case of information technology devices, Dusek does concede that the “claim of effective functioning of technological devices is socially constructed.” While in engineering theory, a device’s effectiveness can be empirically measured by the ratio of output to input, in practice, whether a technology device or platform is considered effective is a product of

multiple complex social factors. These include the composition, character and interests of user groups. This can be argued to be much more significant when analyzing the effectiveness and impact of a social media platform.

A good understanding of philosophy can enhance collaboration and improve results. Modern fields such as climate research and space exploration *require* multiple disciplines and offer philosophy workshops to a wide range of technical and non-technical researchers (O'Rourke & Robinson, 2015). One of the challenges with analyzing the effectiveness of information systems is that the ultimate test of information utility is with user groups. Husserl (1936) articulated the concept of phenomenology, or description of experience, as being an integral part of developing knowledge. However, he stressed that knowledge had to be derived indirectly, through intuition built from both perceptual and conceptual understanding of experience. Heidegger (1954), on the other hand, focused more on the actual experience of lived reality, thus taking the concept closer to what is generally viewed as a constructivist approach today.

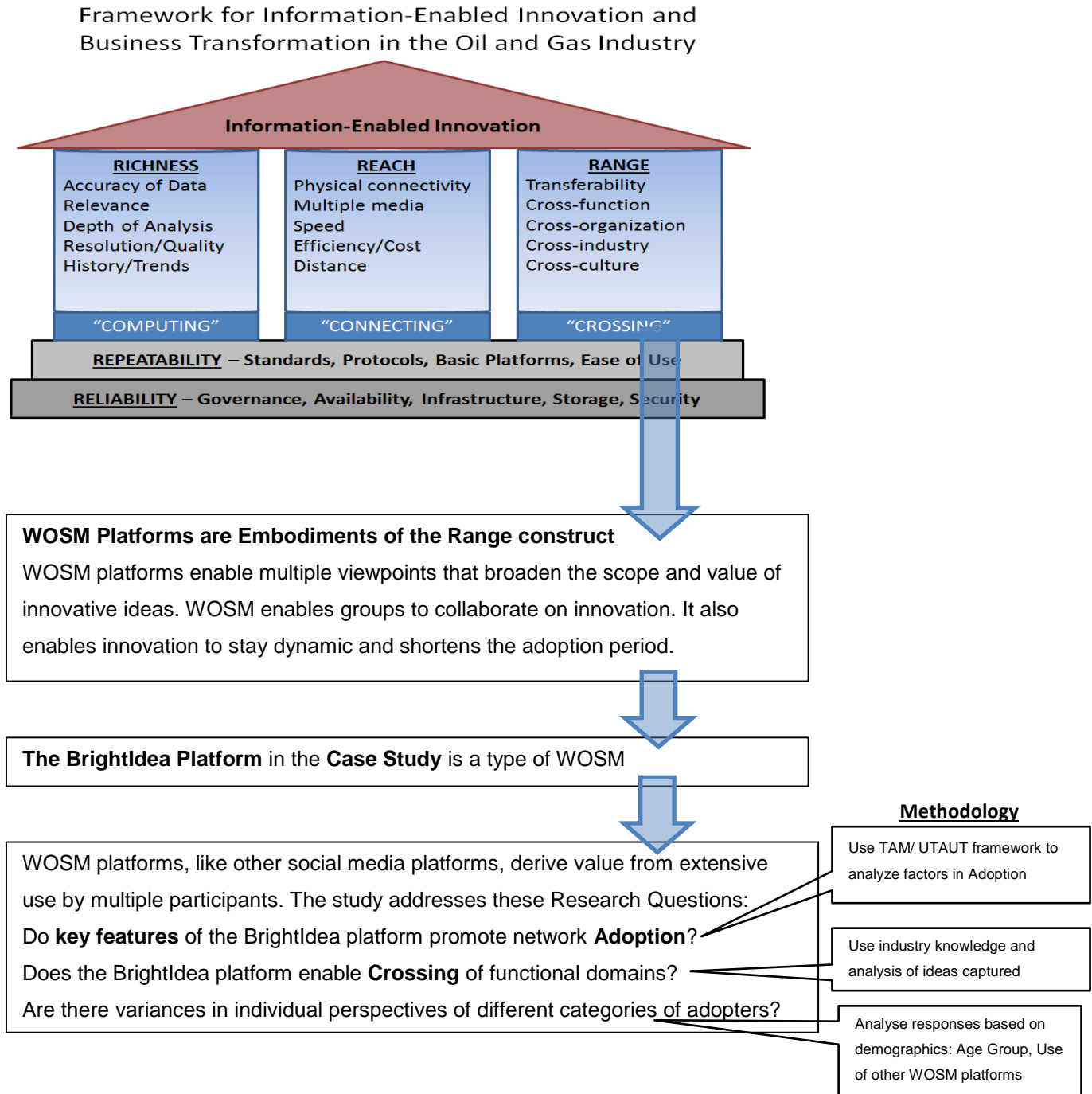
While the phenomenological viewpoint is not incompatible with American pragmatism, it differs in purpose and usage. Knowledge creation as a goal in itself, or pure intellectualism, cannot be pragmatic, as there must be some intention to use knowledge gained for some current or future practical application. This leads to different research approaches, as the subject matter of research is necessarily limited, in the case of pragmatism, to areas where knowledge can help solve problems. However, as pragmatism freely embraces conclusions derived from both positivist and interpretive research, it facilitates a broader range of acceptable, albeit debatable solutions. It could be argued, then, that pragmatism is well suited for organizational research, which usually incorporates elements of uncertainty and risk. Risk, and an understanding of its sensitivity to environment, events and human agency, is fundamentally linked to business organizations, being the basis for competitive differentiation and interwoven with the availability of business opportunity (Belgard & Rayner, 2004; Kaplan & Norton, 2001; Porter, 2008).

Arguing that it is limiting to look at ontology as an either/or proposition, Loevinger (1957) presents a reconciliation of positivism with constructionism, which she called “constructive realism”; the concept is further expanded by Wallner (1998). He postulates that the path to knowledge is to translate and juxtapose proposition systems from one scientific framework to another in a *different domain*, a process he calls “strangification”. This at first creates confusion, which Wallner argues is really a sign of progress. It is through the process of identifying *implicit rules* in each domain - which become evident only when they clash with external frameworks – and making such rules *explicit*, that knowledge is acquired. This research incorporates an epistemological stance that could be viewed

as dually consonant with Wallner's construct of strangification. First, the concept of Range is itself compatible with strangification, as it envisages crossing of domains of functional discipline, organisation, industry and culture in promoting innovation. Second, the use of mixed methods in the research enables the creation of knowledge and understanding that is not limited to a particular methodological framework, but combines a number of factual and opinion-based data points with contextual analysis.

Developing the Research Questions

The figure below is a graphical representation of the development of the research questions and methodology:



Research Questions

In designing research questions, a critical balance must be achieved between connecting theoretical concepts to research questions and effectively employing research resources. This involves establishing and analyzing the trade-off between comprehensive scoping that would address all significant assertions and narrower scoping that may have higher limitations but would result in a higher probability of effectively completing the research with given resources. Hart (1998) argues that narrowing the topic “can be difficult and can take several weeks or even months, but it does mean that the research is more likely to be completed.” Additionally, he posits that the tasks and choices involved in narrowing a topic helps development of intellectual capacity and practical skills, by fostering a “research attitude” and aiding the researcher to “think rigorously” about the topic and the practical aspects of completing the research in a limited time. This efficiency aspect is arguably more relevant in business research, as research participants may be more likely to be employed professionals who tend to be not only juggling multiple priorities but inherently more conscious of time as a resource than other groups, for example pub patrons, indigenous tribes or social clubs.

In developing a line of research that would address the broad question - Can Range in Information Technology boost innovation in mature industries? – the first narrowing of scope is to look at the O&G industry. The O&G sector is a mature sector, accounting for more than half of the world’s energy needs (International Energy Agency, 2018) and between 2 and 3% of the world’s total GDP. Second, as Empco is a large organization in the O&G sector, it qualifies as a good candidate for a case study, creating a significant further narrowing of scope. The case study as a methodological tool is well suited to realist research and a pragmatic methodological approach. While a case study by itself has significant limitations in terms of generalizability and even credibility as a reliable source of knowledge, it provides a real-life situational analysis that can both inform and prompt action (Yin, 1984; Noor, 2008). WOSM platforms are widely known and it is argued that these platforms are embodiments of the Range construct, enabling multiple viewpoints that broaden the scope and value of innovative ideas. WOSM platforms enable groups within and across organisations to collaborate on innovation, knowledge-sharing and other areas. Since these platforms use editable media (electronic instead of paper) and offer flexible and customizable features, they enable innovation to stay dynamic and potentially shorten the adoption period. The final scoping decision is related to the use of a single platform, the BrightIdea platform deployed by Empco in 2016, for the case study. The platform was deployed with the intention of promoting innovation and collaborative idea-sharing at Empco, making it a good candidate for analysis in this research. It is recognized that the use of a case study on a single platform at a single organization (albeit a large one) would tend to involve

significant limitations with regard to the validity and repeatability of research findings. However, the study of the BrightIdea platform and its features is complemented by other quantitative and qualitative work as described earlier in this document. Additionally, the use of a large cohort for the survey should help to draw useful conclusions in furtherance of the research objectives.

The research questions fall under three categories – the primary questions (Questions 1 and 2) cover the efficacy of platform features (both inherent and implementation-related) in promoting network objectives, and the extent of domain-crossing . The secondary question (Question 3) is related to understanding the effects of two moderating factors – age-group and familiarity with social-media-type platforms outside of BrightIdea – on expectations and attitudes toward the BrightIdea platform. An auxiliary question was added to the secondary question, as recommended by Empco’s innovation team – it relates to preferences for an alternative platform structure.

Primary Questions: Do key features of the BrightIdea platform promote network adoption, and did domain-crossing occur in the Empco case?

Question 1: Do features of the platform promote network adoption

- 1a:** Do key intrinsic features of the BrightIdea platform, such as colorful graphics and an engaging interface, Likes, Comments and Published Usage Statistics, promote network adoption? Platform adoption may be promoted directly via features that make it easy and fun to use, as well as features that tend to increase utility through direct individual experience of a shared creative space.

- 1b:** Does promotion and influence by management, through multiple initiatives and communiques, promote network adoption? The research aims to address the influence of both senior leadership and lower management levels in employees’ decisions to participate and engage in the BrightIdea platform.

- 1c:** Were performance expectations of the platform, as developed and combined with implementation factors, generally met? The research aims to compare users’ expectations prior to joining the platform with their perception of the value actually delivered by the platform and the related implementation initiatives.

Question 2: Does the BrightIdea platform enable and/or encourage *Crossing* of functional domains?

While the platform enables crossing of functional domains, does only a small group of risk-tolerant network actors actually make suggestions or post ideas outside of their functional domain?

Secondary question: Are there variances in the level of engagement from different categories of platform adopters?

Question 3a: Are there differences in expectations and perceptions between different generations of coworkers? Based on the age-group data captured from the cohort, are there differences between Millennials (born after 1983), Generation-X (born between 1966 and 1983) and Baby Boomers (born before 1966)? These generational categories are commonly used in the United States.

Question 3b: Are there differences in expectations and perceptions between users who use multiple forms of WOSMs? The research seeks to understand linkage between attitudes and opinions regarding BrightIdea and respondents' use of other WOSM platforms (LinkedIn and Yammer).

Question 3c: Would a different platform format – a 'time-bound challenge' format – be preferable to the current open-forum format? This question was added after an innovation manager reviewed the proposed survey and noted that it would be useful to gauge interest in 'time-bound challenges'. The current tool differs from a time-bound challenge-based tool in two critical ways. First, the challenge element signifies that the company has an interest in solving a specific problem. The second is the time limitation, which imparts a sense of urgency to participants in the challenge.

Development of primary research questions:

The first research question (RQ) was developed to further the analysis of adoption factors impacting WOSM platforms, using a line of research recommended by Venkatesh et al. (2016). Venkatesh et al. advise focusing on specific features in technology products, arguing that this would be more valuable than adding new models or details to the existing, extensive literature relating to human factors supporting technology adoption. In the context of BrightIdea and similar platforms, this is interpreted to extend to features like voting buttons, 'likes', video attachments, ability to tag articles and people, and ability to search for items of interest. The pragmatic value derives from translating 'perceived utility' (a TAM/UTAUT construct) at a *platform* level to perceived utility at a *feature* level. This helps in comparing alternative platforms that offer the same basic functionality. The chosen features (Likes, Comments and Published Usage Statistics) differentiate WOSM platforms from other business applications and are likely to be significant factors in platform adoption. This broad RQ is comprised of several sub-questions on platform features.

Additionally, features of the implementation by the enterprise – including coordination and communication – influence decisions to adopt the technology. The second RQ addresses non-technology factors, including inter-personal aspects and broad motivation. Promotion by management, with linkage to enterprise goals, may influence adoption directly, through perception that participation is expected or mandated. Promotion by management may also influence adoption indirectly, through social norming as co-workers encourage each other to participate.

Network adoption and development is also influenced by performance expectations, prior to initial adoption of the platform. This factor is relevant to the expectation of continued use of the platform by participants. It also affects the likelihood that they will exert social influence on others to join the network. The original TAM model and its successors TAM2 and UTAUT did not isolate the positive reinforcement effect as an element of performance expectancy.

The second RQ was developed to further the broad theoretical framework for Range. The enabling of Crossing is a significant element of Range; however, since domain-crossing is risky for most network actors, it could be expected that there would only be a small percentage of domain-crossing ideas and solutions presented by network participants in this enterprise-wise forum. As argued in this paper, this small group of ideas is more likely to comprise radical and transformative ideas.¹⁷

Question 3 was developed from curiosity as to whether there were generational differences in attitudes towards WOSM and post-implementation experiences of the platform. Question 3 was expanded to include a sub-question relating to Time Bound Challenges (TBCs) upon the request of an innovation project manager.¹⁸

Section Summary

This section connects the theoretical framework to research objectives, leading to three research questions. The research objectives are driven by a Realist ontology and epistemology. The section contrasts and compares Realism to other approaches, and provides some context for its use in Information Science. A visual, linking the 5Rs framework to the research approach and research questions, is presented in this section.

¹⁷ The research scope does not include evaluation of the efficacy or feasibility of domain-crossing ideas. The scope only covers the existence of such ideas in the platform.

¹⁸ The auxiliary question relating to TBCs was initially added only to gather data on this as an alternative format. However, after analysis, this option appeared to offer value as an *extension* (instead of a replacement) of the open-forum format. The original question was not modified, but the alternative of an extension has been included in the results and recommendations.

The first research question (RQ) covers intrinsic and implementation factors of the BrightIdea platform in the Empco case, to understand the impact of these factors on employee participation on the platform. The UTAUT framework is adapted to analyse motivational factors driving network participation and adoption. The second RQ addresses a core research objective, which is to link the construct of Range to the crossing of functional disciplines. The third RQ covers areas of secondary interest, which is the understanding of moderating factors (age group and WOSM usage) and attitudes towards an alternative format for presenting ideas.

4. RESEARCH METHODOLOGY

The research questions entail a combination of motivation factors (leading to joining and continued participation), implementation factors and actual results achieved in terms of number of ideas and the extent of discipline-crossing ideas. This indicates the need for a methodology that combines motivational analysis with observation of organizational actions, as well as data analysis of ideas presented by participants on the platform.

In gaining knowledge from the case study, the use of mixed methods appears to offer a dual set of opportunities; to employ relevant research methods and tools, as well as to engage appropriate personnel in the organization in the process of data-gathering and inferential analysis. Additionally, analysis of external data on platform alternatives and the use of similar tools at other organizations provides an opportunity to add context and breadth to the study.

The efficacy of mixed methods – combining observation, surveys, interviews and quantitative network data is well supported in business research across multiple disciplines. Krivokapic-Skoko and O'Neill (2011) postulate that as a research approach, mixed-methods is strongly complemented by Pragmatism as a philosophical approach, as it is consistent with a practical and outcome-oriented method of inquiry and a *need-based* approach to research methods and concept selection. They argue that simply viewing methodologies and methods through a qualitative vs. quantitative lens tends to restrict both intellectualism and contextual scope. While Krivokapic-Skoko and O'Neill capture central concepts of the compatibility of mixed methods with a Pragmatist worldview, they do appear to neglect a critical element – resource availability. Mixed methods approaches allow for the efficient use of resources available to the researcher without inconclusive debate on the merits of quantitative versus qualitative research. Instead, available resources are used to support or negate research hypotheses. Methods are viewed as teleological, chiefly as instruments to resolve issues (Menand, 1997). This teleological view flows naturally from the Pragmatist outlook on ideas themselves, which are viewed as bridges to utilitarian value and not inherently valuable. Louis Menand, author of *The Metaphysical Club* (2001), provides an elegant analogy:

“An idea for them (pragmatists) has no greater metaphysical stature than, say, a fork; when your fork proves inadequate to the task of eating soup, it makes no sense to argue about whether there is something inherent in the nature of forks or something inherent in the nature of soup that accounts for the failure, you just reach for a spoon.” Menand, Video: Pragmatism's Three Moments, 2014, At time: 21min,05sec. URL: <https://www.youtube.com/watch?v=GFdei5zKGSg>

The successful employment of mixed methods is also well documented outside of organizational research, for example, in health research. Researchers seek to view theories and issues from multiple perspectives to enhance the depth and breadth of their work. It may also help to contextualize information and build on the overall conclusions by adding separate data points and referential material. Additionally, merging quantitative and qualitative data could help develop a more complete understanding of phenomena through contrast, triangulation and illustration (Creswell et al., 2011; Plano Clark, 2010).

In organization research, the case study method may complement a critical realist ontology and epistemology, combined with pragmatic methodology. Easton (2010) argues that a case study approach is particularly well suited to situations where there are clear boundaries, as may be encountered in a single organization or industry sector, but where there are complex questions that are not easily answered through non-contextualized data analysis. The method is also well suited to areas where interesting phenomena observed during the course of the research may lead to emergent questions and findings that may add significant value to the research and in some cases may even change the basic course of the research. The use of data collection to first establish patterns and phenomena, and then try to explain the underlying causes of such phenomena, is a key element of a critical realist approach. In mixed-methods research, quantitative analysis tends to serve a relatively descriptive function (describing the phenomena), while the qualitative portions tend to support the higher-value findings related to understanding and explaining context, relevance and causality of the phenomena (Mingers, Mutch, & Wilcocks, 2013).

This case study incorporates a two-pronged approach to understanding and analyzing the BrightIdea WOSM platform itself. The first part, representing a miniscule but important part of the research effort, comprised of a review and tabulation of the user cases presented by the BrightIdea organization on its website (BrightIdea, 2019). These cases are in the form of detailed user testimonials, and are presented with related facts and statistics chosen by the user organization. There are 10 such cases, typically around two pages each, which may be viewed as 'success stories' or customer endorsements. While they provide useful data for research grounding, they are obviously designed from a marketing perspective and should be regarded with professional skepticism. None of the cases provide criticism or review the limitations of the platform or software.

The second part, representing most of the case study research work, is the gathering and analysis of data on the adoption and implementation of the BrightIdea platform at Empco, and the analysis of the level of cross-discipline ideas presented on the platform. Considering the intent to understand

the influence of the platform features on the individual-level decision to use the platform, the UTAUT model serves as a solid foundation for building this additional understanding.

Simplifying and extending the UTAUT model, we can analyze the impact of platform-intrinsic and implementation features on selected determinants of Behavioral Intention (BI), which is the primary precursor to actual adoption of technology. The connection between BI and use behavior is not only intuitive but also has been established to be so strong that BI can effectively be used as a proxy for actual behavior (Venkatesh & Davis, 2000). The distinction between behavioral intent and actual behavior with regard to platform participation was moot in this study due to the research cohort being limited to those who had actually participated. For the application-intrinsic features being studied, the most relevant determinants in the UTAUT model appear to be:

- a) Performance expectancy – How prospective adopters see their use of the platform as promoting their own performance aspirations and achievement of goals
- b) Social influence – How prospective adopters are influenced by peers and leaders to see usage of the technology as socially desirable
- c) Hedonistic motivation – Whether prospective adopters see usage of the platform as pleasurable

The age and duration of work experience of users were considered relevant moderating factors to be included for demographic data collection and analysis. However, the gender factor, which has been researched in multiple projects (Gefen & Straub, 1997; Goodhue & Thompson, 1995), has been deliberately omitted, due to the researcher's belief that including an analysis of gender as a moderating factor in this type of project is inadvisable in the contemporary American organizational research context for two distinct reasons. First, using gender as a factor in general or technical studies could tend to reinforce stereotypes that have traditionally put women at a disadvantage in the workplace. These may include perceptions or prejudices related to qualities like risk-aversion, confidence, self-esteem or assertiveness as moderated by gender. More importantly, in this area of research, the gender factor cannot reasonably be expected to inform management practice. Creating alternative practices and policies based primarily on gender are considered inappropriate and may even be illegal in some jurisdictions. Hence, analysis of gender as a moderating factor seems incongruent with the pragmatic approach and aims of this research. Age and work experience factors, on the other hand, are both academically relevant and of practical value. The O&G industry and other mature industries are preparing for what is called "the big crew change", as the Boomer generation leaves the workforce and is replaced by Millennials and Gen-Z workers.

The determinants of performance expectancy and social influence are also relevant to the analysis of implementation features discussed earlier.

Methods

Assessment of the influence of platform and implementation features in adoption of BrightIdea at Empco necessitated both indirect data collection and analysis and direct data collection from adopters. The platform was accessed by over 4,000 users and curated by a dedicated team of employees at Empco. Over 800 ideas were contributed to the BrightIdea platform – several employees contributed multiple ideas.

The research project includes qualitative interviews with the dedicated team, a pilot survey with a small number of coworkers, and a full survey (using mixed methods) of approximately 400 Empco users. A total of 144 users completed the survey. In addition, quantitative data was gathered on number of users, number of ideas generated, number of ideas piloted and implemented. To quantify the percentage of ideas submitted by personnel outside of the functional areas to which the ideas were related, data was gathered on the departments and job titles of contributors.

The research methods for the analysis of the BrightIdea platform included pre-survey interviews with Empco's team of innovation experts. The research plan called for the use of these experts to comment on their experiences and objectives, provide feedback on implementation of the platform at Empco, and to review the proposed survey questionnaire. As detailed later in this paper, a significant question was added to the survey; this question was related to the participants' views on the potential future use of an alternative format of innovation promotion.

Survey questions were broadly structured in the format used in the UTAUT development, adapted and extended to fit the current research questions. The survey questions are included as Appendix 2. For most of the questions, it was considered appropriate to elicit responses using a Likert scale to allow for calibration and validation. While the conversion of Likert nominal scales to parametric values do present some issues and challenges in calibration and validation, their effective use has been documented in multiple studies in the social sciences and medical fields (Carifio & Perla, 2008; Sullivan & Artino, 2013).

In choosing to use 7-point vs. 5-point scales, the arguments for improved validity, reliability and discriminating power propounded by Preston and Colman (2000) were considered. Additionally, Finstad (2010) argues that a 5-point scale could force interpolation and lead to measurement error,

which can be avoided by use of a 7-point scale. While this research is not overly concerned or contingent upon precise measurement, the extra effort in using a 7-point appears to be merited, as it would offer more flexibility to respondents and facilitates a more nuanced analysis when compared to a 5-point scale.

Pilot Survey

Prior to release to the full cohort, a Pilot survey was conducted with seven respondents. These respondents were chosen from a cohort of coworkers with whom the researcher had interacted earlier in the context of the RIO project and who were known contributors to the BrightIdea platform. The proposed e-mail introduction and request was sent to each of them, and they were asked to use the link provided in the e-mail to access the Survey Monkey tool, take the proposed survey and provide comments and direct feedback. As expected, all seven responded to the request to review the survey questionnaire and suggest improvements. Based on the feedback and analysis from these respondents, changes were made in four different areas:

BrightIdea and RIO nomenclature:

Three respondents noted that the name BrightIdea did not immediately trigger an association with the platform, which was commonly called RIO or Rio Ideas within Empco. Based on this feedback, the e-mail cover note requesting survey participation was adjusted to clarify the internal name "RIO" instead of just the platform name (BrightIdea). This change improved the clarity of the solicitation email as well as survey questionnaire itself.

E-mail request to participate in research:

Two respondents noted that the general tone and wording of the proposed cover appeared rather strong, and could be seen as pushy. Using this feedback, the tone of the email was softened to be less aggressive and more appealing to the collaborative intent of responders.

Use of the Empco Yammer platform:

A question on the use of LinkedIn was included in the pilot questionnaire as part of the intent to understand and relate respondents' use of other social media to their attitudes regarding BrightIdea. Two pilot respondents pointed out that Empco had added an enterprise-wide Yammer media platform over a year earlier, and the use and views of this platform could be a good indicator of attitudes to WOSMs. A new question on Yammer was added to the questionnaire after receipt of this suggestion.

Survey Mechanics:

One pilot responder offered an important suggestion to improve the mechanics of the survey in the web-based Survey Monkey tool, pointing out that the page views at the end did not properly show survey completion. Upon further review, it was discovered that the set-up had included two blank pages at the end of the survey, which may have been the result of a combination of erroneous user set-up and a programming issue. This was eventually fixed in the Survey Monkey tool. Another respondent pointed out that one of the questions had been incorrectly set up to allow more than one answer, when the answers should have been set as mutually exclusive. This was easily fixed in Survey Monkey.

Validity and Reliability

Validity claims in case studies using quantitative methods are bolstered by drawing on qualitative approaches, particularly those that help contextualize and triangulate results. In business and social science, the aim of case studies is to obtain general knowledge through integrated analysis of multiple dimensions of the case. The typical course of experimentation and repeatable processes practiced in physical and natural scientific research is not practical in social sciences except for mundane areas. This is driven by the complexity of human behavior and the context-specific ways in which humans respond to their environment (Rendtorff, 2015). In business case studies and other context-specific research, 'external validity' is excluded by design if the term is narrowly defined. Bordens & Abbott (2008) define external validity of a study as the degree to which a study's results can be extended and generalized beyond the limited research setting and sample in which they were obtained. However, if the study is intended to guide thought and action, it can be useful to theory and practice without being repeatable. As a didactic methodology, the inclusion of case studies in MBA courses as a form of 'action learning' has great value (Greiner, Bhambri, & Cummings, 2003; O'Shannassy, Kemp, & Booth, 2010). A comprehensive course can help learners, according to O'Shannassy et al., "demonstrate the ability systematically and critically to identify and analyse problems and opportunities in an organization and to develop recommendations appropriate to the circumstances." The use of social media platforms and analysis of attitudes and behaviors related to these platforms present special challenges to research. The challenges include access to licenses and restrictions on use of the platform. Additionally, attitudes to technology and its utility tend to be context-driven and subjective (Dusek, 2006; Jordan, 2018).

Survey data for the BrightIdea platform survey was collected from 144 respondents. The population of platform users at Empco reached over 4,000 in just over three years. From this set of platform users, just over 400 had submitted ideas on the platform. The survey was sent to 380 of the idea-submitters; the others were not contactable either due to having left Empco or due to names being unidentifiable from the platform. Of the 380 emails sent, 55 were out of office at the time of emailing. The response rate for survey completion was 38% if all 380 solicited are considered; the rate was 44% when adjusted for respondents who were out of office.

The response rate is viewed as favorable, and the sample size of 144 was above the targeted size of 100-120. The statistical validity and reliability of large samples is well documented. Hobart et al. (2012) found sample sizes of a minimum of 20, for reliability, and 80, for validity provided highly representative estimates of values. Additionally, respondents appeared well distributed among the primary demographic control variable – age group – with 44 (31%) Millennials, 69 (48%) Gen-Xers and 31 (21%) Boomers responding. While Pew reports a 35%-33%-25% distribution of the three groups in the US labor force, the ratios in the responses are more likely to be representative of the Empco split due to the specialized nature of most operations in the O&G industry.¹⁹

In assessing reliability of survey data, one of the most important criteria of the quality of a measurement instrument is the reliability of the scoring method. The most frequently used reliability measure in the social sciences is Cronbach's alpha (Cronbach, 1951; Nunnally, 1978; Kuipers, van der Ark, & Coon, 2013). When the measurements represent multiple test items, Cronbach's alpha signifies internal consistency. Internal consistency does not mean that the measures are parallel or have the same variances. In practice, alpha is used to test whether a construct that is measured through more than one question provides some reliable measure in terms of consistency. Reliability is a necessary condition for validity, but not a sufficient condition (Bonett & Wright, 2015).

The measure requires the computation of mean covariance between pairs or sets of responses by an individual respondent and the variance for overall scores. The basic formula is set out as follows:

Cronbach's basic equation for alpha

$$\alpha = \frac{n}{n-1} \left\{ 1 - \frac{\sum V_i}{V_{test}} \right\}$$

Where:

n = number of questions

V_i = variance of scores on each question

V_{test} = total variance of overall scores on the entire test

Source: (Kuipers, van der Ark, & Coon, 2013)

¹⁹ This percentage was not compared to the actual age-group distribution of the Empco workforce, as this data was not obtained.

Sijtsma (2009) is highly critical of the research community for misusing alpha tests in two ways. First, he notes that alpha is a lower bound to the reliability, which often results in gross underestimation. Second, he posits that the use of the test as a measure of trait validity is fallacious, as it confuses 'interrelatedness' with unidimensionality of a set of items. Sijtsma argues that interrelatedness is weakly defined and cannot be used to draw conclusions on measurement error and validity. However, in the social sciences, such analysis is not used to make life-saving or life-altering decisions, such as detection of cancer or cardiac disease. Validity and reliability testing merely provide some level of credibility of results and documentation of a scientific process.

While measures of alpha above 0.7 are considered reliable in the social sciences, Bonett & Wright (2015) argue that reliability in alpha values should be calculated with due regard to sample size and researchers' expectations of population characteristics.

In this paper, alpha was calculated on sets of items that were clearly related by design and intent. The results are presented below. Computations were performed in Excel with the Data Analysis add-in and ANOVA tables. The results were cross-verified with IBM's SPSS software. The only data set with alpha below 0.7 was the Platform Features set with 0.67. This lower score is accepted as reliable due to variability in individual views on different features, which are not parallel.

Computing Alpha for Survey Data Sets

Data Set Description	Assertions	Cronbach's Alpha
Set 1: Platform Features	<ul style="list-style-type: none"> a. The Likes and Comments features are desirable and useful in achieving the objectives of the platform b. Empco made a Good decision to Remove/Omit a Dislike/Downvote button in the platform c. Usage Statistics, Ideas Statistics and Dashboards are useful in achieving the objectives of the platform 	<i>Alpha for Platform Features responses: 0.669</i>
Set 2: Hedonistic Motivators	<ul style="list-style-type: none"> a. Enjoyed browsing and reading innovative Ideas posted by coworkers b. Enjoyed browsing and reading Comments posted by coworkers c. The BrightIdea Platform is fun and entertaining 	<i>Alpha for Hedonistic Motivators responses: 0.867</i>
Set 3: Empco Leadership Implementation Factors	<ul style="list-style-type: none"> a. Empco leadership demonstrated support for the BrightIdea platform as a forum for innovative ideas b. There was a clear linkage of usage of the BrightIdea platform to Empco's goal of promoting Innovation c. The process of advancing ideas to Pilot stage, after at least 15 Likes and SME evaluation, was clear. 	<i>Alpha for Implementation Factors responses: 0.735</i>
Set 4: Social Norming	<ul style="list-style-type: none"> a. My co-workers use of BrightIdea encouraged me to participate in the initiative b. Interactions with my manager/supervisor encouraged me to participate in the platform c. It was expected that all employees join the platform to show support for innovation d. It was expected that all employees contribute to the platform, through Ideas, Likes or Comments 	<i>Alpha for Social Norming responses: 0.791</i>
Set 5: Core Utility of Platform	<ul style="list-style-type: none"> a. When I first started using the RIO BrightIdea platform, I expected it to provide significant value b. Work Oriented Social Media platforms like RIO BrightIdea and Yammer are useful in business c. Increasing employees' usage of the platform helps Empco achieve the goal of improving innovation d. Usage of the platform increased my knowledge of innovation at Empco 	<i>Alpha for Core Utility responses: 0.754</i>

Section Summary

The concept of Range is people-centric; its value is realized through the wide adoption of tools and platforms that include and engage people to contribute their knowledge and lived experiences to help other individuals and their organizations to solve problems and improve their environment. To focus the research objectives, the aspect of network participation was selected, as it is a key element of strategic alignment with organization goals in the promotion of innovation. The case study was designed to understand and analyse the factors to be considered in improving participation.

The research questions arise from the broad intent to explore and analyse the elements of WOSMs that promote wider adoption and participation. The Technology Acceptance Model (TAM) and its derivative Unified Theory of Acceptance and Use of Technology (UTAUT) framework are well established in the literature as reference frameworks from which to analyse the incentivization of network participation. The research project was structured to employ these models as well as incorporate additional academic direction regarding the value of understanding specific features of technology in promoting wider adoption.

Additionally, the extent of domain-crossing, which is central to the construct of Range, can be observed and tested through the case study through enumeration of discipline-crossing ideas.²⁰

²⁰ Since the BrightIdea platform covered in the study was limited to Empco's organisation, other aspects of crossing such as cross-enterprise or cross-industry were not observable.

5. CASE STUDY – A WOSM PLATFORM TO PROMOTE INNOVATION

Organizational Context

In 2015, [REDACTED] (Empco'), a large upstream oil and gas company headquartered in the United States, began a major innovation and business-transformation initiative dubbed RIO [REDACTED]. The industry had experienced several years of significant growth with the advent of massive investments in the rapidly-growing areas in Texas, North Dakota and Colorado, and a large number of new players had entered the market. Commodity prices had started to come under pressure and there was increased competition for oilfield leases and investment dollars.

Mature companies, some of them coming close to a hundred years in the business, were competing against lean and innovative upstarts. The upstarts had the benefit of starting businesses with newer equipment, advanced systems and low demands for dividends. The lower dividend demands were attributable to their classification as 'growth' investments in equity markets.

The broad vision of the RIO initiative was to position Empco to take advantage of emerging technological advances that have been transforming operations in a number of industries. The initiative focused on intelligent equipment, analytics, connecting people, promoting innovative solutions, and providing access to a new operational database. The stated objectives were to guide the organisation to 'move from just understanding the past to seeing and improving the future'.

The RIO initiative included several major phases and sub-initiatives; including:

1. Offsite 'visioning' sessions with over 100 employees who were selected as change leaders (identified as 'Change Champions'); teams formed in these sessions were a combination of experienced functional experts and less-experienced co-workers from multiple disciplines. The teams were asked to identify key operational and commercial issues affecting the company and come up with ideas for process and technology change to help resolve them. The intent was to use a combination of 'top-down' (driven by management) and 'bottom-up' (driven by front-line personnel) approaches to identifying and resolving issues
2. The customisation and implementation of a new, large enterprise resource planning (ERP) system to replace the existing ERP system, which had been identified as deficient in critical functional areas. The existing ERP system was constrained by issues with vendor-support and was determined to be at the end of its design life.

3. The creation of multiple work teams to tackle functional improvement in Drilling and Completion, Production, Maintenance, Engineering, Procurement and Finance. In contrast with the short-term 'visioning' sessions, these teams were allotted between 6 and 18 months to review processes and structures to identify opportunities and re-design workflows .
4. The purchase and enterprise-wide implementation of an idea-sharing WOSM software platform called BrightIdea, internally branded as RIO BrightIdea, which was intended to promote an innovative mindset and promote open idea-sharing throughout the company.

Each of the initiatives were promoted throughout the enterprise by senior management as well as by Director-level personnel in multiple disciplines. The ERP system change, representing investment of tens of millions of dollars by Empco over a three-year period, was guided by a Steering Committee consisting of executives in Operations, Finance, Commercial and Information Technology.

The implementation of BrightIdea platform offered an opportunity for a detailed analysis of the intrinsic features and management factors relevant to WOSM platforms aimed at promoting innovation. Additionally, the data captured on the platform enabled an analysis of ideas contributed to determine the extent of domain-crossing ideas, since most of the ideas were categorized by functional area. When combined with data available from Empco [REDACTED] regarding the functional group of each contributor, the database allowed for a determination of whether the idea originated within the contributor's functional grouping or came from a different area.

The BrightIdea platform afforded the researcher an opportunity to directly observe and participate in the generation of innovative ideas, as well as build on existing relationships to gather qualitative and quantitative data relevant to the research objectives and methodology.

Analysis of Expert Viewpoints

The research plan called for engagement with Empco's team of innovation experts to solicit their experiences and objectives, provide feedback on implementation and rollout of the platform, and to review and suggest changes to the proposed survey questionnaire. Meetings were conducted with four internal experts whose roles focused on innovation initiatives within Empco. These comprised:

- the Technology department head, [REDACTED]
- the project management specialist, [REDACTED]
- an innovation technical expert, [REDACTED] and [REDACTED]
- an innovation/administration generalist, [REDACTED], whose role included coordination and management of the BrightIdea platform.

Aside from changes to the proposed survey questions, there were three key learnings from these interviews. First, the researcher was informed that the timing of research was fortuitous, as there was an initiative to launch a 'refresh' of the innovation program, due to growing evidence that the energy and enthusiasm experienced earlier on was flagging. Three years had passed since the original roll-out of the program. During that time, the company had also experienced some challenges with the ERP-system implementation, which had taken a lot of management attention. Second, that there was a belief that many good ideas and potential innovative projects were not being brought to the BrightIdea platform but were instead being promoted and tested outside of the established process. This was seen as being a negative development, and the possibility was raised that this was due to a lack of faith amongst co-workers that the idea-gathering and vetting system was effective, or a general sentiment that contributors to the platform were not being adequately recognized and rewarded. Finally, it was revealed that there was consideration being given to a significant change in the idea-promotion platform and methodology, with a possible migration towards a Time-Bound Challenge approach. Under this approach, company management posts a challenge and solicits solutions, by a given date, for a stated reward, as a means of promoting collaborative work and crowd-sourced innovation. The Time-Bound Challenge platform under consideration either could replace the current format or supplement it. This format has been used extensively in public organisations, and many private organizations have started to adapt it, often using the internet to promote the challenges to a broad audience (Galasso, Mitchell, & Virag, 2018).

Technical expert [REDACTED], the only one of the four interviewed who was 'field-based' (the others were based at the corporate office) had extensive contact with a number of contributors to the platform. As a long-experienced employee in the oilfield, he had a close-up perspective on reactions and attitudes of front-line contributors. To some extent, the level of participation and contributions fell short of his expectations. He said:

"I worked with the design of the platform from the beginning. We saw this as a good way for people to connect. Regarding ideas, we thought we would get a lot of folks covering different topics. But that didn't happen. People started providing ideas that helped only their own Business Unit ... and some ideas they didn't share at all."

Project Manager [REDACTED] noted that there had been an overall decline in participation rates, after some initial success. He attributed the decline in participation to three factors: (a) Human behavior and habit, and the fact that there was no published expectation for frequency of site visits, (b) Lack of prominence of BrightIdea on the company's intranet home page, and (c) Decline in top leadership involvement through follow-up communications and direct participation on the site by top leaders.

█ also provided some background on the Time-Bound Challenges alternative, after discussing the basic workings:

“When we first looked at bringing this to [Empco] we thought we might use something like that [a time-bound challenge]. Now we are looking at that again. I think we could get a lot of good ideas if we focus on technical and operations issues and ask for help in fixing them. The same company can help us design it. It isn’t hard to do, but I don’t know how well people will use it. The company is going through a lot of change; people are really busy with their regular work and may not respond well.”

Overall, these insights were very useful to the research project, and summaries of the interviews have been included as Appendix 2.

Analysis of Alternative WOSM Platforms

To improve understanding of alternative WOSM platforms and obtain a broader view of the factors and features that affect selection and implementation, an interview was planned and conducted with a senior official of the National Aeronautical and Space Administration (NASA). The nature and objectives of the research were provided and the official, Steve Rader, Deputy Manager for NASA’s Center of Excellence for Collaborative Innovation (‘the Center’), expressed a keen interest in the project and agreed to be named as a contributor.

General Comments

Rader sees a large number of students and young professionals competing in multiple public challenges. Of knowledge-sharing and collaboration, he says:

“The current generation (still studying or just entering the workforce) doesn’t necessarily know more than previous ones, but they know how to access information in efficient and creative ways. They use various platforms to quickly learn or find answers. They use community forums like Stack Overflow, Reddit or even YouTube as important sources of shared knowledge. We find through our use of challenges or freelance projects that these users are great at accessing the information or training that they need to produce high quality solutions. For example, we were able to use a freelancer to develop a smartwatch application prototype for less than \$3,000. During that project, this freelancer actually taught himself to code for the special smartwatch operating system that we were seeking” (Rader, 2019).

Platforms used by NASA

The broad philosophy of NASA, which is publicly funded through the Federal government, is to permit employees and contractors to use a wide variety of platforms. Rader provided a current list of platforms used by NASA employees and contractors, which is not necessarily a comprehensive list of the platforms used.

Collaboration and Innovation Media Platforms				
National Aeronautical and Space Administration (NASA)				
May 2019				
	NAME	PRIMARY FUNCTION RELATED TO NASA INNOVATION	WEBSITE	NUMBER OF USERS*
1	NASA@WORK	Internal challenge platform (build on ideaScale - similar to BrightIdea)		
2	TopCoder	Competitive challenges in open global community of designers, developers and data scientists	topcoder.com	> 1 Million
3	Kaggle	Data science hub with project-sharing, competitions and shared programming code	kaggle.com	> 1 Million
4	Innocentive	Challenge-driven innovation platform using large resource of problem-solvers	innocentive.com	> 380k
5	NineSigma	Companies (mostly large industrial) pose problems and Solution providers engage with solutions	ninesigma.com	1,000 Corp Clients
6	HeroX	Crowdsourcing platform focused on Enterprises and innovation community	herox.com	N.A.
7	Tongal	Video content for businesses - created by free-lance videographers	tongal.com	>125k
8	Luminary Labs	Consultants - with partnerships. Not crowdsource platform	luminary-labs.com	N.A.
9	Common Pool	Run competitions based on enterprise-specified criteria	commonpool.org	N.A.
10	OpenIDEO	Social issues - challenges from civic bodies and non-profits	openideo.com	N.A.
11	Patexia	Shared resource for patent attorneys and patent issues. Not a crowdsource platform	patexia.com	N.A.
12	Yet2	Connector and open innovation consultant for large companies and resources for innovation	yet2.com	>120k
13	Freelancer	Post projects and select projects to work - freelancing model. Claims to be world's largest in users and projects	freelancer.com	> 16 Million
14	GrabCad	Computer-aided design (CAD) community with members sharing data and models	grabcad.com	> 6 million
15	cOutsource/Crowd Platform	Enterprise IT Outsourcing. Fortune 500 freelancing solution allows companies to create web-based projects	cOutsource.crowdplat.com	N.A.
16	Amazon Mechanical Turk	Allows enterprises of all sizes to crowdsource projects as well as outsource needs to managed teams	mturk.com	> 100k

*Based on website claims (not verified in this research)

Tracking of Participation

Rader noted that the Center tracked participation data across multiple channels. This helps in comparison between different fora from the perspective of channel effectiveness. The understanding and analysis of participation rates also helped the Center with its social mission of connecting with the innovation community. The social aspect is considered important as the Center uses public funds and has accountability to elected representatives in the US Congress.

Tracking of Results

The Center maintains data on results achieved and makes it available to the public. Additionally, organizations may approach the Center to license its intellectual property for commercial use. These activities fall within the broad federal-level mission of the organization. Results are tracked in multiple formats – by discipline, by platform source, by period. The Center uses these results to gauge the effectiveness of various programs.

Use of Social-media-like features such as Likes and Comments

Many of these platforms had WOSM-type features; however, some were structured to resemble online marketplaces instead of social media. The online-marketplace format appeared to make more sense for platforms such as Freelancer and Amazon’s Mechanical Turk. On these platforms, organizations and individuals seeking well-defined project services or completion of repetitive tasks try to match with freelance workers seeking to sell their services.

One site, OpenIDEO, which focuses on finding solutions to social issues, included a ‘Heart’ button that any users could employ to indicate support for a particular solution. The site clearly indicated the limited impact of a Heart vote: While some of the sites, including time-based challenge sites, allowed for Likes and Comments, they were not used as a means to separate good ideas or a voting tool to promote ideas into a second review phase. The OpenIDEO platform provides clarity on this:

“Clicking the heart button for contributions and comments is a way of showing your support and encouragement. There’s so much great stuff going on at OpenIDEO, we wanted you to be able to high-five the ideas you love. We don’t select challenge shortlists and winners by the amount of applause they receive, but your encouragement means a lot!”

<https://www.openideo.com/faq-challenges>, Pg. 1

The question of the use of popular vote as an integral part of the screening process also arose in the Empco BrightIdea implementation and evaluation. However, unlike OpenIdeo and other platforms used by the Center, Empco had decided that an idea posted on the BrightIdea platform needed to get 15 or more ‘votes’ to pass on to the next stage, which was evaluation by functional experts.²¹

BrightIdea Platform Results at Other Organizations

In preparation for detailed data-collection and analysis of the platform implementation at Empco, a research effort was conducted to review the results and learnings from other organizations that used

²¹ Refer to the section Implementation features at Empco later in this document for this and other implementation features

the BrightIdea platform. There were three important limitations to this line of inquiry. First, there were only ten customer cases published on the BrightIdea organization website²² (Source: www.brightideas.com/customers). Second, it could be reasonably expected that not only were failures and major challenges excluded from the case-deck, but also the cases reported would tend to skew towards the most successful. Finally, these case narratives tended to focus on outcomes while providing minimal details regarding organizational inputs and the processes enabling those outcomes. These limitations were recognized and considered in the analysis. On the positive side, it may be argued that organizations that are willing to share their internal success stories in a public forum tend to be more outward-looking and more open to innovation outside of their core activities. While this may be a tenuous argument, a clear benefit of reviewing the published cases is that they are easily available and relevant to the case study. However, it is clear that 10 'customer success stories' cannot be considered representative of the field experience of customers of the platform.

The cases published are tabulated below; some additional analysis of numbers (employees, ideas, projects) and ratings was performed using a separate Excel workbook but the results have not been included in this paper as there was limited value perceived. Six out of the ten cases lacked sufficient detail of outcomes achieved to build a meaningful deck of cohort organizations. The four that did provide some narrative detail did not provide analysis of the organizational inputs and processes which enabled those outcomes.

²² Based on the existing corporate relationship between Empco and BrightIdea, it may have been feasible to request additional, non-public data from BrightIdea; however, this option was not pursued as requesting it could have been viewed as an Empco manager taking undue advantage of a service provider.

CASE #	ORG. NAME	CASE TITLE	INDUSTRY/ SECTOR
1	AUTOLIV	Helping the World's Largest Automotive Safety Supplier Save Lives Through Innovation	Manufacturing
2	AXA	How the World's Largest Insurance Company is Transforming Itself for the 21st Century	Insurance
3	BT	How BT is Turning Creative Ideas Into Concrete Projects with Measurable Returns	Telecommunications
4	CHILDREN'S MIRACLE NETWORK	How Children's Miracle Network Leveraged Innovation to Engage 95% of Employees and Raise \$350k	Healthcare
5	CISCO	How Cisco is Achieving Millions in Innovation Outcomes	Information Technology
6	GE POWER	GE Harnesses Open Innovation to Make Power Grid Technology Smarter	Power (part of Conglomerate)
7	HPE	HPE is Accelerating Next with BrightIdea	Information Technology
8	MERCK	Cultivating Ideas and Internal Communities at Scale	Healthcare
9	NIELSEN	Creating a Realistic Innovation Roadmap	Media Services
10	PEARSON	Pearson Education Makes a Difference for Kids with ADHD	Education

Salient Features of the BrightIdea Platform

The salient features of the platform can be categorized into Application-Intrinsic features, ie. features inherent in the platform itself, and Implementation features, which relate to the mechanisms and processes employed by Empco to promote network growth, usage and effectiveness.

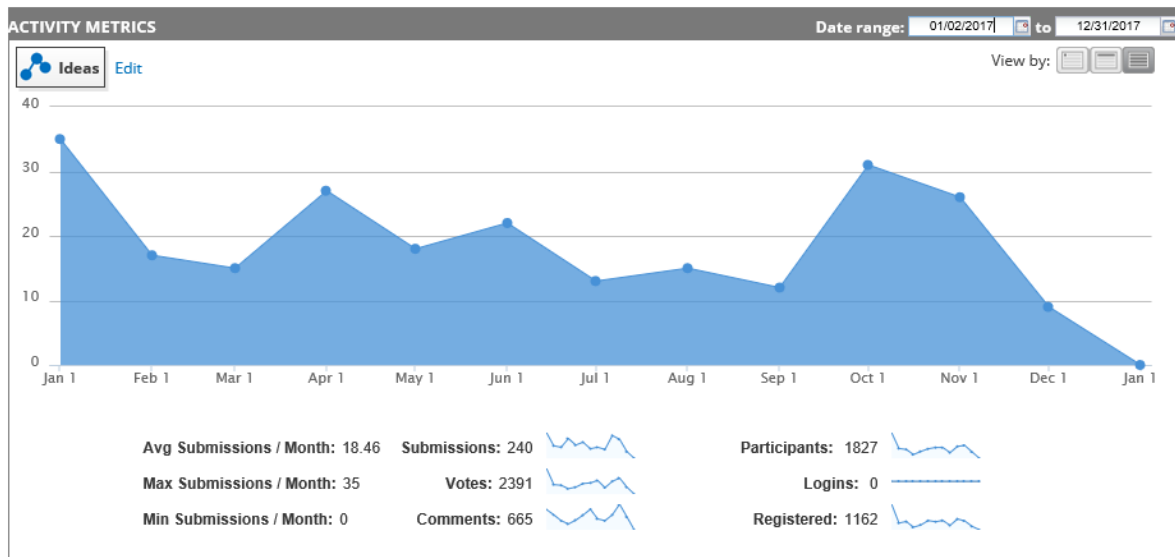
Application-Intrinsic features of the BrightIdea platform

- 1. Graphic Title for each Idea** – Each new idea form allows the presenter of the idea to import a picture or graphic, create an appropriate title, and publish the idea after filling in a few details. The ideas can be viewed in multiple formats, which can be customized by readers. The type of detail collected on each idea, eg. expected cost of pilot, degree of difficulty and functional area, are customizable by the organization. These are described under Implementation Features. The screenshot below illustrates the use of graphic titles. The ability of the idea-presenter to customize the visual associated with an idea creates an opportunity to use creativity and individual style. They can influence viewers to support and promote the underlying idea. A screenshot of graphic titles is provided on Appendix 5.

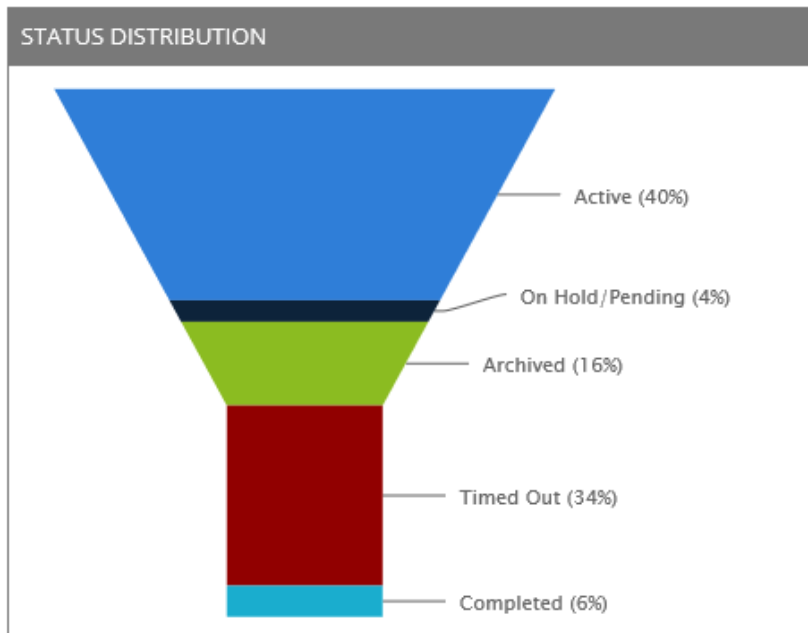
2. **Views** – The application tracks how many individuals viewed the idea, and displays that number. The number of views is displayed through two separate numbers - Total Views and Unique Views - the latter simply eliminating the duplication of counts when a participant re-clicks on an idea. The view counter is progressed when a participant clicks on an idea's Graphic Title. The counters allow for analysis on the attractiveness of ideas based on their categories and titles, the percentage of viewers who vote for an idea (percentage of those clicking on an idea) and other statistical analysis.
3. **'Likes'/Upvote** – This feature enables a participant on the platform to 'like' (ie. vote for) any idea that has been posted. The interface is simple; a green arrow pointing upward in the bottom left portion of the idea's Graphic Title. A count of the number of likes is displayed as an overlay on the Graphic Title, to enable participants to immediately see how many others have voted for the idea. This feature offers to browsers a quick alternative to searching for 'popular' ideas – for instance, they may use, instead, a category-based browsing screen but only view ideas that reach a level of popular support. There is also a basic browsing alternative that simply displays the most popular ideas (see below).
4. **Categorization** – Ideas are captured in categories that are configured by enterprise administrators of the platform. The number of categories and the type of categorization fall under the purview of Implementation Features. The platform also offers visualization tools that enable users to hone in quickly and easily on areas that may interest them. Additionally, the graphics offer a quick way to gauge the level of interest and participation in various functional disciplines. A screenshot of Category Distribution, an example of this feature, is provided on Appendix 5.
5. **Browsing Ideas** – The platform offers multiple alternatives to browsers trying to select a few ideas to read and possibly comment or vote. Browsing can be done by Most Recent ideas (chronological), New to Me (ideas that have not been viewed by the browser), Most Popular (those with the highest Likes or votes), Category-based (by function or area of business) and by a Fastest Riser selection, which is based on a platform algorithm combining freshness and popularity. See below for further discussion regarding the Fast Risers algorithm.

6. Statistics and Timelines – The statistics and timelines indicate how many ideas were posted each day, week, month and year. The numerical data can be accessed in multiple ways, including graphic charts, Excel downloads and tabular displays. Statistics can be compared across periods, across organizations or sub-groups, or in various formats selected by the participant organization. The screenshots below serve as examples of this feature. The statistics and timelines features allow for both enterprise-level and individual-level configuration of views. These create a dynamic and flexible user interface.

In the examples below the first is a graphic of the number of new ideas, in this example a monthly view has been selected. The second example is a dynamic funnel-chart indicating the total number of submissions and the current status of each. The format is commonly used by sales personnel to show the progress from initial lead to receipt of a firm order from the customer.



Activity by month – the Y-axis indicates number of new ideas submitted. Activity can also be viewed by day and by week. The platform’s functionality allows for users to easily switch views to suit their needs and interests, using simple mouse-clicks and mouse drags for an interactive experience.



Status charts provide a quick summary of the population of ideas by current status – Active (currently being viewed and assessed), On Hold (decision pending), Archived (Decision was made not to implement; idea is maintained for reference), Timed Out (significant time has passed and no action taken) and Completed (Implemented)

7. Fastest Risers – The Fastest Risers feature highlights relatively recent ideas that have gathered multiple votes in a short time. This relative measure is driven by an algorithm that combines (relative) freshness with vote-counts. The Fastest Risers feature enables participants in the network to identify popular ideas with momentum. The rationale behind this feature is that such ideas can be highlighted to general audiences, who mostly do not have the time to see all ideas.²³

FASTEST RISERS	
Idea Title	Votes
Re	61
De	263
In	16
W	167
Fl	148
Ac	61
Re	64
Ye	48
Ho	104
Co	106

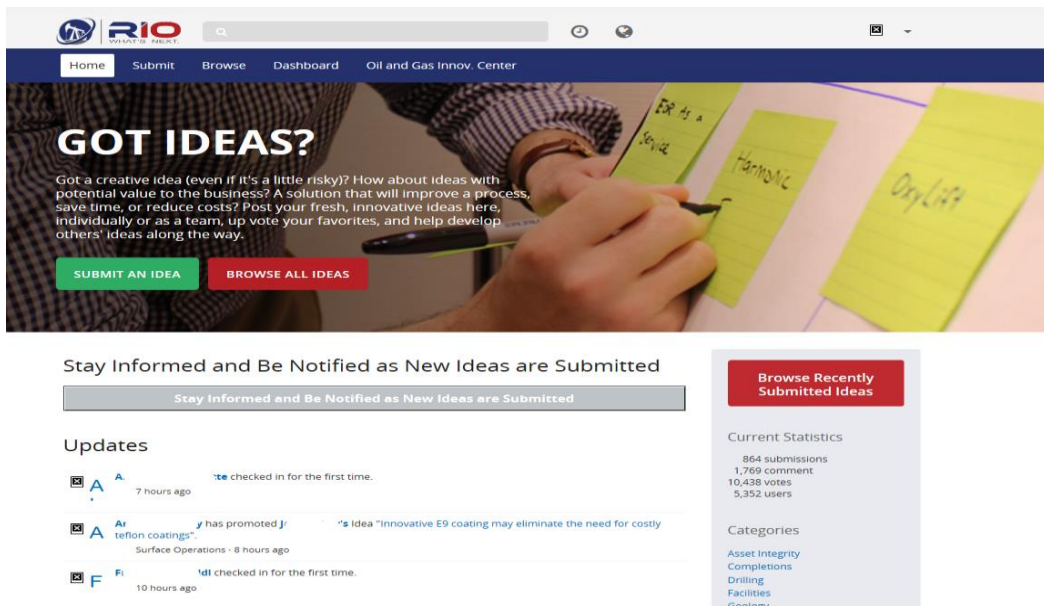
²³ The concept of 'fast risers' is also employed in popular, non-work-related social media platforms such as Facebook and Twitter. The algorithms that underlie such identification enable the partial translation of human interest into computer code. A post that 'goes viral', a popular term in social media, is fundamentally a post that became popular quickly and then was boosted by algorithms to a wide audience that further interacted with it through views, likes and comments.

This concept can be applied to academic papers in peer-reviewed journals, or to published books and general articles. For instance, one may question who is more influential, a renowned scholar who published an acclaimed article in a reputed journal in 1990 and by 2018 was cited in 10,000 academic papers, or a lesser-known scholar who published an article in the same journal in 2011 and was cited by 8,000. Based on a total population of, say, 50,000 papers, a researcher may manually identify the latter as being more influential. However, as the total population rises above 1 million papers, the researcher may realize the value of a computer algorithm that facilitates this identification. That is not to assert in any way that the more influential paper is superior or more relevant, it is simply another data point for the researcher. However, it could be argued that a Fast Riser analog for academic research papers is more relevant than a simple 'Cited By' number, which is the current data point offered by Google Scholar, NTU Libraries and other institutions.

Implementation features at Empco (BrightIdea was implemented in 2016)

1. **Voting recognition mechanism** – Empco’s management and implementation team decided that an idea that received 15 votes, or more, would represent an idea that would merit additional investigation for potential implementation. The use of a 15-vote threshold was not based on analysis or testing, but was an arbitrary number that was considered a reasonable threshold to help filter out ideas that had no chance of success.²⁴ The initial form of the next level investigation would be a review by an expert panel, which typically had 3-5 individuals with expertise in that particular field or topic, or Subject Matter Experts (SMEs). If the SMEs agreed that implementation was viable, and that it had a reasonable chance of successful implementation in Empco’s business, then the leader of the relevant business unit or function would be approached to fund a pilot project. After a successful pilot and further evaluation, the proposal would be implemented.
2. **Promotion by top management and middle managers** – Empco’s top leadership and middle management created a number of events and fora to publicize the new ideas platform. Executives used both formal and informal communications to deliver the message through multiple channels, in an effort to get a large number of employees to log in and utilize the platform. These efforts were largely successful, with over 4,000 employees joining the platform (around 50% of the total number of employees). An attractive ‘landing space’ was created, and convenient links provided, to encourage employees to join. The screenshot below illustrates a portion of the communication effort, which is the Home Page of the platform as implemented.

²⁴ This 15-vote threshold was seen as a negative feature by some participants, who believed that a good idea might have fewer supporters for a number of reasons, including a lack of knowledge by other participants of specialized topics, the idea being more complicated or presented verbosely, and a simple lack of popularity of the presenter. Conversely, a well-known presenter might get votes based on their individual popularity instead of the merits of their idea. This was gleaned from the T.R. interview as well as ethnographical observation.



3. **Recognition of Contributors** – Empco’s management created recognition schemes whereby idea-contributors were recognized and rewarded through spotlight articles on the company’s websites, bonus payments and on-the-spot awards (gift certificates and thank-you cards). Dozens of contributors were recognized through a combination of these avenues. Team awards were provided when participants banded together to submit a joint idea, or when a group were engaged to assist in a pilot project arising from an idea submitted on the platform.

4. **Links to external resources** – Empco innovation leaders provided links to external resources, including the Oil and Gas Innovation Center, a non-profit organization unaffiliated with Empco, that focuses on enabling and show-casing innovative solutions from dozens of companies (mostly early-stage enterprises). The screenshot on Appendix 5 relates to the links on the BrightIdea platform to the Oil and Gas Innovation Center, These links had a dual purpose – to inform participants about technology advances in the sector as well as to stimulate creative thinking and problem-solving.

The implementation was broadly structured to position participation as somewhat of a ‘civic duty’, building a perception that joining the platform, contributing ideas and voting on ideas would be viewed as good citizenship by management and by peers. This was done through both overt messaging as well as more nuanced factors, including prominent signage at the entrance to corporate headquarters, a dedicated team of promoters and the creation of Change Champions at

multiple levels throughout the organization. The Change Champions were provided with 'swag' items such as badges, Lego blocks and banners, and were encouraged to spread the messaging in both formal and informal settings.

Section Summary

This section provides background and context to the Empco case, covering both qualitative and quantitative analysis of implementation aspects of the BrightIdea platform at the company. The use of the BrightIdea platform at other organizations is described and briefly analyzed. Additionally, data is presented on competing or complementary platform used at the National Aeronautical and Space Administration (NASA), a government organization widely regarded as a leader in innovation.

Interviews with innovation-promotion personnel at Empco are summarized and discussed, as is an interview with a senior leader at NASA.

The section includes descriptions of the key features of the BrightIdea platform, aided by charts and graphics sourced directly from the platform for illustration.

6. FINDINGS

Findings presented here are primarily derived from a survey (n = 144) of participants in BrightIdea, all of whom contributed at least one idea to the platform. In addition to the survey, analysis of data obtained from the platform itself was used in RQ 2, relating to the crossing of functional disciplines. Two demographic factors were analysed for moderating impact; the age group of the respondent and the other factor was the level of use of other WOSM platforms – LinkedIn and Yammer.

Presented below is a summary tabulation of survey results²⁵:

FACTOR	Median Response	Mean Response	Category Mean
<u>Platform Features</u>			
Likes and Comments Features Boost Participation	Slightly Agree	2.87	2.83
Good Decision to Skip Dislike/Downvoting Button	Slightly Agree	3.05	
Usage and Ideas Statistics and Dashboards are Useful	Agree	2.58	
<u>Hedonistic Motivators</u>			
Enjoy Browsing and Reading Innovative Ideas	Agree	2.47	2.75
Enjoy Browsing and Reading Comments	Agree	2.60	
Enjoy BrightIdea Platform in General	Slightly Agree	3.18	
<u>Social Norming/ Social Mandate</u>			
Co-worker Encouragement	Neutral	4.16	3.83
Manager/Supervisor Encouragement	Neutral	4.54	
Employees Expected to Show Support by Joining	Slightly Agree	3.25	
Employees Expected to Contribute Ideas/Comments	Slightly Agree	3.35	
<u>Empco Implementation Factors</u>			
Promotion of Programme by Empco Leadership	Slightly Agree	3.35	3.31
Linkage of Platform Usage to Innovation Promotion	Slightly Agree	3.31	
Clarity of Process for Advancing Ideas from Platform	Slightly Agree	3.47	
Implementation Aspects Encouraged Idea Contribution	Slightly Agree	3.09	
<u>Core Utility - Expectations</u>			
Positive Expectations: BrightIdea Platform	Agree	2.17	2.68
Positive Expectations: Work Platforms in General	Agree	2.56	
Larger Group Participation helps Innovation	Agree	2.67	
Individual Participation Improves Knowledge	Slightly Agree	3.29	
<u>Core Utility - Outcomes</u>			
BrightIdea provided significant business value to Empco	Slightly Agree	3.43	3.36
Participation Improved Personal Knowledge	Slightly Agree	3.29	

Key:

Strongly Agree - 1; Agree - 2; Slightly Agree - 3; Neutral - 4; Slightly Disagree - 5; Disagree - 6; Strongly Disagree - 7

²⁵ It is recognized that Mean values are of limited usefulness in Likert-type scales, due to the inconsistency of intra-puntal measurements. However, Means and Category Means help in comparison of items across categories.

Do Key Features of the BrightIdea Platform Promote Network Adoption?

The three categories of assertions reviewed in this section relate primarily to respondents' attitudes to the platform itself, although elements of social norming overlap with Empco implementation factors. Below is a high-level graphical representation of the responses based on category sets. At a high level, there was clear agreement that the platform features encouraged participation and that using the platform was enjoyable. There was significantly less agreement that social norming was an important factor in the use of the platform. Detailed data tables and analysis follow.

Agreement with assertions, by category



The **Platform Features** category was related to participant views on the *intrinsic* features of the BrightIdea platform, including colorful graphics, an engaging user interface, Likes, Comments and Published Usage Statistics, to understand whether such features promote network adoption. The underlying premises of this question is that platform adoption may be promoted directly via features that make it easy and fun to use, as well as features that tend to increase performance expectancy through direct experience of a shared creative space.

There was broad agreement that social-media-like platform features – Likes and Comments, promoted platform objectives. 72% of respondents agreed with this assertion; the Median response was Slightly Agree (SLA) and the Mode response was Agree. Within the Features category, the Usage Statistics and Dashboards question had an even higher level of agreement, with 77% of respondents agreeing with the assertion; both Median and Mode responses were Agree. However, only 57% of respondents agreed with the assertion that the disabling of the Dislike button (an optional feature) was positive.

Data Table 1: Attitudes towards Basic Platform Features

ATTITUDES TOWARDS PLATFORM FEATURES

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Slightly Agree</u>	<u>Neutral</u>	<u>Slightly Disagree</u>	<u>Disagree</u>	<u>Strongly Disagree</u>	<u>TOTAL</u>
Likes and Comments Features Boost Participation	14 10%	53 37%	37 26%	27 19%	7 5%	3 2%	3 2%	144 100%
Good Decision to Skip Dislike/Downvoting Button	23 16%	42 29%	17 12%	42 29%	10 7%	7 5%	3 2%	144 100%
Usage and Ideas Statistics and Dashboards are Good	15 10%	73 51%	22 15%	26 18%	3 2%	3 2%	1 1%	143 100%
<i>Mean Responses - Platform features</i>	17 12%	56 39%	25 17%	32 22%	7 5%	4 3%	2 1%	143 100%

Hedonistic motivation for platform use was tested through three questions in the survey. The first question asked if reading *ideas posted by co-workers* was enjoyable. The second question related to hedonistic motivation was with regard to reading the *comments posted by co-workers* on their ideas and the ideas of other co-workers. Responses to both these questions were positive, with 79% expressing agreement with the assertion that reading ideas was enjoyable and a similar number, 77%, agreeing that reading comments was enjoyable. The Median and Mode responses to both questions were Agree. There was higher enjoyment of browsing ideas as compared to reading coworkers comments. The difference may be attributed to some instances of negative comments that were posted, or just the fact that ideas are positive but comments may be neutral (such as those asking for some information), negative or irrelevant. In general, comments were not subject to policing/moderation by administrators; the use of real names and the fact that this was an employer-sponsored site obviously reduces the risk of inappropriate or rude comments.

The third question related to hedonistic motivation was predicated on the general enjoyment of the platform itself, which is essentially about the user interface, including elements like colourful graphics, easily-navigable ('user-friendly') functional menus and aesthetically pleasing screens. Overall agreement with this assertion was lower than the other two assertions related to enjoyment, with 63% of respondents in general agreement and the Median response being Slightly Agree. The conceptualization of the BrightIdea platform as a form of 'entertainment' may be seen as a bit premature in the context of the Empco case. This could be attributed to a general perception that participation on the platform is part of one's work responsibilities, even though it was not mandatory.

In contrast, the Yammer platform, implemented by Empco shortly after BrightIdea, has channels that feature entertainment as the prime offering. The Yammer channels that appear to be focused on entertainment include “404: Topic Not Found”, which is a programming joke title for a channel devoted to humour, “Bookworms”, a channel for Empco’s Book Club members, and a number of other channels whose titles indicate clearly that they are not work-related.

Data Table 2: Hedonistic Motivation to Use Platform

<u>HEDONISTIC MOTIVATORS</u>	<u>Strongly Agree</u>	<u>Agree</u>	<u>Slightly Agree</u>	<u>Neutral</u>	<u>Slightly Disagree</u>	<u>Disagree</u>	<u>Strongly Disagree</u>	<u>TOTAL</u>
Enjoy Browsing and Reading Innovative Ideas	27 19%	64 45%	22 15%	22 15%	3 2%	4 3%	1 1%	143 100%
Enjoy Browsing and Reading Comments	22 15%	62 43%	28 19%	23 16%	2 1%	6 4%	1 1%	144 100%
Enjoy BrightIdea Platform in General	8 6%	38 26%	44 31%	38 26%	9 6%	4 3%	3 2%	144 100%
<i>Mean Responses - Hedonistic Motivators</i>	19 13%	54 38%	31 22%	28 19%	5 3%	5 3%	2 1%	144 100%

Social norming was also queried as a factor in participation on the platform. Social norming in a corporate environment comes from interactions with coworkers as well as personal perceptions regarding what employees were expected to do to help in the corporate mission.

Approximately 60% of respondents agreed with the assertion that employees were expected to show support for innovation by joining the platform, and a similar number agreed that employees were expected to contribute ideas and comments.

Perceptions of encouragement from coworkers to join were significantly lower. Only 34% of respondents agreed that their coworkers encouraged them.

The lowest factor in the Social Norming category was encouragement from managers or supervisors. Only 26% of respondents agreed with the assertion, which was the lowest rate of agreement on any assertion regarding motivation. There is an overlap of this assertion with the Management Action category, which is covered in the next section.

Data Table 3: Social Norming or Perceived Mandate to Use Platform

SOCIAL PRESSURE OR MANDATE

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Slightly Agree</u>	<u>Neutral</u>	<u>Slightly Disagree</u>	<u>Disagree</u>	<u>Strongly Disagree</u>	<u>TOTAL</u>
Co-worker Encouragement	3 2%	21 15%	24 17%	49 34%	6 4%	31 22%	10 7%	144 100%
Manager/Supervisor Encouragement	3 2%	16 11%	19 13%	40 28%	13 9%	34 24%	19 13%	144 100%
Employees Expected to Show Support: By Joining	13 9%	50 35%	22 15%	31 22%	10 7%	11 8%	7 5%	144 100%
Employees Expected to Contribute Ideas/Comments	11 8%	53 37%	21 15%	25 17%	9 6%	17 12%	8 6%	144 100%
<i>Mean Responses - Social Norming</i>	8 6%	35 24%	22 15%	36 25%	9 6%	23 16%	11 8%	144 100%

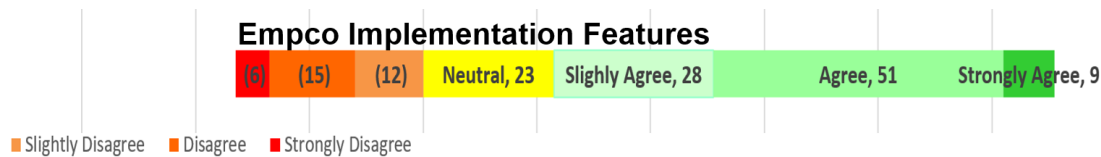
Management Action and Influence in Network Adoption

Does promotion and influence by management, through multiple initiatives and communiques, promote network adoption?

The research addressed the influence of both senior leadership and lower management levels in employees’ decisions to participate and engage in the BrightIdea platform. However, the influence of lower management was categorized in the social norming group to give due consideration to team structures. It is recognized that there is an overlap in this factor.

At a category level, agreement with positive assertions related to Empco implementation factors was lower than hedonistic motivation and platform features, but higher than social norming factors.

Agreement with assertions, Empco Implementation category



Responses indicated a wide difference in the influence of senior leadership when compared to lower-level managers and supervisors. Over 60% of respondents agreed that senior leadership had demonstrated support for the BrightIdea platform as a forum for innovative ideas and a similar number believed there was a clear linkage of participation in the BrightIdea platform to Empco's goal of promoting innovation. However, the responses for interactions with lower-level managers (mid-level and front-line supervisors) were highly contrasted. The questions regarding interactions with participants' managers/supervisors and coworkers and encouragement to participate in the platform were the *only* assertions where the Median response was lack of agreement *to any degree*.²⁶ Only 26% of respondents agreed that interactions with their immediate managers had encouraged them to use the platform. (See Data Table 3 in the previous section) This indicates that mid-level managers and supervisors across the organization did not promote the platform and/or the underlying initiative. This could be attributed to any of the following factors, or perhaps some combination of factors:

- The use of non-organizational communication lines in the BrightIdea process
- A perception that employees should not use work time to try to solve problems outside of their functional expertise
- A perception that contributors to the platform could be viewed by others as being disengaged from their 'day-jobs'
- An expectation that 'good' ideas should be brought to the attention of the employee's supervisor first
- The managers themselves being very focused on delivering their functional goals. Managers may have perceived the ideas-promoting process as a distraction, or may not have enough time to make an assessment of the value

While the survey did not include questions to address the actual reasons for perceived lack of engagement by lower-level managers, the response to this survey question is viewed as an important finding, with significant implications for management practice, and is discussed further in the Conclusions section.

²⁶ The key non-demographic questions were worded as positive assertions, and in this case, the assertion was categorized under 'social influences' with the following wording: "My manager/supervisor encouraged me to participate" The Median response to this assertion was Neutral, and the Mode response was also Neutral.

Data Table 4: Effect of Empco Leadership Implementation Factors

EFFECT OF EMPCO IMPLEMENTATION FACTORS

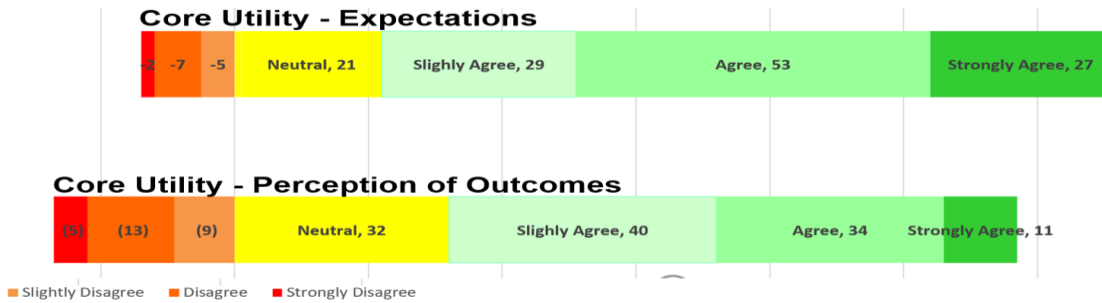
	<u>Strongly Agree</u>	<u>Agree</u>	<u>Slightly Agree</u>	<u>Neutral</u>	<u>Slightly Disagree</u>	<u>Disagree</u>	<u>Strongly Disagree</u>	<u>TOTAL</u>
Promotion of Programme by Empco Leadership	8 6%	48 33%	32 22%	22 15%	13 9%	17 12%	4 3%	144 100%
Linkage of Platform Usage to Innovation Promotion	8 6%	46 32%	33 23%	28 19%	12 8%	13 9%	4 3%	144 100%
Clarity of Process for Advancing Ideas from Platform	12 8%	51 35%	18 13%	19 13%	16 11%	20 14%	8 6%	144 100%
Implementation Aspects Encouraged Idea Contributic	7 5%	61 42%	31 22%	23 16%	7 5%	9 6%	6 4%	144 100%
<i>Mean Responses - Effect of Implementation Factors</i>	9 6%	51 35%	28 19%	23 16%	12 8%	15 10%	6 4%	144 100%

Were Performance Expectations Generally Met?

The third element of RQ 1 related to performance expectations of the platform, as developed and combined with implementation factors. The research aimed to compare users' expectations prior to joining the platform with their perception of the value actually delivered by the platform and the related implementation initiatives.

Initial performance expectations were generally high, with 84% expressing some level of agreement with expectations that the platform would provide "significant value" to Empco. Both Median and Mode responses were Agree, and over 70% of responses were either Agree or Strongly Agree. This level of positive response is commensurate with the survey population being those who actually chose to participate on the platform, and cross-validates the critical factor of Perceived Usefulness underpinning adoption of new technology as conceptualized in the Technology Acceptance Model (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh et al., 2003; Zhang et al., 2008)

Agreement with assertions, Performance Expectations vs. Performance Outcomes



Perception of *actual* business outcomes was lower than expected business outcomes. The survey assertion used the same non-scaled parameter – “significant business value to Empco” – to enable this comparison of pre-implementation expectations with post-implementation ‘gut-feel’ assessments of value attained. General agreement with the assertion of ‘significant value’ dropped from 84% pre-implementation to 60% post-implementation, and both Median and Mode responses dropped from Agree to Slightly Agree. Importantly, *disagreement* with the assertion of ‘significant value’ increased from just 4% of respondents in the pre-implementation question to 16% in the post-implementation question, while Neutral responses increased from 10% to 24%.

Data Table 5: Perceptions of Outcomes Related to Core Utility (Promoting Innovation)

PERCEPTION OF CORE UTILITY OUTCOMES

	Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree	TOTAL
BrightIdea provided significant business value to Empco	8 6%	27 19%	50 35%	35 24%	8 6%	10 7%	6 4%	144 100%
Individual Participation Improved Knowledge	14 10%	40 28%	31 22%	28 20%	9 6%	17 12%	4 3%	143 100%
<i>Mean Responses - Perception of Outcomes</i>	11 8%	34 24%	40 28%	32 22%	9 6%	13 9%	5 3%	144 100%

The difference between initial expectations and perception of actual outcomes was analyzed using demographic data (generational-group and use of other WOSM platforms) as moderating factors. There were some differences based on respondents’ use of other WOSM platforms (Yammer and LinkedIn), and some differences attributable to generational-group. These are discussed further in Questions 5 and 6. Importantly, in every single demographic group or sub-group the perception of actual performance was lower than expectations.

Did BrightIdea Promote Crossing of Functional Domains?

Question 2 of the case study covered the Range-related construct of Crossing. While the platform itself, by basic design, enables crossing of functional domains, does only a small group of risk-tolerant network actors actually make suggestions or post ideas outside of their functional domain and expertise?

To answer this question, the full set of ideas posted on BrightIdea (n = 763) was used as the primary data source. The following is an analysis of the ideas posted on the platform (within the categories defined on the platform), sorted by categories with the largest numbers of ideas posted:

Row Labels	Count of Category
IT	111
Facilities	83
Surface Operations	68
Human Resources	61
Production Engineering	49
Health Environmental and Safety	42
Supply Chain	40
Buildings and Office Facilities	35
Not Listed	31
Growth and Operations Support	31
Completions	26
Well Servicing	26
Midstream	23
Drilling	20
Data Management & Analytics	20
Asset Integrity	20
Reservoir	17
RIO	16
Geology	11
Plants	10
Accounting and Finance	10
Land	6
Geophysics	4
Petrophysics	3
Grand Total	763

Except for 31 ideas that were uncategorized, the ideas had been categorized by submitters into the groupings provided by the Empco innovation team at the outset of the platform implementation.

Separately, a data file was obtained [REDACTED] that indicated the functional department of every employee of Empco. By comparing these data sets, it could then be established whether the idea submission was from within the functional domain of the submitter or whether it was an example of crossing of functional domain. Those ideas that were from within the function were coded as 'Y' and those that were from outside of the function (functional-crossing) were coded as 'N'

The process of determining whether a posted idea was a cross-functional contribution (N) or a within-function contribution (Y) proved rather challenging. A number of issues arose with the process of assigning the appropriate codes to the 763 ideas in the BrightIdea database.

Information Technology (IT) Idea Category: The IT category, which was the largest category of ideas with 111 ideas (14% of the total number submitted). Of the 111 IT-category ideas, 56 (approx. 50%) were submitted by personnel outside of the IT functional department. However, without individual analysis of the submitter's roles and responsibilities, it could not be ascertained whether ideas submitted by personnel outside of the IT dept. should be coded as 'N' (functional-crossing) or 'Y' (within function). Therefore, such ideas were initially placed in a new coding category 'P' (for partially functional-crossing).

'Human Resources' Idea Category: While idea submitters who worked within the HR functional department clearly did not cross functional boundaries to propose ideas in this category, it is not clear whether others were suggesting ideas that were truly outside their functional roles. For instance, a senior manager who suggested the consideration of an on-site pet-care facility could be considered to be working within her role as a manager to improve the work-related benefits and perquisites of her staff. As with IT, unless each idea was analyzed individually in the context of the submitter's roles and responsibilities²⁷, it could not be ascertained whether the ideas submitted by personnel outside of the HR dept. merited an 'N' (outside of function) or a 'Y' (within function). Therefore, these ideas were also placed in the 'P' category.

Buildings and Office Facilities Category: This category posed similar issues to those described above for Human Resources. The treatment of the data was similar to the Human Resources category.

Health, Safety and Environment Category: Empco, like nearly all modern industrial companies, places a high value on HSE and often reiterates to its employees that the area of HSE is a shared responsibility of every individual and team in the company. Based on this approach, all HSE-related

²⁷ The analysis of individual ideas beyond the scope of the research project

ideas would reasonably be considered to be within the contributor's functional area, even if they do not work in the HSE functional discipline and/or department.

Category not Listed: There were 31 ideas (4%) that fell outside of the listed categories. These included ideas on general improvements that did not fit into the categories provided by Empco. These ideas could all be considered outside of the functional area of the contributors. In some cases, it is possible that the contributors were working on a particular project or task that might have benefitted from implementation of the idea, or their regular roles did not fit into one of the categories provided.

After consideration of the limited value of using the 'Partial' or 'P' classification (the primary limitation being the impracticality of calibration of the extent of association of the idea with the functional role of the contributor) the 'P' classification was combined with the 'Y' and 'N/A' classifications and classified as 'not functional-crossing', as there was insufficient evidence of functional-crossing.

A summary count and comparison of ideas that were clearly outside of the functional discipline of the contributor (ie. functional-crossing ideas) is presented below:

Data Table 6: Ideas Submitted from Outside Functional Area

	All Ideas	From Outside Functional Area	% From Outside Functional Area
Land Management	6	6	100%
Accounting and Finance	10	7	70%
Midstream	23	15	65%
Plants	10	6	60%
Completions	26	14	54%
Drilling	20	10	50%
Reservoir	17	8	47%
Asset Integrity	20	8	40%
Petrophysics	3	1	33%
Production Facilities	83	26	31%
Well Servicing	26	8	31%
Surface Operations	68	11	16%
Production Engineering	49	7	14%
Geology	11	0	0%
Geophysics	4	0	0%
SUB-TOTAL DISCIPLINE-SPECIFIC	376	127	34%
Shared Functions and Unclassified*	387		
TOTAL	763	N.A.	N.A.
* Shared functions and non-specific categories			
<i>Buildings/office facilities</i>	35		
<i>Data Management and Analytics</i>	20		
<i>Growth and Operations Support</i>	31		
<i>Health Environmental and Safety</i>	42		
<i>Human Resources</i>	61		
<i>IT</i>	111		
<i>Not Listed</i>	31		
<i>RIO</i>	16		
<i>Supply Chain</i>	40		
<i>Total Shared Functions and Unclassified</i>	387		

While there was no baseline data on cross-functional idea posting against which the results in this study could be compared, the results appeared to be positive prima-facie. A total of 127 discipline-specific ideas, representing over one-third of the total discipline-specific ideas submitted, came from individuals outside of the functional discipline in which the ideas were categorized. These discipline-crossing idea-counts excluded a large number of partial discipline-matches and also excluded a small number of individuals for whom the ‘home’ discipline could not be identified (noted as N/A), so the actual number of discipline-crossing ideas is likely to be higher than 127 (34%).

It was observed that areas that are considered more technical in the O&G industry – including Geoscience areas (Geology, Geophysics and Petrophysics), Drilling, Production and Surface Operations - had a lower rate of contributions from outside the discipline. It could be argued that these technical areas are where the most business value lies, and also that these areas would benefit

the most from ideas that came from outside of the expert circles. These could be stimulated through awareness of the operational challenges (like with Time-Based Challenges) as well as through greater sharing of knowledge and resources.

It was also observed that the categories of Land, Accounting and Midstream had discipline-crossing ideas representing a proportion of two-thirds or higher of the total ideas submitted. Further analysis could reveal additional information underlying this [REDACTED]. There may be a general perception that these areas are more amenable to improvements by people not working the day-to-day execution of the business. This could be associated with the perceptual bias known as the Dunning-Kruger effect, wherein individuals whose knowledge of a topic is at a very basic level tend to overestimate their knowledge and ability to contribute, while experts tend to underestimate the complexities and nuances of a topic that they have studied, practiced and fine-tuned over years of experience. (Schosser et al., 2013)

Variances in Engagement from Different Categories of Adopters

Question 3 of the case study was related to understanding demographic influences on the level of engagement on the platform. The first element of RQ 3 related to differences in expectations and perceptions between different generations of coworkers. Based on the age-group data captured from the cohort, are there differences between Millennials (born after 1983), Generation-X (born between 1966 and 1983) and Baby Boomers (born before 1966)? These generational categories are commonly used in the United States.

Performance expectations and perceptions of actual business value achieved:

All three groups had similar *expectations* of value from the BrightIdea platform – all three had a Median response of Agree. All three groups also had somewhat similar perception of *actual* value gained from implementation of the platform. The Median response for perception of actual value gained was Slightly Agree for all three groups. While no group perceived business value at the level of expectations, the gap was more significant for the younger groups than for Boomers.

Data Table 7: Expectations vs. perceptions of actual value gained

	Responses	Expected to provide 'Significant Value'*	Perceived 'Significant Value' since Implementation*
Millennials	44	89%	57%
Gen-X	69	86%	57%
Boomers	31	81%	68%
All respondents	144	85%	59%

*Percentages in this table represents any level of agreement with assertion

This could be attributed to combination of lower expectations and a generally more favorable attitude amongst Boomers towards the business value of WOSMs in general (including BrightIdea and Yammer), as nearly one-fourth of Boomers' strongly agreed with the assertion that WOSM platforms in general were useful in business.

Data Table 8: General attitudes towards WOSM platforms

	Responses	WOSM Platforms like BrightIdea & Yammer are Useful in Business			
		Strongly Agree	Agree	Slightly Agree	Total
Millennials	44	20%	34%	34%	89%
Gen-X	69	7%	45%	28%	80%
Boomers	31	23%	42%	16%	81%
All respondents	144	15%	41%	27%	83%

Additionally, there was a marked difference in responses to the assertion that *increased network use (by coworkers) have a positive impact on innovation*. 30% of Millennials strongly agreed with this assertion, compared to 10% and 12% for Gen-X and Boomers respectively. While overall rates of agreement were comparable across the groups, the level of participation by coworkers appears to have a high utility value to Millennials. This could indicate that the Millennials group either a) did not perceive adequate levels of adoption and participation by co-workers, or b) did not perceive expected levels of innovation²⁸, or c) did not perceive expected levels of management support and attention to building and growing the platform, leading to their lower perception of actual value.

²⁸ A further analysis of this gap in perceived value could establish that either the number of ideas or the quality of ideas (in terms of innovativeness or impact) were lower than expected by Millennials, and to a lesser extent by the Gen-X and Boomer groups as well

Data Table 9: Perception of importance of wide participation

	Responses	Increasing employees' usage of the platform helps Empco innovate			Total
		Strongly Agree	Agree	Slightly Agree	
Millennials	43	30%	35%	12%	77%
Gen-X	69	12%	39%	25%	75%
Boomers	31	10%	45%	23%	77%
All respondents	143	17%	39%	20%	76%

Perceptions of Mandated Use (Management directive to use the platform)

Empco management publicized the linkage between using the platform and the organization's intention to encourage and promote innovation at all levels. However, there was no direct mandate to join, no time-limit to register, and no extrinsic rewards offered by the organization. Millennials and Boomers responded Slightly Agree (Median response) to both survey questions related to mandated use – the first question was whether all employees were expected to join the platform to show support for innovation at Empco, and the second was whether all employees were expected to contribute to the platform via ideas, likes and comments. The Gen-X group responded Neutral to both questions. The phrase “all employees were expected to...” was used in both survey questions specifically to understand the issue of mandatory participation as contrasted with social norming.. The Neutral response from the Gen-X group may be viewed as more reflective of an unbiased observation of the lack of direct reward or punishment. The Slightly Agree response from the other two groups may have been influenced by the buoyant approach and positive messages surrounding the publication of the platform, which could have led to an implicit mandate from the organization's leadership.

Enjoyment of Platform Features:

Millennials responded Agree to the two questions related to the passive enjoyment of the platform – browsing Ideas posted by others and reading the Comments posted by others. Millennials responded Slightly Agree to the question about the general level of hedonistic utility - “the BrightIdea Platform is fun and entertaining”. Both Gen-X and Boomers responded Slightly Agree to all three questions. This difference between Millennials and older groups may be attributable to the higher levels of comfort and familiarity with social media in general amongst ‘digital natives’, those who were born around the advent of the internet. Millennials tend to share and interact more online than older groups, and are more accustomed to developing work and personal relationships over digital media.

Use of Corporate Yammer Platform:

Millennials had the highest rate of joining the Yammer platform set up by Empco (97%), and also of frequent use (32%). Gen-X had the next highest join rate (94%), but only 20% use it frequently.

Compared to other groups, Boomers had a slightly lower join rate (87%), but 26% of Boomers used the Yammer platform frequently. It should be noted that the question on Yammer participation did not specify a threshold for the term 'frequently', allowing respondents to use their own definition of the term. It is possible that Boomers' level of Yammer participation is not significantly higher than that of Gen-X, but that they use a lower threshold to define the term 'frequently' than the younger groups. However, it was also noted that WOSM usage outside of the workplace (see the LinkedIn responses below) was also higher in Boomers, which is consonant with the Yammer usage results.

Use of LinkedIn:

To assess the level of comfort around use of work-oriented social media platforms and the use of platforms outside of employment, the survey included the question "Do you have a LinkedIn profile and use the platform at least once a month?" As expected, a high percentage of Millennials (89%) said Yes, a significantly higher number than Gen-X respondents, of which only 74% were LinkedIn users. An unexpectedly large percentage of Boomers (81%) use the LinkedIn platform; this result was consistent with their relatively higher use of Yammer compared to Gen-X participants. A possible explanation for this higher use of LinkedIn by Boomers compared to Gen-X is that Boomers had more 'catching up' efforts in the last decade of internet growth, and had larger networks of former colleagues and business contacts due to their higher number of years in business. No additional inquiry was conducted to further understand or analyse this phenomenon.

Question 3 of the study was also concerned with understanding differences in expectations and perceptions between users who use multiple forms of WOSMs and those who do not. The research looked at linkage between attitudes and opinions regarding BrightIdea business value and respondents use of other WOSM platforms concurrently with BrightIdea.

The research also looked at the moderating effect of respondents' use of other WOSM platforms on the perceived outcomes from the BrightIdea platform.

Usage of the Yammer platform correlated with expectations of value from BrightIdea

Only 36 (25%) of the respondents used Empco's Yammer frequently. Frequent usage of Yammer did not correlate with higher performance expectations of the BrightIdea platform. However, in comparing the perceived actual benefits of the platform, this group responded Slightly Agree (median response) to the question of actual value delivered. The other 108 respondents (75%), who do not Yammer frequently (including those who do not use it at all), had similar initial expectations as the Yammer-frequenting group (Median response of both groups to the assertion was Agree). However, this group

had a larger gap between expectations and perceived outcomes, with the Median response to the outcomes assertion being Neutral (compared to Slightly Agree for the frequent Yammer users). Speculating on the reasons for this variance, frequent Yammer users may put a higher value on the intangible and longer-term benefits of WOSM platforms.

Usage of the LinkedIn platform correlated with expectations of value from BrightIdea

A large percentage of respondents are LinkedIn users – 115 (80%) said they had LinkedIn accounts which they accessed at least once a month, while the remaining 29 (20%) either did not have an account or used it so infrequently (averaging less than once a month) that it was not an effective social media platform for them. The group of LinkedIn users responded to the assertion on initial expectations with Agree (the Median response), and the assertion on outcomes with Slightly Agree.

Non-users of LinkedIn had both lower initial expectations (Median of Slightly Agree) and lower perception of positive outcomes (Median of Neutral).

These findings for this external WOSM platform were similar to those of the internal one (Yammer). Again, this could be attributed to users of other platforms putting a higher value on the intangible and longer-term benefits of WOSM platforms.

Question 3 was extended to include an auxiliary element Would a different platform format – a ‘time-bound challenge’ format – be preferable to the current open-forum format?

The survey included an explanation of the alternative format of a time-bound challenge (TBC), where management posts specific business problems to be solved, and then solicit ideas and suggestions directly related to solving them. Additionally, solutions must be submitted within a specified time-frame, and there is a stated reward for the individual or team that provides the best solution.

Only 42% of respondents agreed with the TBC-superiority assertion, of which only 7% expressed strong agreement. The Median response was Slightly Agree, and the Mode response was Neutral. A Neutral response can be interpreted as ‘Don’t Know’ or ‘Not Applicable’ in Likert-style surveys (Blasius & Thiessen, 2001) and it is probable that this was the case here. It is likely that some responders were not familiar with the TBC approach, and either did not read the explanation provided or did not fully understand it. Even if the respondent understood the alternative proposed, in the absence of data they may have balked at agreeing that it was superior to the current format.

The assertion was worded to present the TBC as an alternative to the current format, and not a supplement. In designing the question, the TBC format was only viewed as a replacement. In

hindsight, this question could have been posed in a manner of presenting the TBC format as an extension or concurrently available option to the current format, instead of a replacement.

In practice, both formats – open forum and TBC – could be available to participants, who could contribute ideas and suggestions in either format, depending on the circumstances.

Section Summary

The case study of the BrightIdea platform provides some evidence of domain-crossing. Of 376 discipline-specific ideas submitted, 127 (34%) were from individuals whose roles were clearly outside the functional discipline. This excluded partial discipline-matches and some individuals for whom the 'home' discipline could not be identified, so the actual number is likely to be slightly higher.

The social media-like features of the BrightIdea platform, including Likes and Comments, were positively viewed by users. Users derived pleasure from browsing comments and engaging with coworkers on the platform; to a lesser extent they also enjoyed the platform interface. While there were some generational differences observed in the level of enjoyment of the platform, with younger employees tending to get more enjoyment from browsing and engaging, there were no significant differences noted in attitudes towards the BrightIdea platform that could be attributed to the respondent's age group.

Senior leadership encouragement was observed, particularly in the context of promoting awareness at the initial rollout of the platform. [REDACTED]

[REDACTED]

Users of other WOSM platforms (Yammer and LinkedIn) tended to perceive a higher value of the BrightIdea platform in boosting innovation at Empco. In general, they had higher initial expectations as well as higher perceptions of actual outcomes.

7. DISCUSSION AND CONCLUSIONS

Range in IT, through its embodiment in WOSM and other forms, appears to promote a culture of innovation and collaboration in industry. However, as with other outcomes of cultural and behavioral changes, the impacts are difficult to measure, as they tend to be intangible and indirect as well as difficult to isolate from other factors such as leadership promotion and organizational ethos.

In the case study, while the key technical areas relating to oil and gas production tended to have lower rates of discipline-crossing ideas in the BrightIdea case, the findings appear to support the conclusion that WOSM platforms facilitate discipline crossing.

In measuring the impact on innovation, the case study did not differentiate between radical and incremental innovation, and no attempt was made to quantify the business value of the innovative ideas posted on the BrightIdea platform. This was recognized as a limitation. However, it could be reasonably inferred, from the large numbers²⁹, that there were a number of high-value ideas and projects that were promoted by the platform. There were high user expectations of the platform for business value to Empco. These were realized to some extent, but below expectations. The gap between expectations and post-implementation views was higher for those who did not use other WOSMs (LinkedIn and Yammer). The age group of users was not a significant factor.

Only 26% of respondents agreed that interactions with their immediate managers had encouraged them to use the platform. This indicates that mid-level managers and supervisors across the organization did not promote the platform and/or the underlying initiative. Given the number of consonant responses, it is possible that mid-level managers and supervisors explicitly or implicitly discouraged participation, although there is no evidence to this effect. This is viewed as an important finding with significant implications for management practice. Higher-level management could respond to this in different ways. One response could be to engage more closely with mid-level managers, getting early buy-in and commitment to take actions promoting such initiatives. An alternative response could be to conduct more frequent and direct communications with the broad employee base, effectively cutting out the barrier represented by middle managers. Modern communications channels make the latter an option even for large organizations, but upper management risks alienating a large number of key personnel by using this approach. As with many

²⁹ There were nearly 800 ideas posted on the platform since inception, and more than 40 of those ideas were implemented by Empco.

practical situations and choices, the best approach may be to seek a balance, using a combination of approaches while taking care not to isolate or devalue the contribution of mid-level managers.

New Knowledge

New theoretical knowledge was developed in creating a simple new conceptual framework – the 5Rs of IT-Enabled Innovation. The framework was developed and analyzed, and a simple evaluation tool was proposed to compare competing IT solutions. The concept of Range was explored and developed. In the context of innovation, the research and analysis concludes that Range may be more desirable and effective than Richness or Reach, and could be considered an important aspect of IT development. Range harnesses the power of social media and the Internet to include actors from a broad spectrum of disciplines and capabilities. Broad engagement and participation could therefore be considered an important intermediate outcome of management action in the overall effort to promote innovation. Both increased participation and cross-discipline sharing of ideas are amenable to objective measurement, creating an opportunity for inclusion in organizational performance targets.

The case study covered both platform-intrinsic and enterprise-determined features. The study used mixed methods and includes investigation of survey data from users of the WOSM platform (n=144), analysis of data collected directly from the WOSM platform itself, analysis of alternative platforms with similar functionality and interviews with members of the functional department tasked with promoting innovation across the enterprise. The results of the case study indicate that attitudes are generally favorable to the utilisation of WOSM platforms to boost innovation.

The features typically found in social media platforms, Likes, Comments and Usage Statistics, are seen as positive and tending to promote participation in WOSM platforms. Participants enjoy reviewing ideas posted by their coworkers and enjoy reading comments posted by coworkers on the platform. To a lesser extent, they also view the BrightIdea platform itself as fun and entertaining.

From empirical analysis of nearly 400 domain-specific innovative ideas posted on the BrightIdea platform in the Empco case, more than one-third of the ideas came from individuals outside the functional domain in which the idea was categorized. While there is no benchmark against which to compare the rate of cross-domain ideas, it is probable that these ideas surfaced only because of the implementation of the platform.

Contributions to Theory and Practice

This work builds on the body of knowledge in IT strategy and organisation in two significant ways:

First, the 5Rs framework can stimulate a new perspective on IT organisation and strategy through a simple and pragmatic mental model. The framework can be applied to broad strategic initiatives as well as specific technology solutions. Innovation was singled out in this work as it is considered a critical area in most organisations in the O&G sector. However, in practice this may be applied to a number of different areas, including employee engagement, organisational change management or implementation of new processes and systems. The construct of Range, in particular, represents an avenue for improvement and growth in the IT functional area. Practitioners could incorporate Range in the evaluation of new systems or the expansion of existing systems and processes. Features and management actions that promote increased participation and cross-disciplinary or other domain-crossing activity would tend to improve the quality and effectiveness of IT service delivery. One practical device provided is an evaluation template for the procurement of new IT solutions. This was developed in Doc 4 and included in this paper at Appendix 2. The evaluation tool incorporates the 5Rs in a weighted score that could be customized to the specific needs and expectations of the proposed IT-based solution.

Second, the research extends the UTAUT framework to a WOSM platform called BrightIdea. In addition to application of the concepts of the UTAUT framework – including performance expectations, social norming and hedonistic factors, the research covers specific features of the platform and their influence on the overall utility gained by users.

The case study of a WOSM platform, a practical example of Range, indicates how Range and WOSMs can be used to promote innovation in a mature organisation. This promotes the notion that Range in IT facilitates crossing of functional domains. The crossing of functional domains tends to promote radical innovation. In the BrightIdea case, over 100 cross-discipline ideas were observed. In other settings, cross-organisation or cross-industry ideas can help promote radical innovation. Practitioners could use this knowledge to boost innovation initiatives. The use of WOSM platforms with social media-like features including Likes, Comments, Statistics and Graphics encourages wider participation and engagement on these types of platforms. Increasing participation creates networking effects that increase individual engagement and stimulate outcomes that are more valuable. The study also covers a number of management-driven factors as well as alternative platforms and formats to provide practitioners with relevant data and analysis.

Limitations

Most case studies have an inherent limitation in academic research; the generalizability of findings and conclusions drawn tend to be limited. However, case studies can be valuable to both theory and practice for reasons discussed earlier in this paper. It is important to note that this research has other perceived limitations that were more specific to the topic, the methodology and the data.

Topic limitations

It is recognized that there are inherent limitations in a strategic analysis of IT service delivery from a user perspective. Individual thinking and work styles vary significantly, and the approaches towards the use and the benefits of technology are diverse and constantly evolving. This has the potential to limit the value of both theoretical constructs and practical applications resulting from research in the area of IT strategy. The 5Rs conceptual framework may be viewed as too basic to provide a meaningful addition to the existing body of knowledge in Information Strategy; however, it is expected to help in justification of resource deployment towards WOSM and other Range-enabling technology.

Methodology limitations

The conceptual linking of the concept of Range to social-media-styled platforms like BrightIdea and LinkedIn, and the linking of participation in such platforms to improvements in innovation may be viewed as overly ambitious. Even when supported by strong theoretical arguments, a single case study may be seen as feeble evidence of such broad claims.

Data limitations

There were some limitations in compiling and analyzing the data in the study. First, in compiling analysis relating to discipline-crossing, there were challenges in establishing whether some of the ideas submitted on the platform were indeed from participants outside of the functional discipline. These challenges arose from the inherent overlaps in functional areas and work responsibilities of idea-submitters, as well as overlaps in the platform's categorization of ideas. Second, no attempt was made to ascribe absolute or relative values to the innovative ideas submitted, or classify them as radical, incremental or radically incremental. While such information could have been valuable to the research, limitations of time and knowledge resources resulted in all ideas being regarded on an equal footing, which is clearly not reflective of operational and economic reality. However, due to the large numbers of platform participants and ideas submitted, it could be reasonably inferred that the study incorporated ideas along a wide spectrum of business and economic value.

Recommendations for Future Research

Further development of the 5Rs Model

Important critical feedback was received from a respondent during the course of building the 5Rs framework:

“One thing I see missing from your framework is the concept of intelligent devices... a huge opportunity! You’ve heard about intelligent oil wells that can diagnose, react... There is what is called cognitive learning, where machines or devices are making decisions on your behalf... and not big decisions, but human-like decisions... if I take all these (automated decisions) and I don’t have to worry about it anymore, I can focus on the next innovative idea. If we are still fire-fighting, if we are still doing everything, I won’t have time to innovate.”

These devices form a transformative opportunity in the oil industry; but are they tools or the product itself? If the goal is innovation, it could be argued smart devices are both tools and end-products. The theoretical model could be expanded to provide depth to such conceptual extensions.

Combination of Open Forum (OF) and Time-Bound Challenge (TBC) Formats

In this paper and the survey questionnaire, the TBC format was presented as an alternative to the current format, and not a supplement. There are benefits to each format, and either one may be seen as superior in a particular set of circumstances; urgency, business value, available expertise and the existence of specific business problems are all potential factors. It could be useful to both theory development and practice to examine the relative merits of each format and devise a mixed format where both OF and TBC are optimized on a single platform.

An emerging question: Individualism vs. Collectivism and its connection to Culture

The value of shared idea-spaces, whether in the form of IT platforms like BrightIdea or physical spaces in a work setting, may be related to the work culture in terms of individualism vs. collectivism. The work culture, in turn, may be connected to societal culture. Hofstede (2011) offers a bare-bones definition of culture that is pragmatic to consider in the context of this research: “Culture is the collective programming of the mind that distinguishes the members of one group or category of people from others”. There is significant work on differences in societies across the globe when viewed through the lenses of the individual-collective dichotomy as well as the ‘power distance’ in societal culture. This impacts the willingness of participants to share ideas and suggestions in an open forum, as well as their compliance in the form of participation in fora perceived to be mandated by senior management or supervisory personnel (Trompenaars, 2007; Basabe & Ros, 2005).

A more nuanced analysis of Range could encompass both the influence of culture on the utility of Range as well as the impact of Range in bringing about transformation through changes in culture. This would represent a constructivist theoretical extension of the Range concept that could provide significant value in integrated management research, connecting the Organizational Research, Human Resources and Information Systems functional areas and potentially improving practice in these professional disciplines.

8. APPENDICES

Appendix I: Illustrating the differences between Reach and Range

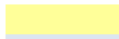
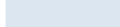
The following example of two technology-based solutions illustrates the differences between a solution enabling Reach and one enabling Range:

Example of IT-enabled Reach	Example of IT-enabled Range
<u>Device:</u> An Email Server and its associated hardware and software components	<u>Device:</u> A Media Platform used by data scientists and data analysts in Multiple Countries and its associated hardware and software components
<u>Network Name:</u> Gmail - Google Mail	<u>Network Name:</u> Kaggle (www.kaggle.com)
<u>Basic Functionality:</u> Send messages, attachments, photos, etc. to recipient(s) who are not physically present which may be viewed at any time	<u>Basic Functionality:</u> Share ideas, questions, blocks of computer code and case-based methods to assist community in data analysis and data presentation
<u>Enhanced Functionality:</u> Categorize email contacts by type – work, family, friends, students, etc.	<u>Enhanced Functionality:</u> Use shared programming structures ('kernels') while maintaining individual control and privacy over the underlying data
<u>Scale/ Number of Users:</u> Google reported in April 2018 that GMail had 1.4 billion users	<u>Scale/ Number of Users:</u> Kaggle reported in June 2017 that had it crossed 1 million users. The scale of the Kaggle platform, in comparison to GMail, is therefore on the order of 1:1000.
<u>Temporal interchange:</u> While emails may be received/viewed days or weeks after dispatch and stored for extended periods, they are primarily intended for one-time conveyance of messages and/or attachments	<u>Spatial interchange:</u> Users of Kaggle are effectively extending their personal libraries of coding blocks and programs to create a community library that other users can access.
<u>User Interaction:</u> Emails are sent to known individuals or groups* to convey specific messages and/or files. When setting up an email account, users are required to provide their names, which are displayed to recipients of their messages	<u>User Interaction:</u> Users not only interact with strangers based on shared interests in projects, but also often do not reveal their identities. Kaggle allows either actual names or aliases to be used by participants
*Aside from spam or fraudulent emails	

Appendix 2: Applying the 5Rs in Evaluating Solutions

Illustrative template – considering and weighting features using the 5R concepts

ASSESSMENT OF SOLUTION (PLATFORM, APPLICATION OR COMBINATION)						
EXAMPLE OF WEIGHTING FORMAT AND SAMPLE QUESTIONS						
	SOLUTION A			SOLUTION B		
	Score (1-10)	Weight %	Weghtd Score	Score (1-10)	Weight %	Weghtd Score
<u>RICHNESS</u>						
Does solution facilitate accurate, relevant data flow?		7%			7%	
Are images/details of adequate resolution and depth?		5%			5%	
Are there clear historical trails for trends/reviews?		3%			3%	
Overall Richness score		15%			15%	
<u>REACH</u>						
Does solution adequately support remote users?		7%			7%	
Is solution scalable to high degree?		4%			4%	
Can solution support high speeds at reasonable cost?		4%			4%	
Overall Reach score		15%			15%	
<u>RANGE</u>						
Does solution facilitate cross-function transfer?		6%			6%	
Is solution compatible with social media?		5%			5%	
Does it support mutiple languages?		4%			4%	
Overall Range score		15%			15%	
<u>REPEATABILITY</u>						
Is solution user friendly; can be learned easily?		7%			7%	
Will it be adopted by target group?		7%			7%	
Vendor/developer financial stability		4%			4%	
Solution is or will be industry standard?		5%			5%	
Overall Repeatability score		25%			25%	
<u>RELIABILITY</u>						
Current server capacity vs. expected data flows?		3%			3%	
Is the solution stable and adequately tested?		5%			5%	
Can users be supported 24/7?		3%			3%	
Can storage needs be meet with current capacity?		3%			3%	
Level of user access security		4%			4%	
Level of cyber security		7%			7%	
Level of developer/change access security		5%			5%	
Overall Reliability score		30%			30%	
OVERALL WEIGHTED SCORE		100%			100%	

 Fill in expected score
 Formulas - no manual input

Appendix 3: Summaries of Interviews with Innovation Experts at Empco

Interviews were conducted with all four members of the team tasked with managing and implementing the BrightIdea platform and related innovation initiatives at Empco. Three of the interviewees were provided with the proposed survey questionnaire in draft form, while a fourth member, who had been interviewed before the others, was unavailable during the period when the survey was being planned. The interviews lasted between 20 minutes and 30 minutes each.

█ (Innovation Specialist) - interviewed July 2, 2018

█'s role includes management and administration of the BrightIdea platform, including access set-up for subject-matter experts (SMEs) and other special roles. █ was advised of research aims and objectives, and agreed to participate in the project. She provided a complete set of downloaded data in the Excel format for review and analysis, and indicated her keen interest and availability for additional support of the research project in the form of data, analysis and opinions. █
█

█ (Chief of Operations Technology) – interviewed Aug 15, 2019

█'s role is the overall management of innovation initiatives as well as new operational technologies affecting the oil and gas division. █ was advised of research aims and objectives, and agreed to participate in the project.

With regard to the BrightIdea platform, █ advised that the company was looking to revitalize the program. A new initiative was about to be delivered at the time that the large acquisition took place; the schedule for the new program was deferred by at least a year. █ advised that he would be very interested in the results of the survey. He expressed particular interest in the response to the general question of whether WOSM platforms like Yammer and BrightIdea have significant business value.

█ reviewed the proposed survey questions, and did not propose any additions or changes.

█ (Project Manager, Innovative Technologies) - interviewed Aug 28, 2019

█'s role is to move ideas and projects through the process of subject matter expert (SME) review, pilot analyses and pilot implementation. The role includes coordinating resources, including staff and funding, for project pilots. █ was advised of research aims and objectives, and agreed to participate in the project. █ noted that there was a significant drop in interest and participation in the BrightIdea platform after two group tours to multiple business locations around the world sparked interest in the platform for some time. He said that the overall decline in participation rates, after initial success, was disappointing. He attributed the steep decline in participation to three factors:

(a) Human behavior and habit – if people did not get used to visiting the site, making it a habit, they just skipped it altogether or visited the site very rarely

(b) Prominence - the site link is not on the company's intranet Home Page, while other key links like Yammer, news items, Community Corner and multiple links take up valuable space on the Home Page

(c) Top leadership involvement and participation – while there was considerable support and communication at the outset from senior management, this was not sustained through follow-up communications. Notably, senior management personnel themselves do not appear to visit the BrightIdea platform regularly, and most do not participate and encourage employees through comments and likes.

█ reviewed the proposed survey and noted that it would be useful to gauge interest in 'Time-bound Challenges'. The current tool differs from a time-bound challenge- based tool in two critical ways. First, the challenge element signifies that the company has a keen and explicit interest in solving a particular problem, which makes it a pragmatic tool and sets a clear path for participants to contribute to the company's success. The second is the time limitation, which imparts a sense of urgency and purpose to participants and tends to motivate them to participate and contribute ideas that could help solve the explicit and articulated problem. The combination of problem-solving and time boundary could be expected to promote the perception of collaborative innovation and adaptation.

Based on the feedback and information from █, a question on the expected value of time-bound challenges, as compared to open semi-structured idea submission, was added as an auxiliary question in the research paper and the survey questionnaire.

█ (Technology Consultant) - interviewed Aug 28, 2019

█'s role is that of a technical specialist, one with many years of field operations experience who can identify practical value and practical issues with a number of technology solutions. With over 35 years of experience in the oilfield, █ is considered an SME in multiple operational areas. █ was one of the early planners of the platform under the RIO initiative, and helped design both the structure and the process.

█ was advised of research aims and objectives, and agreed to participate in the project. When asked about his view of participation in the BrightIdea tool, he opined that the main drawback was that the practical implementation was overly focused on the 'Business Unit', instead of treating the whole company as a single entity for this purpose. The platform was designed so that people would not feel limited by which Business Unit or which Functional Area they worked in, but would contribute freely to a multitude of projects and ideas. However, from █'s observation this was rarely the case, and the majority of ideas and suggestions were contributed from the 'home turf' of the participant.

█ noted that another drawback was that very few ideas got traction through the platform. The Voting system in place, whereby 15 votes were needed to get an idea promoted to the SME review stage, was not a good

indicator of value. In practice, the people who voted for an idea were from the immediate or broader workgroup of the idea-contributor. Further, a number of ideas that were posted, and almost all of the ones that got traction, were not new ones conceived as part of the initiative, but were ideas that were being worked on by the contributor or their teams prior to posting on the platform.

Another key area for improvement is in recognition and reward. ■■■ believed that there should be more transparent and well-communicated processes to recognize and reward contribution. Many people who expressed initial engagement and interest began to lose interest after their ideas and efforts went unrecognized and buried in the crowd. The Innovation Awards that were presented in 2018 were based on identification and screening by General Managers of Business Units. The posting of an idea or solution on the platform was not one of the criteria for nomination. In most cases (estimated at close to 90%), ideas and solutions nominated for awards came from outside the BrightIdea platform. More importantly, none of the ideas that actually won awards came through the pipeline. This could tend to send a message that sharing and collaborating on ideas was not important, thus placing more emphasis on outcome vs. process and effort, and possibly discouraging people from sharing ideas, especially radical or long-shot ideas.

■■■ reviewed the proposed survey questions and did not suggest any additions or changes.

Appendix 4: Survey Questions

RIO BrightIdea Platform - Application-Intrinsic and Implementation Features

About the responder

1. What is your age group
 - a. Millennial (under 36)
 - b. Gen X (36-52)
 - c. Boomer (over 52)
2. Years of experience in current functional area
 - a. Under 5 years
 - b. 5-15 years
 - c. 16-25 years
 - d. Over 25 years
3. I have a LinkedIn profile **and** use the platform at least twice a month on average
 - a. Yes
 - b. No
4. I have a Yammer profile **and** use the platform at least twice a month on average
 - a. Yes
 - b. No

Performance Expectancy

1. Work Oriented Social Media platforms like RIO BrightIdea and Yammer are useful in business
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
2. When I first started using the RIO BrightIdea platform, I expected it to provide significant value to Empco
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
3. Since implementation in May 2016, the RIO BrightIdea platform has provided significant business value to Empco
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
4. Increasing employees' usage of the platform helps Empco achieve the goal of improving innovation
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
5. Usage of the platform has increased my knowledge of innovation and innovative ideas being proposed and implemented at Empco
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree

Social Influence

1. My coworkers use of BrightIdea encouraged me to participate in the initiative
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
2. My manager/supervisor encouraged me to participate
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
3. It was expected that all employees contribute Ideas and/or Likes and Comments
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
4. It was expected that all employees join the platform to show support for innovation at Empco
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree

Hedonistic Motivation

1. I enjoyed browsing and reading innovative Ideas posted by my coworkers
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
2. I enjoyed browsing and reading Comments posted by my coworkers
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
3. The BrightIdea Platform is fun and entertaining
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree

Specific Platform Features

1. The Likes and Comments features are desirable and useful in achieving the objectives of the platform
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
2. Empco made a Good decision to Remove/Omit a Dislike/Downvote button in the platform
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
3. Usage and Ideas Statistics and Dashboards are useful in achieving the objectives of the platform
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
4. When browsing Ideas submitted by my co-workers (Pick the one most applicable)
 - a. My attention is mainly drawn to ideas with the Highest Votes/ Most Popular ideas
 - b. My attention is mainly drawn to ideas in a particular category with which I am familiar
 - c. My attention is mainly drawn to the Most Recent ideas
 - d. My attention is mainly drawn to Fast Risers (ideas with relatively higher votes in a short period)

Implementation Features

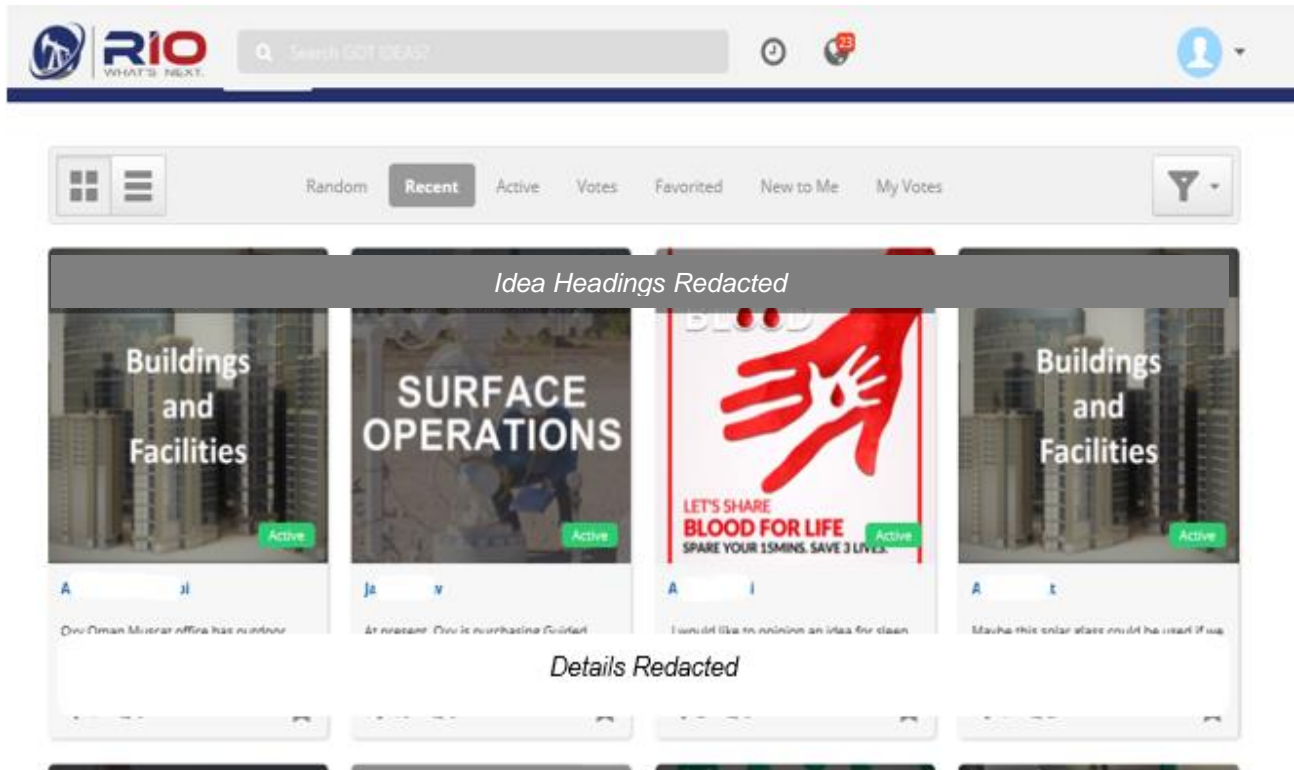
1. Empco leadership demonstrated support for the BrightIdea platform as a forum for innovative ideas
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
2. There was a clear linkage of usage of the BrightIdea platform to Empco's goal of promoting Innovation
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
3. The process of advancing ideas to Pilot stage, after receiving at least 15 Likes and being evaluated by subject matter experts, was clear to me
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
4. The implementation process encouraged employees to contribute ideas to the platform
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree

Future Changes

1. I believe that the use of Time-Bound Challenges, where management posts a challenge and solicits solutions, by a given date, for a stated reward, will be useful in promoting Innovation
 Strongly Disagree Disagree Slightly Disagree Neutral Slightly Agree Agree Strongly Agree
2. Please provide additional comments and suggestions in 200 words or less

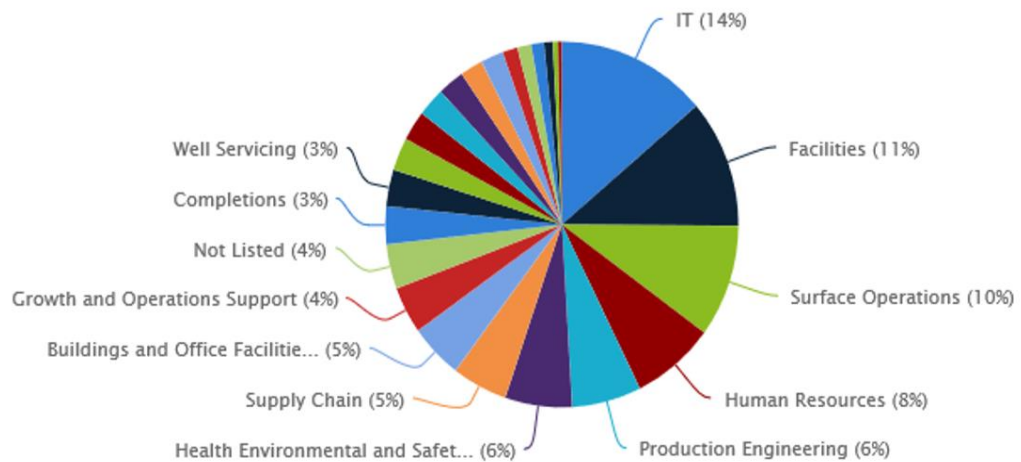
Appendix 5: Examples of Graphic Displays of Ideas and Categories

Graphic Displays of Individual Ideas




Graphic Display of Category Distribution of Ideas on the BrightIdea Platform

CATEGORY DISTRIBUTION




Appendix 6: Link to External O&G Innovation Showcase



A Showcase for New Technologies

[HOME](#) [ABOUT](#) [JOIN](#) [EVENTS](#) [MEDIA](#) [CONTACT](#)



2019 Innovation Showcase

- 2019 Innovation Showcase Agenda
- C
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"Innovation distinguishes between a leader and a follower."
- Steve Jobs

Categories

- Additives & Chemicals
- Coatings & Materials
- Communications, Electronics & Power
- Filtration & Fluids
- Flow & Motion Control
- Health, Safety & Environment
- Innovation Showcase
- Inspection & Monitoring
- Security
- Sensors
- Software

Search for:

INNOVATION SHOWCASE

- 2019 Innovation Showcase
- 2018 Innovation Showcase
- 2017 Innovation Showcase
- 2016 Innovation Showcase
- 2015 Innovation Showcase
- 2014 Innovation Showcase
- 2013 Innovation Showcase
- 2012 Innovation Showcase
- 2011 Innovation Showcase
- 2010 Innovation Showcase
- 2009 Innovation Showcase
- 2008 Innovation Showcase

LATEST COMPANIES

Company
Names
Redacted

MONTHLY PROFILES

- 2019
 - May 2019
 - April 2019
 - March 2019
 - February 2019
 - January 2019
- 2018
 - December 2018
 - November 2018
 - October 2018
 - September 2018
 - August 2018
 - July 2018

Featured Company
Names Redacted

9. REFERENCES

- Adler, P., Hecksher, C., & Prusak, L. (2007, May). Building a Collaborative Enterprise. *Harvard Business Review*.
- Adler, P., Hecksher, C., & Prusak, L. (2011, Jul-Aug). Building a Collaborative Enterprise; Four Keys to Creating a Culture of Trust and Teamwork. *Harvard Business Review*, 2-9.
- Ahmadinia, H., Karim, M., & Ofori, E. (2015). Primary Analysis of Information Distribution at Walkbase Company: Developing an Information Strategy. *International Journal of Industrial Distribution & Business*, 6(4), 5-16.
- Applegate, L., Austin, R., & McFarlan, F. (2002). *Corporate Information Strategy and Management: The Challenges of Managing in a Network Economy*. McGraw-Hill, Inc.
- Barnes, D., Mieczkowska, S., & Hinton, M. (2003, Oct). Integrating Operations and Information Strategy in e-Business. *European Management Journal*, 21(5), 626-634.
- Basabe, N., & Ros, M. (2005). Cultural dimensions and social behavior correlates: Individualism-Collectivism and Power Distance. *Revue Internationale de Psychologie Sociale*, 18(1), 189-225.
- Battelle, J. (2005). *The Search: How Google and Its Rivals Rewrote the Rules of Business and Transformed our Culture*. Portfolio (Penguin Group).
- Belgard, W., & Rayner, S. (2004). *Shaping the Future: A Dynamic Process for Creating and Achieving Your Company's Vision*. Amacom.
- Benkler, Y. (2006). *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. Yale University Press.
- Berger, J. (2016). *Invisible Influence: The Hidden Forces that Shape Behavior*. Simon & Schuster.
- Blasius, J., & Thiessen, V. (2001). The Use of Neutral Responses in Survey Questions: An Application of Multiple Performance Analysis. *Journal of Official Statistics*, 17(3), 351-367.
- Bonett, D., & Wright, T. (2015). Cronbach's Alpha Reliability: Interval Estimation, Hypothesis Testing, and Sample Size Planning. *Journal of Organization Behavior*, 36, 3-15.
- Bordens, K., & Abbott, B. (2008). *Research Design and Methods: A Process Approach* (7th ed.). Mc-Graw-Hill.
- Botha, L. (2011). Mixing Methods as a Process Towards Indigenous Methodologies. *International Journal of Social Research Methodology*, 14(4), 313-325.
- Bresnahan, T., & Trajtenberg, M. (1995). General Purpose Technologies: Engines of Growth. *Journal of Econometrics*, 65(1), 83-108.
- BrightIdea. (2019, June 7). *BrightIdea Customers*. Retrieved from BrightIdea: <https://www.brightidea.com/customers/>
- Briscoe, B., Odlyzko, A., & Tilly, B. (2006, July). Metcalfe's law is wrong - communications networks increase in value as they add members-but by how much? *IEEE Spectrum*, 43(7).

- Candi, M., & Melia, M. C. (2019, Dec). Two Birds with One Stone: The Quest for Addressing Both Business Goals and Social Needs with Innovation. *Journal of Business Ethics*, 160(4), 1019-1033.
- Carifio, L., & Perla, R. (2008). Resolving the 50-year Debate Around Using Likert Scales. *Medical Education*, 42(12), 1150-52.
- Carr, N. (2008). *The Big Switch: Rewiring the World, from Edison to Google*. W.W. Norton & Company, Inc.
- Carr, N. (2014). *The Glass Cage: Automation and Us*. W.W. Norton & Company.
- Case, S. (2016). *The Third Wave: An Entrepreneur's Vision of the Future*. Simon & Schuster.
- Cash, J., Earl, M., & Morison, R. (2008, Nov). Teaming Up to Crack Innovation and Enterprise Integration. *Harvard Business review*, 86(11), 90-100.
- Chalmers, D. (2010). The Singularity: A Philosophical Analysis. *Journal of Consciousness Studies*, 17, 7-65.
- Chesbrough, H. (2006). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.
- Coleman, J., Gulati, D., & Segovia, O. (2012). *Passion & Purpose: Stories from the Best and Brightest Young Business Leaders*. Harvard Business Review Press.
- Creswell, J. (1994). *Research Design: Qualitative and Quantitative Approaches*. Sage.
- Creswell, J., Klassen, A., Plano Clark, V., & Clegg Smith, K. (2011). *Best Practices for Mixed Methods Research in the Health Sciences*. Office of Behavioral and Social Sciences Research (OBSSR).
- Cronbach, L. (1951). Coefficient Alpha and the Internal Structure of Tests. *Psychometrika*, 16(3), 297-334.
- Dance, J. (2008, September 27). *Five Reasons Why Collaboration Contributes to Innovation*. Retrieved from Fresh Consulting: <https://www.freshconsulting.com/5-reasons-why-collaboration-contributes-to-innovation/>
- Danowski, J. (2012). Social Media Network Size and Semantic Networks for Collaboration in Design. *International Journal of Organisational Design and Engineering*, 1-20.
- Datta, A., & Jessup, L. (2013). Looking Beyond the Focal Industry and Existing Technologies for Radical Innovations. *Technovation*, 33(10), 355-367.
- Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319-340.
- Dewar, R., & Dutton, J. (1986). The Adoption of Radical and Incremental Innovations: An Empirical Analysis. *Management Science*, 32(11), 1422-1433.
- Dillon, K. (2020). *Disruption 2020: An Interview with Clayton M. Christensen*. MIT Sloan Management Review. Retrieved Feb 4, 2020, from <https://sloanreview.mit.edu/article/an-interview-with-clayton-m-christensen>
- Dishaw, M., & Strong, D. (1999). Extending the Technology Acceptance Model with Task-Technology Fit Constructs. *Information and Management*, 36(1), 9-21.
- Dominguez-Escrig, E., Broch, F., Lapiedra, C., & Chiva, R. (2018). Promoting Radical Innovation Through End-User Computing Satisfaction. *Industrial Management & Data Systems*, 118(8), 1629-1646.
- Donnelly, J. (2015, Sep). Interview with 2016 SPE President Nathan Meehan. *Journal of Petroleum Technology*.

- Drucker, P. (1985, May-June). The Discipline of Innovation. *Harvard Business Review*, 67-72.
- Drucker, P. (1993). The Rise of the Knowledge Society. *Wilson Quarterly*, 7(2), 52-70.
- Dusek, V. (2006). *Philosophy of Technology: An Introduction*. Blackwell Publishing.
- Duus, R., & Muditha, C. (2014). Together We Innovate: Cross Cultural Teamwork Through Virtual Platforms. *Journal of Marketing Education*, 36(3), 244-257.
- Earl, M. (. (1996). *Information Management - the Organisational Dimension*. Oxform University Press.
- Earl, M. (1993, March). Experiences in Strategic Information Systems Planning. *MIS Quarterly*, 17(1), 1-24.
- Easton, G. (2010). Critical Realism in Case Study Research. *Industrial Marketing Management*(39), 118-128.
- Fagerberg, J., Fosaas, M., & Sapprasert, K. (2012). Innovation: Exploring the Knowledge Base. *Research Policy*, 1132-1153.
- Farbey, B., Targett, D., & Land, F. (1994). The Great IT Benefit Hunt. *European Management Journal*, 12(3), 270-279.
- Farbey, B., Targett, D., & Land, F. (1995). Taxonomy of Information Systems Applications: The Benefits Ladder. *European Journal of Information Systems*, 4(1).
- Few, S. (2006). *Information Dashboard Design: The Effective Visual Communication of Data*. O'Reilly.
- Finstad, K. (2010). Response Interpolation and Scale Sensitivity: Evidence Against 5-Point Scales. *Journal of Usability Studies*, 104-110.
- Fodor, J., & Pylyshyn, Z. (2015). *Minds Without Meanings: An Essay on the Content of Concepts*. The MIT Press.
- Fortune. (2017). LinkedIn Claims Half a Billion Users. Retrieved 10 12, 2018, from <http://fortune.com/2017/04/24/linkedin-users/>
- Friedman, T. (2005). *The World is Flat; A Brief History of the Twenty-First Century*. Farrar, Straus and Giroux.
- Galasso, A., Mitchell, M., & Virag, G. (2018). A Theory of Grand Innovation Prizes. *Research Policy*, 47, 343-362.
- Gartner Group. (2013). *IT Glossary*. Retrieved Nov 13, 2013, from Gartner: <http://www.gartner.com/it-glossary/>
- Garvey, J., & Stangroom, J. (2012). *The Story of Philosophy: A History of Western Thought*. Quercus Editions Ltd.
- Gefen, D., & Straub, D. (1997). Gender Difference in the Perception and Use of E-mail: An Extension to the Technology Acceptance Model. *MIS Quarterly*, 21(4), 389-400.
- Gershenfeld, N. (1999). *When Things Start to Think*. Henry Holt and Company, Inc.
- Goodhue, D., & Thompson, R. (1995). Task-Technology Fit and Individual Performance. *MIS Quarterly*, 19(2), 213-236.
- Greiner, L., Bhambri, A., & Cummings, T. (2003). Searching for a Strategy to Teach Strategy. *Academy of Management Learning and Education*, 2(4), 402-420.
- Hamel, G., Doz, Y., & Prahalad, C. (1989, Jan). Collaborate with Your Competitors - And Win. *Harvard Business Review*.

- Hammer, M. (2004). *Deep Change: How Operational Innovation Can Transform Your Company*. *Harvard Business Review*.
- Hammer, M., & Champy, J. (1993). *Reengineering the Corporation: A Manifesto for Business Revolution*. Harper Collins.
- Hart, C. (1998). *Doing a Literature Review: Releasing the Social Science Research Imagination*. SAGE Publications.
- Heath, C., & Heath, D. (2007). *Made to Stick: Why some Ideas Survive and Others Die*. Random House.
- Heidegger, M. (1954). *The Question Concerning Technology and Other Essays*. Oxford: Blackwell (1977, in English).
- Henderson, B. (1989). The Origin of Strategy. *Harvard Business Review*, 67(1), 139-143.
- Henderson, R., & Clark, K. (1990, Mar). Architectural Innovation: The Reconfiguring of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly*, 35(1), 9-30.
- Hobart, J., Cano, S., Warner, T., & Thompson, A. (2012). What Sample Sizes for Reliability and Validity Studies in Neurology? *Journal of Neurology*, 259, 2681-2694.
- Hofstede, G. (2011). Dimensionalizing Cultures: The Hofstede Model. *Online Readings in Psychology and Culture*, 2(1). Retrieved from <https://doi.org/10.9707/2307-0919.1014>
- Hogan, B. (2010). The Presentation of Self in the Age of Social Media, Distinguishing Performances and Exhibitions Online. *Bulletin of Science Technology Society*, 30(6), 377-386.
- Husserl, E. (1936). *The Crisis of European Science and Transcendental Phenomenology*. Northwestern University Press (1970, in English).
- International Energy Agency. (2018). *Global Energy Statistics*. Retrieved from International Energy Agency: <https://www.iea.org/statistics/balances/>
- Johnson, S. (2010). *Where Good Ideas Come From: The Natural History of Innovation*. Riverhead Books.
- Johnson, S. (2014). *How We Got to Now: Six Innovations That Made the Modern World*. Riverhead Books.
- Jordan, K. (2018). Validity, Reliability, and the Case for Participant-Centered Research: Reflections on a Multi-Platform Social Media Study. *International Journal of Human-Computer Interaction*, 34(10), 913-921.
- Kaplan, R., & Norton, D. (2001). *The Strategy Focused Organization*. Business School Press.
- Kaplan, S. (2008, Sep-Oct). Framing Contests: Strategy Making Under Uncertainty. *Organization Science*, 19(5), 729-752.
- Keyes, J. (2005). *Aligning IT with Corporate Strategy - Implementing the IT Balanced Scorecard*. Auerbach Publications - Taylor & Francis Group.
- Koulopoulos, T. (2012). *Cloud Surfing: A New Way to Think About Risk, Innovation, Scale and Success*. BiblioMotion.
- Krivokapic-Skoko, B., & O'Neil, G. (2011). Beyond the qualitative-quantitative distinction: Some innovative methods for business and management research. *International Journal of Multiple Research Approaches*, 5(3), 290-300.
- Krogerus, M., & Tschappeler, R. (2008). *Fifty Models for Strategic Thinking*. Profile Books Ltd.

- Kuipers, R., van der Ark, L., & Coon, M. (2013). Testing Hypotheses Involving Cronbach's Alpha using Margin Models. *British Journal of Mathematical and Statistical Psychology*, 66, 503-520.
- Laursen, K., & Salter, A. (2006). Open for Innovation: The Role of Openness in Explaining Innovation Performance Among U.K. Manufacturing Firms. *Strategic Management Journal*, 27, 131-150.
- Le Masson, P., Weil, B., & Hatchuel, A. (2010). *Strategic Management of Innovation and Design*. Cambridge University Press.
- Leca, B., & Naccache, P. (2006). A Critical Realist Approach To Institutional Entrepreneurship. *Organization*, 13(5), 627-651.
- Lee, Y., Kozar, K., & Larsen, K. (2003). The Technology Acceptance Model: Past, Present and Future. *Communications of the Association for Information Systems*, 12(50).
- Levy, S. (2011). *In the Plex: How Google Thinks, Works, and Shapes Our Lives*. Simon and Schuster.
- Li, M., & Jia, S. (2018). Resource Orchestration for Innovation: the Dual Role of Information Technology. *Technology Analysis & Strategic Management*, 30(10), 1136-1147.
- Loevinger, J. (1957). Objective Tests as Instruments of Psychological Theory. *Psychological Reports*, 3, 635-694.
- Loiacono, E., & McCoy, S. (2018). When did Fun Become so much Work: the Impact of Social Media Invasiveness on Continued Social Media Use. *Information Technology & People*, 966-983.
- Lopes-Nicolas, C., Molina-Castilo, F., & Bouwman, H. (2008, September). An Assessment of Advanced Mobile Services Acceptance: Contributions from TAM and Diffusion Theory Models. *Information and Management*, 45(6), 359-364.
- MacDonald, S. (1994). Is Collaboration Good for Innovation? *Industry and Higher Education*, 8(3), 141-146.
- Majchrzak, A. (2009). Social Networking and Collaboration. *Presentation to the Society for Information Management's Advanced Practices Council*. Atlanta, GA.
- Majchrzak, A., Malhotra, A., Stamps, J., & Lipnack, J. (2004, May). Can Absence Make a Team Grow Stronger? *Harvard Business Review*, 82(5), 131-137.
- Majchrzak, A., Rice, R., King, N., Malhotra, A., & Ba, S. (2000, Jan-Mar). Computer-Mediated Inter-Organizational Knowledge-sharing: Insights from a Virtual Team Using a Collaborative Online Tool. *Information Resources Management Journal*, 44-53.
- Maslow, A. (1943, July). A Theory of Human Motivation. *Psychological Review*, 50(4), pp. 370-396.
- McAfee, A. (2006). Enterprise 2.0: The Dawn of Emergent Collaboration. *MIT Sloan Management Review*(47/3), 20-28.
- McAfee, A. (2009, Nov). Shattering the Myths about Enterprise 2.0. *Harvard Business Review*.
- McCoy, K. (2017, May 23). Target to pay \$18.5M for 2013 data breach that affected 41 million consumers. *USA Today*. Retrieved from <https://www.usatoday.com/story/money/2017/05/23/target-pay-185m-2013-data-breach-affected-consumers/102063932/>
- McDermott, R., & Archibald, D. (2010, Mar). Harnessing Your Staff's Informal Networks. *Harvard Business Review*.
- McKinsey & Company. (2015). *Transforming the Business Through Social Tools*. McKinsey & Company.

- McKinsey Global Institute. (2011). *Big data: the Next frontier for innovation, competition and productivity*. McKinsey & Company.
- Menand, L. (1997). *Pragmatism: A Reader*. Vintage.
- Menand, L. (2001). *The Metaphysical Club*. Farrar, Straus & Giroux.
- Menand, L. (2014, Apr 14). Video: Pragmatism's Three Moments. *Lecture at Harvard Graduate School*. Youtube.com - url: <https://www.youtube.com/watch?v=GFdei5zKGSg>. Retrieved Dec 26, 2014, from <https://www.youtube.com/watch?v=GFdei5zKGSg>
- Mills, M. (2013, May 8). Big Data and Microseismic Imaging Will Accelerate the Smart Drilling Oil and Gas Revolution. *Forbes*, p. Online. Retrieved May 29, 2013, from http://www.forbes.com/sites/markpmills/2013/05/08/big-data-and-microseismic-imaging-will-accelerate-the-smart-drilling-oil-and-gas-revolution/?goback=%2Egde_137931_member_239161582
- Mingers, J., Mutch, A., & Wilcocks, L. (2013). Critical Realism in IS Research. *MIS Quarterly*, 37.
- Mubarak, S. (2019, 11 2). Knowledge Economy World. *LinkedIn Post*. Chairman, SPE Digital Energy Technical Section.
- Murray, R., Caulier-Grice, J., & Mulgan, G. (2010). *The Open Book of Social Innovation*. The Young Foundation.
- Murray, W. (2019). *Reducing Regulatory Barriers to Carbon Capture Investment*. R Street. Retrieved June 2019
- Nobbay, A. (2015). *Which Aspects of Information Technology can Lead to Transformative Change in the E&P Sector?* NTU (Apprenticeship Piece, Doc 3).
- Nobbay, A. (2016). *Can Range in Information Technology Lead to Transformative Change in the Oil and Gas Industry?* NTU (Apprenticeship Piece, Doc 4).
- Nonaka, I. (1994). A Dynamic Theory of Organisational Knowledge Creation. *Organisation Science*(5(1)), 14-37.
- Nonaka, I., & Takeuchi, H. (1995). *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press.
- Noor, K. (2008). *Amercian Journal of Applied Sciences*, 5(11), 1602-1614.
- Nunnally, J. (1978). *Pschometric Theory*. McGraw-Hill.
- O'Rourke, M., & Robinson, B. (2015). *Toolbox*. Retrieved from Toolbox-Project: toolbox-project.org
- O'Shannassy, T., Kemp, S., & Booth, C. (2010). Case Studies in MBA Strategic Management Curriculum Development from Australian Universities. *Journal of Management and Organization*, 16(3), 467-480.
- Ott, I., Papillod, C., & Zulsdorf, T. (2009). What Drives Innovation? Consequences for Nanotechnologies. *Managing Global Transitions*, 7(1), 5-26.
- Panopoulos, A., Prokopis, T., & Poulis, A. (2018). Revisiting Innovation Adoption Theory. *Information Technology and People*, 30(1), 21-40.
- Park, C., & Kim, Y. (2003). A Framework of Dynamic CRM: Linking Marketing with Information Strategy. *Business Process Management Journal*, 9(5), 652-671.

- Pedersen, E., Gwozdz, W., & Hvass, K. (2018). Exploring the Relationship between Business Model Innovation, Corporate Sustainability, and Organisational Values within the Fashion Industry. *Journal of Business Ethics*, 149(2), 267-284.
- Peppard, J., & Ward, J. (2016). *The Strategic Management of Information Systems: Building a Digital Strategy*. John Wiley & Sons.
- Pew. (2018). *Millennials are the Largest Generation in the U.S. Labor Force*. Retrieved from <https://www.pewresearch.org/fact-tank/2018/04/11/millennials-largest-generation-us-labor-force/>
- Pew Research Center. (2015). *Social Media Usage: 2005-2015*. Pew Research Center. Retrieved July 10, 2017, from http://assets.pewresearch.org/wp-content/uploads/sites/14/2015/10/PI_2015-10-08_Social-Networking-Usage-2005-2015_FINAL.pdf
- Pink, D. (2005). *A Whole New Mind: Why Right-Brainers Will Rule the Future*. Riverhead Books.
- Plano Clark, V. (2010). The adoption and practice of mixed methods: U.S. trends in federally funded healthrelated research. *Qualitative Inquiry*, 16(6), 428-440.
- Porter, M. (1979, Mar-Apr). How Competitive Forces Shape Strategy. *Harvard Business Review*.
- Porter, M. (1980). *Competitive Strategy: Creating and Sustaining Competitive Performance*. Free Press.
- Porter, M. (2008). The Five Competitive Forces that Shape Strategy. *Harvard Business Review*, Vol.86(1), pp.78-93.
- Porter, M., & Millar, V. (1985). How Information Gives You Competitive Advantage. *Harvard Business Review*, 149-160.
- Prahalad, C., & Hamel, G. (1990, May-June). The Core Competence of the Corporation. *Harvard Business Review*, 79-91.
- Prahalad, C., & Krishnan, M. (2008). *The New Age of Innovation: Driving Co-Created Value through Global Networks*. McGraw Hill.
- Preston, C., & Colman, A. (2000). Optimal Number of Response Categories in Rating Scales: Reliability, Validity, Discriminating Power and Respondent Preferences. *Acta Psychologica*, 1-15.
- Rader, S. (2019, Aug 2). Open Innovation at NASA. (A. Nobbay, Interviewer)
- Reese, C., Hoefner, M., Seetharam, R., & Killian, K. (2008). An Enterprise Approach to Digital Oilfield. *SPE Intelligent Energy Conference and Exhibition*. Amsterdam, The Netherlands: Society of Petroleum Engineers (SPE).
- Rehm, S., Goel, L., & Junglas, I. (2017). Using Information Systems in Innovation Networks: Uncovering Network Resources. *Journal of the Association for Information Systems*, 18(8), 577-604.
- Rendtorff, J. (2015). Case Studies, Ethics, Philosophy, and Liberal Learning for the Management Profession. *Journal of Management Education*, 39(1), 26-55.
- Rhodium Group. (2019, Jan 8). *Preliminary US Emissions Estimates for 2018*. Retrieved from Rhodium Group Research: <https://rhg.com/research/preliminary-us-emissions-estimates-for-2018/>
- Ritter, N. (2010). Understanding a Widely Misunderstood Statistic: Cronbach's Alpha. *Southwestern Educational Research Association*. New Orleans, LA.

- Rodrigues, S., & Fonseca, M. (2015, Nov 12). Can Information be Spread as a Virus? Viral Marketing as Epidemiological Model. *Mathematical Methods in the Applied Sciences*.
- Rogers, E. (1983). *Diffusion of Innovations* (Third ed.). The Free Press.
- Schlosser, T., Dunning, D., Johnson, K., & Kruger, J. (2013). How Unaware are the Unskilled? Empirical Tests of the “Signal Extraction” Counterexplanation for the Dunning–Kruger Effect in Self-evaluation of Performance. *Journal of Economic Psychology*, 39, 85-100.
- Schneider, A., & Arnold, C. (2019, July 22). Equifax To Pay Up To \$700 Million In Data Breach Settlement. *NPR Morning Edition*. Retrieved from <https://www.npr.org/2019/07/22/744050565/equifax-to-pay-up-to-700-million-in-data-breach-settlement>
- Shaw, E., O'Loughlin, A., & McFadzean, E. (2005). Corporate Entrepreneurship and Innovation Part 2: A Role and Process-based Approach. *Journal of Innovation Management*, 8(4), 393-408.
- Sherwin, R., Mcdaniel, R., & Dickerson, R. (2002). *USA Patent No. US 2002/0035551 A1*.
- Sijtsma, K. (2009). On the Use, the Misuse, and the Very Limited Usefulness of Cronbach's Alpha. *Psychometrica*, 74(1), 107-120.
- Singh, D., Khamba, J., & Nanda, T. (2017). Influence of Technological Innovation on Performance of Small Manufacturing Companies. *International Journal of Productivity*, 66(7), 838-856.
- Slaper, T., & Hall, T. (2011). *The Triple Bottom Line: What Is It and How Does it Work?* Retrieved from <http://www.ibrc.indiana.edu/ibr/2011/spring/article2.html>
- Stengel, J. (2017). *Unleashing the Innovators: How Mature Companies Find New Life with Startups*. Crown Publishing Group.
- Straub, D. (1994). The Effect of Culture on IT Diffusion of E-mail and Fax in Japan and the US. *Information Systems Research*, 5(1), 23-47.
- Straub, D., Kreil, M., & Brenner, W. (1997). Testing the Technology Acceptance Model Across Cultures: A Three Country Study. *Information and Management*, 33(1), 1-11.
- Sull, D. (2015, May). The Simple Rules of Disciplined Innovation. *McKinsey Quarterly*, pp. 1-10.
- Sullivan, G., & Artino, A. (2013, Dec). Analyzing and Interpreting Data from Likert-Type Scales. *Journal of Graduate Medical Education*, 5(4), 541-543.
- Surowiecki, J. (2005). *The Wisdom of Crowds*. Anchor.
- Trompenaars, F. (2007). *Riding the Whirlwind : Connecting People and Organizations in a Culture of Innovation*. Oxford: Infinite Ideas Ltd.
- Tucker, T. (2016). *Technology Business Management: The Four Value Conversations CIOs Must Have With Their Businesses*. TBM Council.
- US Energy Information Administration. (2019, April 26). *US Energy Facts*. Retrieved from https://www.eia.gov/energyexplained/?page=us_energy_home
- Van de Ven, A. (2007). *Engaged Scholarship*. Oxford University Press.
- van den Berg, F. (2016). Collaborative Working - Harvesting Value and Evolving with New Technologies. *SPE Intelligent Energy International Conference and Exhibition*. Aberdeen, United Kingdom: SPE.

- Venkatesh, V., & Davis, F. (2000, Feb). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, 46(2), 186-204.
- Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User Acceptance of Information Technology: Towards a unified view. *MIS Quarterly*, 27(3), 425-478.
- Venkatesh, V., Thong, J., & Xu, X. (2016). Unified Theory of Acceptance and Use of Technology: A Synthesis and the Road Ahead. *Journal of the Association for Information Systems*, 17(5).
- Vinge, V. (1993). The Coming Technological Singularity: How to Survive in the Post-Human Era. *Whole Earth Review*.
- von Berg, U. (2001). *The Triumph of Ethernet*. Stanford University Press.
- Von Hippel, E. (2003). *Democratizing Innovation*. The MIT Press.
- Von Krogh, G., Ichigo, K., & Nonaka, I. (2000). *Enabling Knowledge Creation: How to Unlock the Mystery of Tacit Knowledge and Release the Power*. Oxford University Press.
- Wallner, F. (1998). A New Vision of Science. *Philosophy of Science*. Boston, Massachusetts: Boston University: The Paideia Archive. Retrieved May 30, 2015, from bu.edu
- Wang, P. (2003). *Development and Applications of Production Optimization Techniques for Petroleum Fields*. Stanford.edu. Retrieved Dec 01, 2013, from pangea.stanford.edu/ERE/pdf/pereports/PhD/Wang03.pdf
- Wells, J., & Gobeli, D. (2003, Mar-Apr). The 3R Framework: Improving e-Strategy Across Reach, Richness and Range. *Business Horizons*.
- Welsh, S. D. (1992, Nov-Dec). Development of the Food Guide Pyramid. *Nutrition Today*, 12-23.
- Wright, P., Kroll, M., & Parnell, J. (1997). *Strategic Management: Concepts* (4th ed.). Prentice-Hall.
- Xing-Zhou, Z., & Jing-Jie, L. (2015, March). Tencent and Facebook Validate Metcalfe's Law. *Journal of Computer Science and Technology*, 246-251.
- Yang, K., Chou, C., & Chiu, Y. (2014). How Unlearning Affects Radical Innovation: The Dynamics of Social Capital and Slack Resources. *Technological Forecasting and Social Change*, 87(1), 152-163.
- Yin, R. (1984). *Case Study Research: Design and Methods*. Sage.
- Zampetakis, L., & Moustakis, V. (2007). Fostering Corporate Entrepreneurship Through Internal Marketing: Implications for Change in the Public Sector. *European Journal of Innovation Management*, 10(4), 413-433.
- Zhang, J., Daim, T., Choi, B., & Phan, K. (2008). A Multiple-Perspective Model for Technology Assessment: Case of Mobile Broadband Technologies Selection in China. *Journal of Technology Management in China*, 3(3), 264-278.