Information-Based Customer Value Creation

A *Research Report* by

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Abstract: Customers hope the products, services, and experiences (P/S/E) that enter their lives are *worth it*. ***Customer value*** is defined in this research report as *the perceived worth of a product, service, or experience as judged by a customer*. Organizations can use *information* to provide more value to customers which will be called ***information-based customer value creation***. Information-based features can be added to products, services, and experiences to provide more value to customers (*P/S/E Enhancement*). Alternatively, new information-based products, services, and experiences can be created to provide more value to customers (*P/S/E Innovation*). The information-based P/S/E portfolio changes can perform such *functions* as informing, notifying, advising, assisting, educating, and entertaining customers. The potential *outcomes* (*results*) of these functions from a customer's perspective can be related to safety, quality, time, money, effectiveness, efficiency, morale, and well-being. Organizations adept at analytics and big data are in a strong position to ideate and test P/S/E portfolio enhancements and/or innovations to achieve such outcomes. The potential contribution to society is a greater number of organizations with P/S/E portfolios that provide more value to customers through the effective use of information.

Keywords: Customer Value, Analytics, Big Data, Innovation, New Product Development

Author's Note: I use the *anthropomorphic convention* in this research report of ascribing human qualities to organizations. For example, a phrase such as "Company X analyzes data on its customers." actually means "Employees of Company X analyze data on their customers."

"*We've got all this data . . . Now what?*"
- Anonymous CEO

I. Customer Value

Customers hope the products, services, and experiences (P/S/E) that enter their lives are *worth it*. ***Customer value*** is defined in this research report as *the perceived worth of a product, service, or experience as judged by a customer*. Customer judgments are personal, idiosyncratic, potentially dynamic, and not necessarily from a monetary perspective. The ***customer value concept*** is relevant for any organization providing a product, service, or experience in exchange for money, time, and/or some other precious customer resource. This set of organizations includes for-profit companies, not-for-profit organizations, and government entities.

The ***customer value concept*** is often generally described (see, e.g., Wikipedia (2018)) as an *equation* involving the "*benefits received*" by a customer (*gets*) and the "*costs incurred*" by a customer (*gives*). For example, the equation could be the ratio "*benefits received* / *costs incurred*" or the difference "*benefits received – costs incurred*." A customer may not be thinking in purely monetary terms when evaluating *benefits* and *costs*. For example, a relatively low-priced product might require a significant time commitment. Suppose Person A buys a 128 GB (gigabyte) flash drive (*gets*) for $24.99 (*gives*) which equates to "5.12 gigabytes per dollar" whereas Person B buys a 128 GB flash drive for $28.99 which equates to "4.42 gigabytes per dollar." Person A is receiving *more value* than Person B from a purely monetary perspective. However, this doesn't take into account travel time and time spent waiting in the check-out line if the flash drive is purchased at a store. An on-line order might involve a prolonged wait and additional shipping charges. Many factors—monetary and non-monetary—can enter into a customer's value judgment and the customer might not even be able to clearly articulate the rationale of a particular value judgment. Let's now consider *value* from the perspective of customer experiences. A new automobile (car) buyer would most likely have experiences like those depicted in Figure 1.

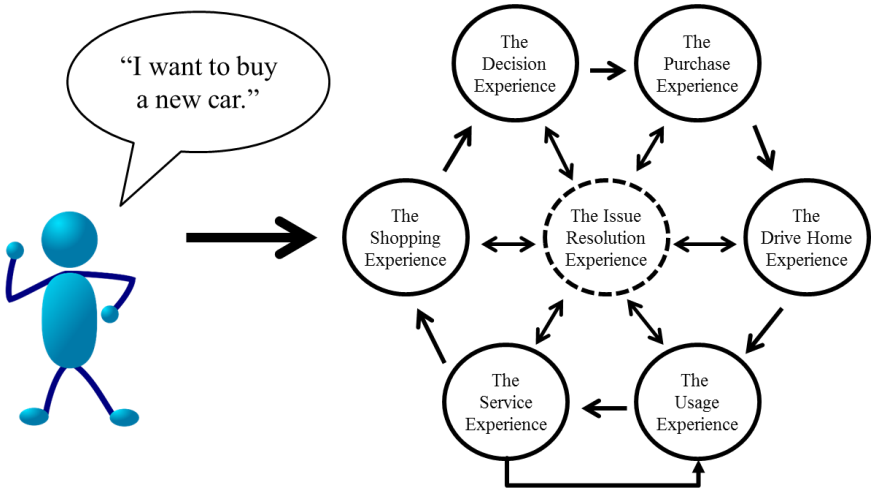

Figure 1. Car Ownership Experiences.

The Shopping Experience: "What are my options?"
The prospective car buyer might search the internet and visit car dealerships to get a sense of what cars are available on the market (*options*) guided by the intended uses (*purpose*) of the car. Vehicle descriptions, photographs, warranty information, and fuel efficiency information might provide value to the prospective buyer during the *Shopping Experience*.

The Decision Experience: "**Which option should I choose?"**
The car buyer makes a purchase decision based on what was learned about the options discovered during the *Shopping Experience*. The decision could be (1) don't buy a car, (2) buy a car later, or (3) buy a particular car now. Comparative information on each car option (*candidates*) including price, warranty, performance, and *extras* might be useful to the car buyer.

The Purchase Experience: "**How do I place an order?**"
The car buyer initiates the purchase once the purchase decision has been made. Transaction information is especially important now in terms of the contract, terms (*fine print*), financing, and warranty. Clear (*plain*) language and a smooth process might be appreciated.

The (*First*) Drive Home Experience: "What happens if I press this button?"
Driving a new car home can be both exciting and harrowing for the (new) customer. The customer might benefit from training at the dealership on such basics as *how to* unlock the doors, turn on the lights, wipers, GPS, and air conditioning. Dealership contact information might be helpful.

The (*Normal*) Usage Experience: "I'm happy I bought this car!"
The customer starts to incorporate the use of the new car into his/her life. The customer should monitor the engine temperature, fluid levels, tire pressure, and other performance items and schedule a service appointment when appropriate. A service reminder might be helpful.

The Service Experience: "Can I get my car serviced on Tuesday morning at 7:30 a.m.?"
The car can be maintained through service appointments (*expected*) and repaired when necessary (*unexpected*). The customer might like to know when to take the car in for servicing, how to schedule the appointment, what will be checked and done to the car, how long the wait will be, how much it will cost, and what is in the vicinity of the car dealership.

The Issue Resolution Experience: "How quickly will they resolve my issue?"
A car-related issue that the customer wants resolved quickly can emerge at any time. The *Issue Resolution Experience* is hopefully simple, quick, assuring, and stress-free.

At some point the car is sold, gifted, traded in for a different car, or scrapped and the Car Ownership Process might start over from the beginning – onto the *Shopping Experience*!

We have just seen how information can potentially play an important role in providing value to the car buyer/owner during each of the major customer experiences. A car dealership can gain a competitive advantage if it can provide unique value to car buyers/owners through the effective use of information. This would require the leaders of the car dealership to think deeply about what information would potentially add more value to its customers and then ideate and test the ideas.

II. Analytics Revolution

There is an *analytics revolution* occurring as evidenced by the growing number of academic programs, advanced degrees, journal articles, books, conferences, and news stories on analytics and big data. There are also a growing number of *analyst*, *statistician*, and *data scientist* job openings in part because numerous organizations are starting to develop analytics and big data capabilities. Many have claimed that we are at the beginning of a new digital age (see, e.g., Schmidt and Cohen (2014)). The *digital universe*, which is the measure of all digital data created, replicated, and consumed in a single year is predicted to reach 44 zettabytes by 2020 according to Turner (2014): "Like the physical universe, the digital universe is large – by 2020 containing nearly as many digital bits as there are stars in the universe. It is doubling in size every two years, and by 2020 the digital universe – the data we create and copy annually – will reach 44 zettabytes, or 44 trillion gigabytes." The widespread use of sensors, smartphones, and other devices makes it possible for massive amounts of data to be rapidly collected, stored, processed, and analyzed.

Analytics and big data techniques are currently being rigorously applied in medicine, agriculture, manufacturing, retail, financial services, professional sports, government, and a multitude of other sectors (see, e.g., Galloway (2017); Marr (2016); Nadella (2017); and Stone (2017)). ***Analytics*** has been defined as ***the collection and analysis of qualitative and quantitative data for decision making*** (Liedtke (2016)). Some have argued that *data* should be viewed as an asset and that it can be monetized (see, e.g., Laney (2018)). The distinction between *data* and *information* will be simplified in this research report. *Data* are viewed here as the *basic elements* that are collected such as the blood pressures of the patients at a hospital, transaction dollar amounts, customer complaint letters, website clickstreams, text messages, wait times, employee suggestions, and photographs. Various types of data can be collected and analyzed such as structured data, unstructured data, and semi-structured data (Simon (2013)). Data are routinely labeled, tagged, categorized, sorted, tabulated, aggregated, stratified, and summarized to produce *information*. The view here is that *data typically precedes information* in that *information is created from data through various forms of analysis*. However, information does not necessarily originate from data.

Organizations have used information for economic benefit for some time (see, e.g., Gleick (2011); Varian *et al.* (2004)). Some organizations are attempting to use analytics to gain a competitive advantage (see, e.g., Davenport and Harris (2017); Porter and Millar (1985)). Zillow—a big data company that functions in the real estate industry—created a distinctive competitive advantage by making (1) massive amounts of residential home data and (2) a user-friendly calculator available to consumers on its website (Rascoff and Humphries (2015)). Organizations such as Amazon.com, Apple, Facebook, Google, IBM, and Microsoft are rigorously applying big data techniques to obtain *deep insights* into customer experiences, market dynamics, and operational excellence (Marr (2016)). The effective application of analytics and big data techniques can identify patterns, trends, outliers, relationship, associations, and best practices.

Some of the *global analytics trends* that have been identified include the emergence of new types of data; more data arriving in real-time; more data storage; faster data processing; more devices and applications; easier mobile access to data; widespread use of the cloud; new analytical techniques; more data breaches; and more *technically savvy* customers (Liedtke (2016)). There

have been several *challenges* associated with developing analytics capabilities that have been identified which include confusing jargon; difficult to interpret data; working with data of low integrity; weak data infrastructure; few people with analytical skills; and employees being overwhelmed by the amount of data (Liedtke (2016)). Also, organizations must be careful when collecting, transmitting, and storing customer data because of potential privacy and security issues.

The term *big data* is often used in conjunction with *analytics* (i.e., *big data analytics*). Laney (2001) is credited with describing the "Three Vs" of big data: *Volume*, *Variety*, and *Velocity*. Some have suggested a fourth V in *Veracity* (see, e.g., Zikopoulos *et al.* (2015)). Other Vs have been mentioned including *Value* (Liedtke (2016)). Such so-called *letter frameworks* are limiting when attempting to describe a new and evolving phenomenon of interest like *big data*. Liedtke (2016) defined *big data* as ***a situation involving a relatively large amount of data consisting of multiple types from multiple sources possibly arriving in real-time of varying degrees of accuracy requiring exploratory data analysis and integrative analytical methods***. This is a broader definition than the Four V Framework. The framework (with *Value*) is depicted in Figure 2.

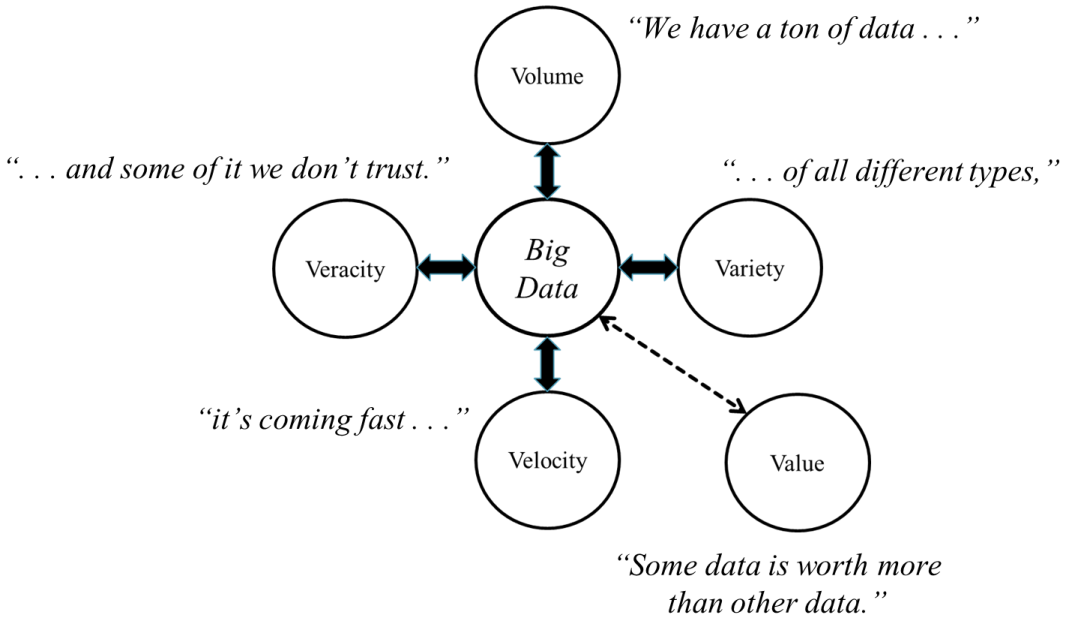

Figure 2. The "Four V" Framework + 1.

Some of the big data tools include advanced statistical tools such as multivariate analysis and regression analysis plus other tools such as search, data mining, algorithms, facial recognition, artificial intelligence, machine learning, deep learning, radio-frequency identification, natural-language processing, sentiment analysis, social media analysis, and game theory (Liedtke (2016, 2017)). Organizations develop and use *black box algorithms* to gain insights and make decisions. Some of these include preference learning, matching, network connections, neural networks, geographic movement/spread, topic trending, and missing puzzle piece (Liedtke (2016)). These algorithms are rarely revealed because they are proprietary and represent so-called *secret recipes*.

We should always be aware of the limitations of *digitized data* from a knowledge management perspective. Polanyi (1966) made the insightful and cautionary comment: "*we can know more than we can tell*." Nonaka and Takeuchi (1995) described two kinds of knowledge: *explicit* and *tacit*. *Explicit* knowledge is formal and systematic and can be easily communicated and shared. *Tacit* knowledge is not easily visible or expressible. Analytics and big data techniques appear to be better suited for explicit knowledge at this point in time, but this could change with the advancement of the ever-growing set of analytics and big data techniques.

The ***analytics process*** varies considerably across organizations. A basic analytics process is depicted in Figure 3. It begins with the development of the purpose of the data collection and a plan; the data is then collected and analyzed producing information; the conclusions are finalized; actions are developed and implemented; and then a review is conducted to identify ways to improve the process.

Figure 3. Basic Analytics Process.

Analytics techniques can be applied in every organizational unit including business units, service lines, divisions, departments, regions, offices, and plants. Figure 4 depicts a *modified version* of the classic *Production Viewed as a System* diagram conceived by Deming (1986) with analytics opportunities added. It is evident from the diagram that there are numerous opportunities to collect and analyze qualitative and quantitative data for decision making (*analytics*) throughout the system to acquire performance insights and identify patterns, trends, outliers, relationships, associations, and best practices. The data and eventual (*produced*) information can help system leaders decide where to focus improvement and innovation activities and where to allocate resources.

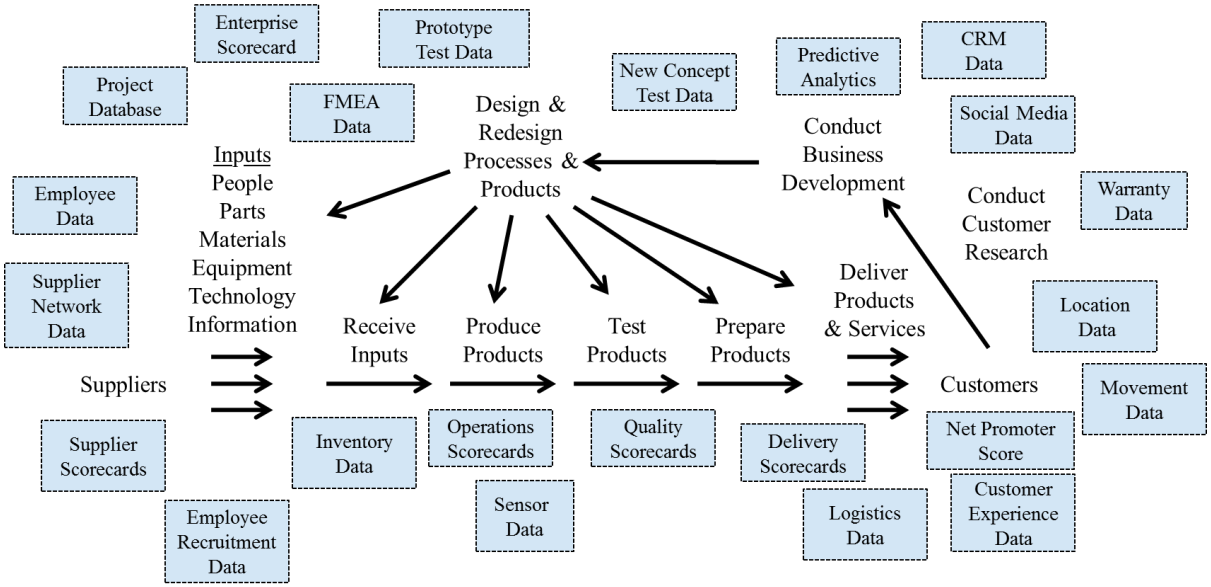

Figure 4. The Start of an Analytics System.

Suppose an organization develops capabilities for collecting and analyzing massive amounts of diverse data in real-time resulting in information: What can the leaders of the organization do with all that information? The leaders of the system would need to think deeply about what information might add the most value to their customers and then ideate and test the ideas.

III. Information-Based Customer Value Creation

Organizations can use information to provide more value to customers which will be referred to as ***information-based customer value creation***. They can achieve this by (1) adding new information-based features to existing products, services, and experiences (*P/S/E Enhancement*) and/or (2) creating new information-based products, services, and experiences (*P/S/E Innovation*). Both activities would involve making changes to a P/S/E portfolio. What follows are several examples of information-based customer value creation.

Navigating the Nagoya Airport

Airline customers flying out of the Nagoya Airport (Japan) years ago had limited access to flight information or airport amenities prior to their flight. The information options for Nagoya Airport customers are much different today. Customers can now visit at their convenience the Nagoya Airport website Home Page prior to their trip. The information can potentially be accessed by *anyone, anywhere, anytime*. Selecting a specific page from the website Home Page reveals a detailed map of part of the airport which depicts where airport services and amenities are located. This is shown in Figure 5. The information could help airline customers plan their airport experience including *way finding* and dining. The information informs and educates airline customers possibly leading to more efficient movement through the airport and less anxiety.

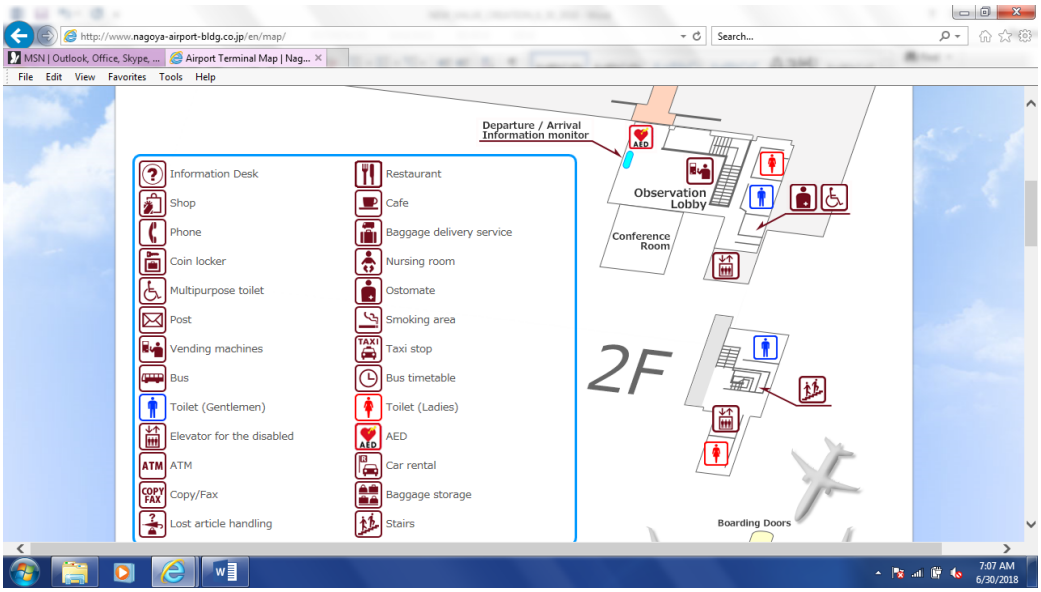

Figure 5. Secondary Website Page.

Nagoya Airport customers have easy access to an **Information Kiosk** area upon entering the airport which is shown in Figure 6. These kiosks inform and educate customers by providing them with real-time information on various topics potentially resulting in more value for customers.

Figure 6. Information Kiosks.

Nagoya Airport customers have easy access further inside the airport to a number of strategically-placed signs containing gate and amenity information. The information is free and so it can potentially enhance customer experiences at no additional cost. Some customers will find value in the signage, some may not care, and some may feel the signage provides little or no value. Customers with some form of vision impairment will most likely not receive any benefit.

Figure 7. Hallway Map Showing Gate Information.

We have just seen several examples of how Nagoya Airport customers can easily acquire *free* information which can provide more value to some or all customers. This might make the airport experience *worth more* as judged by customers. The airport's information-based features on its website and in the airport perform such functions as informing, notifying, and educating customers hopefully leading to a smoother, less stressful airport experience. The Nagoya Airport had to invest in those information-based products and features without directly and conspicuously charging airport customers. An organization might *predict* its *return on investment* before information-based P/S/E portfolio changes are made and then calculate the *actual return on investment* once customers have made their judgments.

Knee Replacement Surgery

A person (*patient*) scheduled for ***knee replacement surgery*** probably hopes the surgical procedure is (1) safe and (2) results in a desirable clinical outcome. Maybe the patient can play sports again and be more mobile if the procedure is successful. The patient begins the process with a physical exam resulting in a discussion with the doctor about options (*Physical Exam Experience*). The patient then chooses one of the options (*Decision Experience*) and schedules the knee replacement surgical procedure (*Scheduling Experience*). The patient prepares for the procedure (*At Home Preparation Experience*) and at some point travels to the hospital (*Travel to Hospital Experience*). The patient is admitted to the hospital and roomed (*Admissions & Rooming Experiences*) and then prepares for the procedure (*Surgical Procedure Preparation Experience*). The actual procedure is performed (*Surgical Procedure Experience*) and the patient hopefully recovers (*Post-Procedure Recovery Experience*). The patient is discharged from the hospital (*Discharge Experience*) and travels home (*Travel Home Experience*). Other ancillary *experiences* might occur such as a visit to a pharmacy or physical therapist. The hospital provides services during some of the *experiences*.

A patient might want to know . . .

What is knee replacement surgery?
How many procedures are performed each year?
What medications will I be prescribed?
How can I expect to feel after the procedure?
Can I have visitors?
Will I be in pain?
What are some tips for a speedy recovery?
What will my procedure entail?
Who will be my surgeon(s)?
What are some possible side effects?
What are the success and complication rates?
When will I be discharged?
How can I best manage my pain?
How much am I likely to pay?

The hospital could collect and analyze knee replacement procedure data and then create and provide *information products* to patients in the form of an on-line document and a paper document. These products would inform and educate patients and could be a new source of value for the patients at no extra charge. The outcomes could be related to more realistic patient expectations, better planning, and greater peace of mind. Some patients might value this information, some may not care, and some may not perceive any value. The information products are depicted in Figure 8 for a fictitious patient named Adrian.

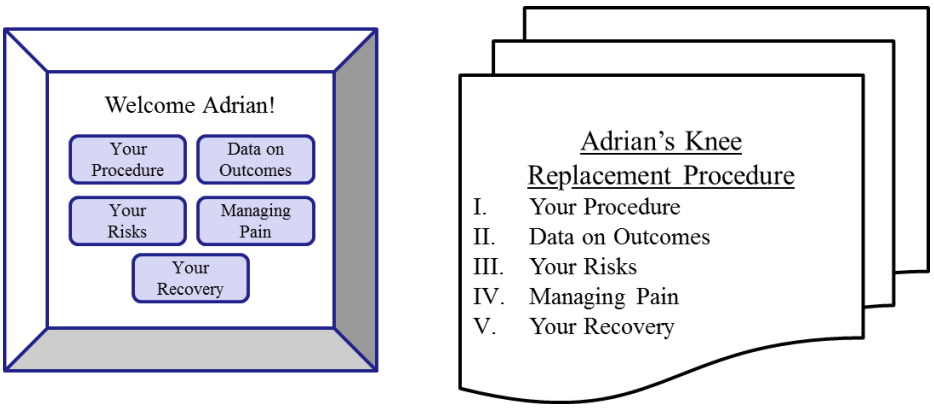

Figure 8. Knee Replacement Procedure Information.

Car Ownership Experiences

The Car Ownership Experiences were depicted in Figure 1 on Page 3. Equipment can be added to cars in the form of sensors, gauges, and data collection modules that can collect massive amounts of data on weather conditions, road conditions, traffic conditions, routes driven, car speed, fluid levels, fuel efficiency, and emissions. What if the car owner could access summary information using various devices (computer, tablet, pad, and phone) for the same price? This would represent information-based customer value creation. In this case the information could conceivably inform, notify, educate, and advise the car owner. Real-time traffic information might help the car owner get from Point A to Point B faster, safer, and in a better mood. Eventually with autonomous cars, a digital assistant might ask the car owner about his/her goals in life. For example, "I want to learn Japanese." The *car* could then *teach* the car owner during trips through videos and audio casts. The car would *in effect* be *developing the car owner* by assisting him/her in the achievement of aspirational goals.

Information could potentially add value in each of the identified car ownership experiences:
Shopping Experience – information on car performance, price, warranty, and financing terms
Decision Experience – comparative information on the cars being considered
Purchase Experience – information on how to order, contract details, terms, and conditions
Drive Home Experience – operational information (e.g., lights, wipers, GPS, heat, etc.)
Usage Experience – information on optimal routes, fluid levels, fuel efficiency, and traffic
Service Experience – information on when to service, whom to contact, and expected costs
Issue Resolution Experience – contact information and the predicted time to resolve the issue

These are all examples of how information could be used to create more value. The information-based car features could inform, notify, advise, assist, educate, and entertain the car owner hopefully leading to such outcomes as time savings, safer trips, fuel efficiency, and happier rides.

Mobile Phone Evolution

Mobile phones have radically evolved over the years. Figure 9 depicts an early mobile phone and a more recent smartphone. The early mobile phones looked like a *shoe box* and they have evolved in terms of price, size, storage, resolution, connectedness, and integration with other devices.

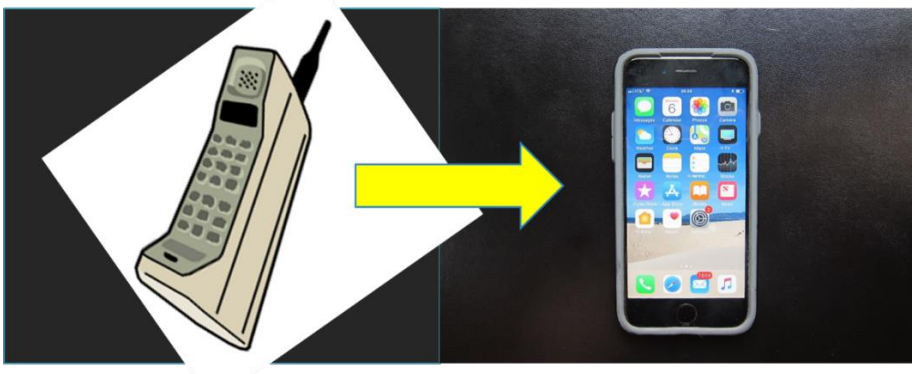

Figure 9. Mobile Phone from Shoe Box to Smartphone.

There is potentially more customer value because of the physical features and information-based features. The emergence of the smartphone dramatically increased information capabilities. Smartphone customers can access information on family, friends, geographies, local businesses, weather conditions, health status, stock market, messages, and numerous other things. These information-based features—sometimes in the form of *apps*—can provide more customer value.

Digital Watch Evolution

Watches share a similar information evolution. Figure 10 depicts an older analog watch and a new smart watch—both worn on the wrist. One key difference relates to information capabilities.

Figure 10. Analog Watch to Smart Watch.

Wearing a smart watch is like having a computer on your wrist that can *sync* with other devices. They perform functions like informing, notifying (alerts), advising, connecting, educating, and entertaining. The outcomes are similar to those of smartphones.

Viewing a Professional Baseball Game

Many Major League Baseball (MLB) fans love statistics. Some of the time-honored statistics of the game include Hits, Batting Average, Slugging Percentage, On-Base Percentage, Fielding Percentage, and Earned Run Average. The clever application of technology and new analytical techniques has led to the creation of new statistics such as On-Base Plus Slugging (OPS), Wins Above Replacement (WAR), Catch Probability, Launch Angle, Exit Velocity, Projected Distance, and Spray Charts which show where baseballs have been hit. This new information is valued by some fans, some fans don't care, and others perceive little or no value. MLB has a long history of analytics (see, e.g., Schwarz (2004)) and the league gained fame with the publication of the book *Moneyball* by Lewis (2003) which featured the analytics prowess of the Oakland Athletics (A's). The A's are very successful again this year with a low player payroll which some attribute to their use of advanced analytics. A *best practice* analytics club today is the Houston Astros—the 2017 World Series Champion (Reiter (2018)). All MLB clubs now have formal analytics capabilities and dedicated staff. Therefore, merely *having analytics capabilities* is no longer a differentiator.

A fan who watches a televised game today will most likely see temporary and permanent *information boxes* in the corners of the screen plus scrolling text along the bottom of the screen. This is depicted in Figure 11.

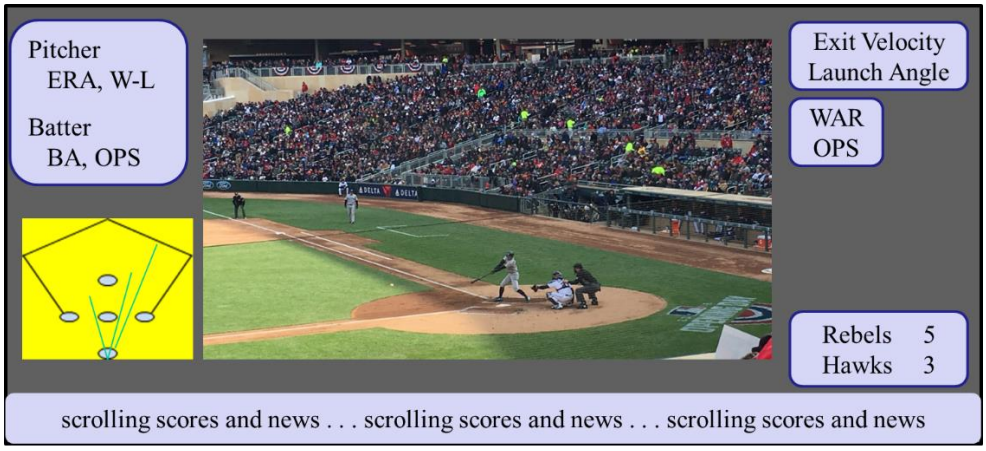

Figure 11. Viewing a Baseball Game.

Some baseball fans find value in the information, some are neutral, and some feel it is distracting and actually detracts from watching the game (*little value*).

Komatsu Limited

Komatsu Limited, the Japan-based multinational heavy equipment manufacturing company, started developing big data capabilities in the late 1990s (Asada (2014)). It is one of the global leaders in heavy equipment manufacturing. Komatsu has been aiming to create *dantotsu* products for several years. *Dantotsu* means *unique and unrivaled* (Hasegawa (2010)). Komatsu has expanded the *dantotsu concept* to include *dantotsu* services and *dantotsu* solutions (Asada (2014)); Sakane (2014)). KOMTRAX is a Komatsu telematics system for monitoring and improving the performance of Komatsu's construction machines (Komatsu (2018)). The system helps Komatsu customers achieve their goals related to productivity and safety through remote monitoring, reporting, and focused interventions. There were more than 350,000 Komatsu machines working with KOMTRAX as of August of 2014 (Asada (2014)). Some of the system's features include the Orbcomm satellite, GPS capabilities, web data delivery, and an Internet user interface. Komatsu also has KOMTRAX Plus which is a machine health monitoring system for mining machines. This is an example of how an organization enhanced its product portfolio by adding information-based services and solutions that inform, notify, advise, assist, and educate customers resulting in safer operations, cost reductions, and increased productivity.

Toyota Motor Corporation

Toyota has earned a strong reputation over the past few decades for producing cars of high quality and reliability. Toyota is also well-known for its Toyota Production System (*lean*) and related set of best practices like *genchi genbutsu* (*go and see*) and *kaizen* (*continuous improvement*).

Toyota is striving to become more competitive in the long-term (Toyota (2017)): "Toyota is stepping up its competitiveness by making ever-better cars while making a strategic shift toward electrification, information, and intelligence to advance initiatives aimed at expanding future mobility value." One aim is *waku-doki* which means *excitement and exhilaration that wows customers* (Toyota (2017)). Toyota has developed a *Connected Strategy* consisting of *Three Arrows* which is depicted in Figure 12.

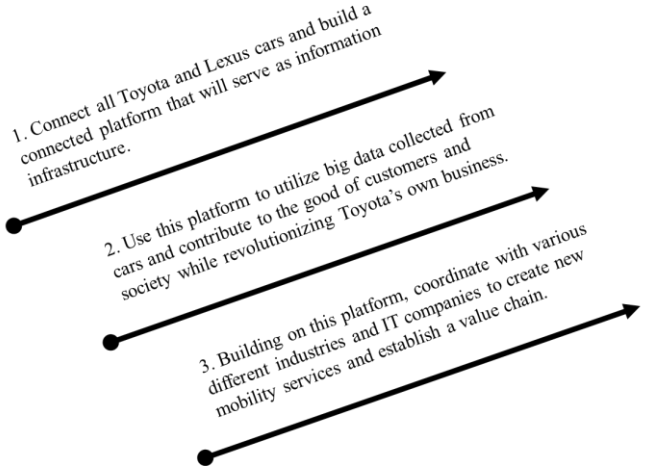

Figure 12. Toyota's *Connected Strategy as Three Arrows*.

Toyota collaborated with Microsoft in the establishment of the Toyota Big Data Center (TBDC) in California. Big data will play an important role for Toyota in the future (Toyota (2017)): "Big data collected from cars will enable a wide range of new mobility services, such as accident and breakdown prediction, the generation of dynamic maps using probe data (vehicle tracking information generated using GPS), and agent functions to help users drive safely and comfortably." Toyota ultimately envisions more value for customers (Toyota (2017)): "As the Internet of Things (IoT) develops, cars are increasingly connected to information networks, enabling consumers to enjoy a variety of new services. Connected technologies have the potential to create new value and services by creating new models of use and new roles for cars. In particular, big data collected from connected cars will be put to use in a wide range of services and businesses. As such, connected platforms that encompass information infrastructure will become extremely important business platforms for automakers." This suggests Toyota is developing capabilities beyond *lean*.

IV. IBCVC Model

The customer value creation examples described in the last section have several characteristics in common—the primary one being that *information* was used to provide more value to customers. **The story goes like this:** (1) an organization has a baseline Product/Service/Experience (P/S/E) portfolio; (2) new information-based features and new information-based P/S/Es are created through ideation that perform such functions as informing, notifying, advising, assisting, educating, and entertaining; (3) the information-based portfolio changes are *realized* by a customer leading to outcomes affecting safety, quality, time, money, etc.; and (4) some customers perceive more value because of the portfolio changes. This is shown in Figure 13 and will now be described.

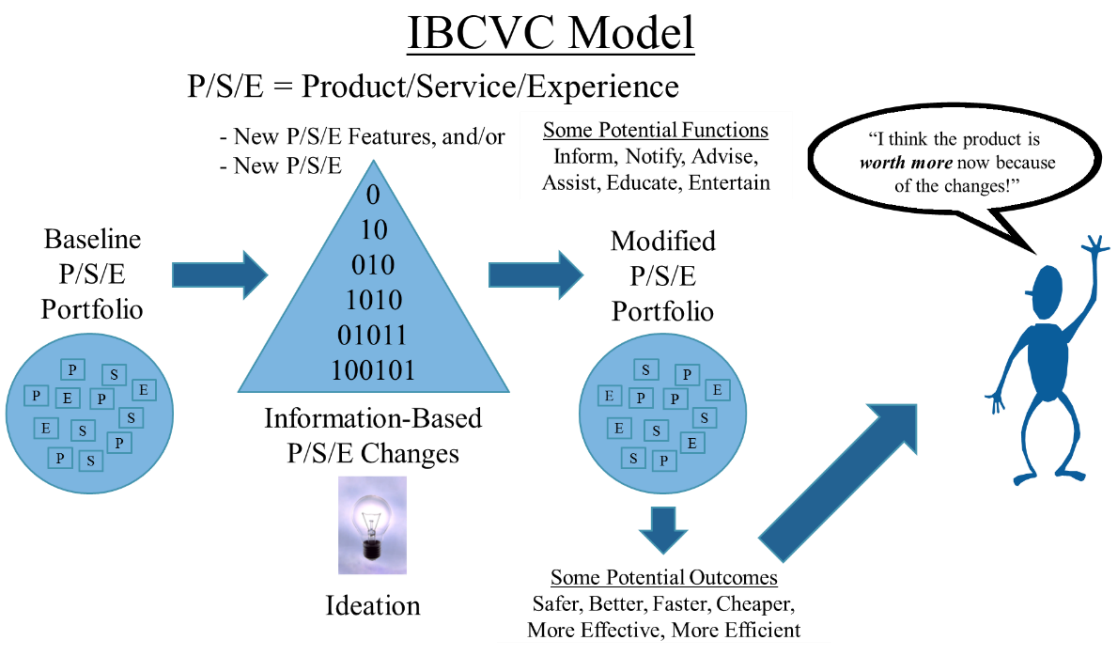

Figure 13. Information-Based Customer Value Creation Model.

(1) Baseline P/S/E Portfolio: An organization has a baseline portfolio of products, services, and experiences at a point in time that it offers in one or more marketplace. These portfolios can be *stable* (few changes over time) or *dynamic* (numerous changes over time).

(2) Information-Based Ideation: Some type of ideation process occurs—possibly in the context of a formal new product/service development process—that leads to *P/S/E Enhancement* (new features) and/or *P/S/E Innovation* (new portfolio items). The information-based changes tend to perform one or more functions like inform customers, notify customers, advise customers, assist customers, educate customers, and entertain customers. The functional categories are not necessarily mutually exclusive or exhaustive.

(3) Information-Based Changes are Realized: A customer uses a product, is provided a service, or lives an experience and notices some outcome affecting safety, quality, time, money, etc.

(4) Value Judgment is Made: The customer forms a *value judgment*. For example, in the case of an information feature added to a product—the customer reactions could be *negative* ("The new information feature makes the product worth less."), *neutral* ("The new information feature doesn't change the value of the product."), or *positive* ("The new information feature makes the product worth more."). The organization hopes the information-based portfolio changes *cause* customers to feel they are receiving more value (*worth more*). The information-based changes might be perceived quite differently for each customer. There are risks associated with making information-based P/S/E portfolio changes with respect to customer receptivity, data/information privacy concerns, and data/information security considerations.

The Kano Model (Kano (2018)) can potentially be used to interpret customer value judgments (*perceptions*) when new information-based features are incorporated into products, services, and experiences. It examines the correlation between an *objective evaluation* of the physical state (the feature is *insufficient* to *sufficient*) and a *subjective evaluation* in terms of the customer's perception (*dissatisfied* to *satisfied*). This analysis leads to the categorization of features with respect to Quality: Attractive Quality, One-Dimensional Quality, Must-Be Quality, Indifferent Quality, and Reverse Quality. *Customer value* is a different construct than *quality* and so a direct application of the model is difficult. Further research is needed to determine how the Kano Model might be applied or modified for the information-based customer value creation context. If a customer focuses on *quality* when making a value judgment, then the Kano Model might apply directly for *value* in that particular case. The reality is that each customer might judge new information-based features differently and the judgments can change over time.

V. Illustrative Case Study

A fictitious bicycle company called **PetaByke** will now be used to illustrate some of the primary ideas associated with information-based customer value creation. The name **PetaByke** is intended to be a *play on words*: a petabyte is equal to one million gigabytes; *peta* resembles the word *pedal*; and *byke* is a humorous way to spell *bike*. A fictional PetaByke bicycle is depicted in Figure 14.

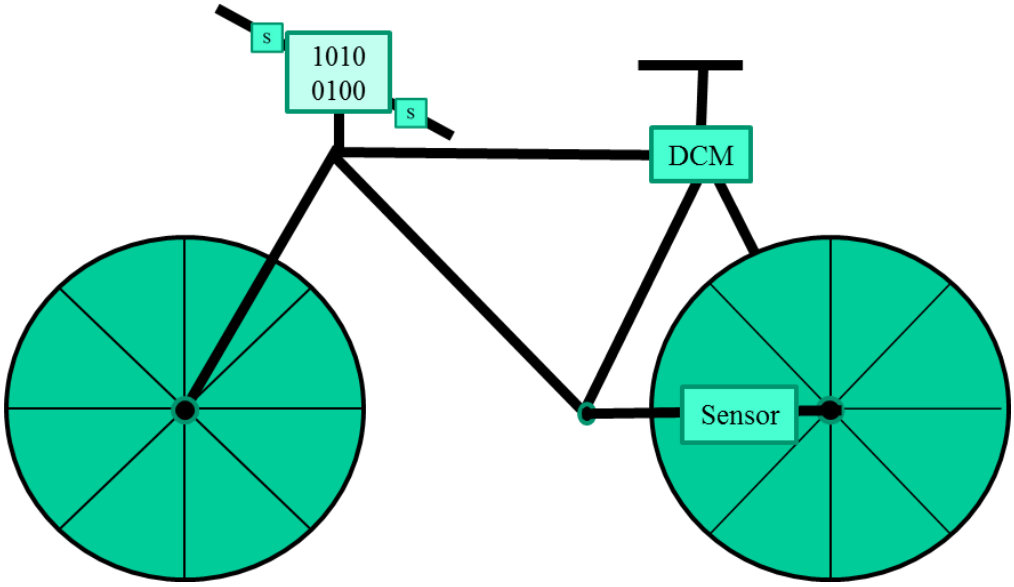

Figure 14. A PetaByke Bicycle.

The PetaByke situation is similar to what many companies are faced with today such as automobile, construction equipment, tractor, commercial lawn mower, airline, and railroad companies. These companies have mobile products that can potentially collect a massive amount of data which can be transmitted via satellites and cellular towers ending up in servers (*the cloud*) to be analyzed. The data can be labeled, tagged, categorized, aggregated, sorted, tabulated, and summarized (*processed*)—i.e., turned into information which can be accessed by multiple stakeholders of the company including employees, partners, suppliers, regulators, and customers.

The basic function of a bicycle is to move a person from some starting point (A) to a destination point (B). Bicycles are purchased and used for different purposes such as joy riding, riding to work, racing, mountain trail riding, and delivering packages. What if the bicycle could be *enhanced* with Information Communication Technology (ICT) features? Information-based customer value creation would then be a feasible endeavor. Let's suppose a PetaByke bicycle has the following ICT features (**Note:** This is fictional and intended to be humorous):

* Data Capture Mechanism (DCM)
* GPS
* Sensors
* Facial Recognition
* RFID
* Camera
* Social Media
* Phone
* Speakers
* Digital Display Screen
* Digital Assistant Christina
* Biometric Security
* Wi-Fi
* Video
* Audio
* Downloadable Applications ("Apps")
* Videoconferencing
* **Optional –** Detachable Drone

Caution! Some of these features should not be used while riding!

A PetaByke would be a customer operated, mobile, connected, data collection machine. It could collect data on the weather, road conditions, traffic, and bicycle performance in addition to the customer's preferences, health, location, movements, and frequently asked questions. How could the massive amount of data that is collected, transmitted, analyzed, and converted to information add value to the customer? The collection and transmission of the data is depicted in Figure 15 whereby PetaByke sensors and the DCM collect data which is uploaded and transmitted via satellite eventually ending up in servers (*cloud*). Cellular towers are not depicted.

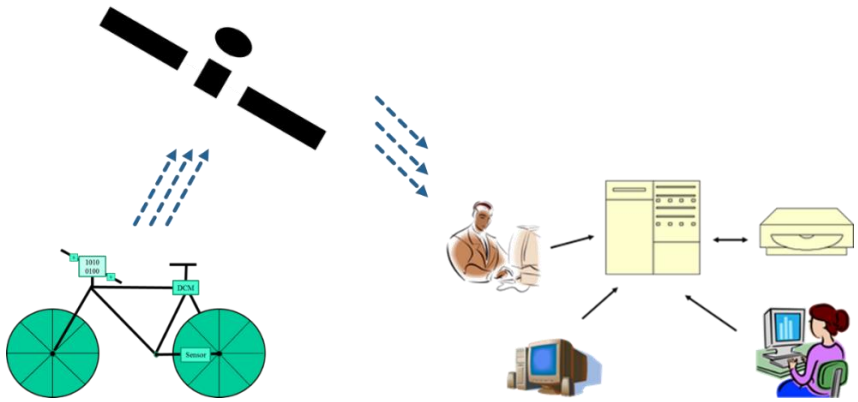

Figure 15. A PetaByke Bicycle Transmitting Data to a Server.

Dynamic Features: The customer could receive *real-time* information on the digital display screen and/or audibly from the digital assistant Christina on distance to destination, speed, optimal routes (from safety and time perspectives), health status (e.g., heart rate and blood pressure), calories burned, entertainment recommendations, pictures, videos, and audio clips. Sensors could capture information on weather conditions, road conditions, traffic, and bicycle performance.

Snap Shot Features: The customer could (1) routinely receive information (*pushed information*) by PetaByke and/or (2) request information (*pulled information*) on such items as routes, performance, health, favorite spots/routes, movements on a map, pictures, videos, audio clips, and weather conditions. A fictional PetaByke digital display screen is show in Figure 16.

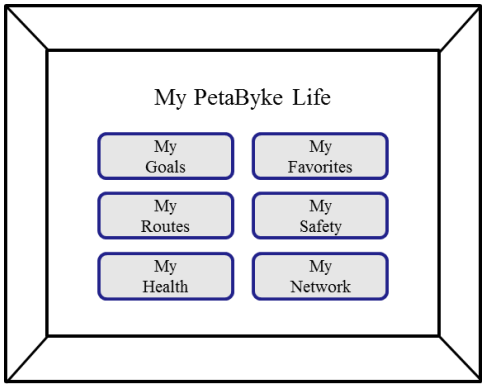

Figure 16. PetaByke Digital Display Screen.

The information-based features could perform various functions. For example,

- ***Inform*** the PetaByke customer of weather and traffic conditions
- ***Notify*** the PetaByke customer of road closures and detours
- ***Advise*** the PetaByke customer on the safest and fastest routes
- ***Assist*** the PetaByke customer in the achievement of goals
- ***Educate*** the PetaByke customer on neighborhoods and historic buildings
- ***Entertain*** the PetaByke customer through song and podcast recommendations

In effect, the PetaByke would be a data collection machine that generates massive amounts of diverse data which can be transmitted, analyzed, and processed giving rise to information that is of value to the customer.

The PetaByke Company might be interested in the following:

- **Portfolio**: What information-based changes should be made to the P/S/E portfolio?
- **Ideation**: What are some global best practices in terms of the ideation process?
- **Functions**: Which functions (e.g., inform, educate, entertain, etc.) should we target?
- **Outcomes**: What outcome areas (e.g., safety, quality, time, etc.) should we try to affect?
- **Analytics and Big Data**: How can we rapidly develop and leverage these capabilities?
- **Information Infrastructure**: What information infrastructure would best meet our needs?
- **Data Governance:** What would be the most effective data governance structure?
- **Privacy and Security:** How can we develop capabilities aligned with customer concerns?
- **Risk:** How can we manage the risks associated with information-based P/S/E changes?
- **Return on Investment:** How should we calculate the ROI associated with P/S/E changes?

The PetaByke case provides insight into what mobile product companies are striving to achieve.

VI. Conclusions & Future Directions

Many organizations collect and analyze massive amounts of data giving rise to information which can be used to provide more value to customers. An organization can *modify* its P/S/E portfolio by adding new information-based features (*P/S/E Enhancement*) and/or *create* new information-based P/S/E items (P/E/S Innovation). The new information-based features and P/S/E items can potentially inform, notify, advise, assist, educate, and entertain customers (*functions*) resulting in benefits related to safety, quality, time, money, effectiveness, efficiency, morale, and well-being (*outcomes*). Information-based customer value creation is not new, but it appears to be gaining momentum and attention because of (1) advances in ICT capabilities and (2) a growing number of organizations who are developing analytics and big data capabilities. Additionally, it appears to be a poorly understood and underdeveloped organizational strategy which could provide organizations with a competitive advantage and/or new core competence. Several examples of information-based customer value creation were described and the Information-Based Customer Value Creation (IBCVC) Model was introduced. A fictional company named PetaByke was then used to illustrate the major components of the model.

Future research is necessary to (1) better define and describe information-based customer value creation and (2) identify global best practices. Case study research whereby a small number of organizations are studied in great depth would be a recommended next research step to explore this phenomenon of interest. The research questions could include the following:

- **Portfolio**: How best can new information-based P/S/E portfolio opportunities be identified, prioritized, and selected?
- **Ideation**: What are some global best practices in terms of the ideation process?
- **Functions**: Which functions do information-based changes tend to perform?
- **Outcomes**: What are the relationships between the functions and outcomes?
- **Analytics and Big Data**: How can organizations best leverage analytics and big data?
- **Information Infrastructure**: What are the most effective information infrastructures?
- **Data Governance:** What are the most effective data governance structures?
- **Privacy and Security:** How do organizations assure data privacy and data security?
- **Risk:** What are the most effective risk management systems related to P/S/E changes?
- **Return on Investment:** What are the most effective ROI calculation models?

Information-based customer value creation holds great promise for those organizations developing analytics and big data capabilities, but it requires an investment and it assumes that some risks must be taken. More research is necessary to identify the most effective and efficient organizational paths and practices, but it should start with a thorough understanding of the underlying *concepts* and *principles* which this research report attempts to reveal and describe.

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