Big Data in Hoshin Kanri

Charles Allen Liedtke, Ph.D.
Excelsior, Minnesota, USA, Strategic Improvement Systems, LLC, charles@sisliedtke.com

Abstract: Hoshin kanri, also known as policy management, has its origins in Statistical Quality Control (SQC). The typical data used by organizations in hoshin kanri activities from the early 1960s to the recent past can arguably be characterized as small-to-medium data. How can an organization best use big data in hoshin kanri activities? Big data is "a relatively large amount of data (volume) consisting of multiple types (variety) possibly arriving in real-time (velocity) of varying degrees of accuracy (veracity)." This definition is based on the "Four V" Framework. Many organizations are starting to develop big data capabilities in order to achieve a sustainable competitive advantage. This paper explores how big data can be used to improve the effectiveness and efficiency of decision-making in hoshin kanri activities. Four suggestions are offered for how organizations can start to develop the capabilities necessary for big data success in hoshin kanri activities: (1) develop the big data Information and Communication Technology (ICT) infrastructure, (2) expand the TQM tool box, (3) streamline decision-making processes for decision flexibility, and (4) improve the data risk analysis process. The Hoshin Kanri Big Data Team (HKBDT) concept is also introduced and discussed.

Keywords: Hoshin Kanri, Policy Management, Big Data, Analytics, Risk Analysis

1 Introduction

1.1 Accomplishing Organizational Performance Objectives

Leaders of organizations sometimes attempt to accomplish objectives related to organizational performance categories such as quality, cost, delivery, safety, education, and morale. Deming Prize applicants are encouraged to accomplish customer-oriented business objectives (Deming Prize Committee (2017)). According to Drucker (1954), "Objectives are needed in every area where performance and results directly and vitally affect the survival and prosperity of the business." Various approaches are used by organizations to develop, deploy, and accomplish these objectives including strategic planning, the Balanced Scorecard (Kaplan and Norton (1992)), and hoshin kanri (also known as *policy management*). This paper will focus on developing objectives as part of the broader activity of developing policies in hoshin kanri.

Numerous decisions are made during the hoshin kanri process and leaders hope their decision-making processes are effective and efficient. Analytics is one area where an organization can gain a competitive advantage according to Davenport and Harris (2007). Some have said that we are at the beginning of a new digital age (see, e.g., Schmidt and Cohen (2014)). Numerous organizations such as Amazon, Apple, Facebook, GE, Google, IBM, and Microsoft are using big data to acquire *deep insights* into market dynamics, customer experiences, and operational performance (Marr (2016)). 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 easy for massive amounts of data to be created, stored, replicated, and transferred. Organizations today have access to massive amounts of data. If more data is created, then organizations potentially need more data storage and data processing capabilities.

Decision-making is not an easy endeavor for leaders of organizations today. Unanticipated global events can occur that increase the amount of perceived uncertainty in decision-making. Recent examples include Brexit, unplanned mass migrations, cyberattacks, and regional armed conflicts. There have also been numerous Information and Communication Technology (ICT) advances in such areas as mobile

devices, cloud computing, machine learning, artificial intelligence, and social media. These ICT advances create opportunities for thought-leading organizations who want to become more effective and efficient at developing, deploying, and accomplishing organizational performance objectives. This paper starts to explore how big data can be used in hoshin kanri—and more specifically—during the *development of policies* in hoshin kanri.

1.2 Hoshin Kanri

Hoshin kanri (*policy management*), is a strategic improvement system that originated in Japan in the 1960s according to Akao (1991). It has been implemented in numerous organizations worldwide and is a prominent item mentioned in *The Application Guide for the Deming Prize* (Deming Prize Committee (2017)). Also, it is one of the core components of TQM along with Cross-Functional Management, Daily Management, and Small Group Activities (Ando and Kumar (2011)). The Japanese Society for Quality Control (2017) recently revised its standard (JSQC-Std 33-001(E):2017) on "*Guidelines for Policy Management*." A research-based definition of hoshin kanri was described by Liedtke (2012):

> "*Hoshin kanri* is a systematic annual process led by senior executives—and preceded by strategic management activities—for developing, deploying, and accomplishing policies (Policies = Priority Issues + Objectives + Strategies) through coordinated organization-wide activities and the rigorous application of the PDCA cycle."

The work of Dr. Walter A. Shewhart (see, e.g., Shewhart (1931)) on Statistical Quality Control (SQC) played an important role in forming the foundation of TQM in general (Ishikawa (1985)) and hoshin kanri in particular (Akao (1991)). Ishikawa (1985) described how many companies had transformed themselves after applying Quality Control (QC). One of the six categories that described the manner in which they were transformed was "Using facts and data to make presentations—utilization of statistical methods." The *data situation* has changed dramatically for leaders of organizations since the early days of TQM. For example, many organizations now collect and analyze data in the form of videos, pictures, sounds, posts, likes, searches, and tweets to acquire *deep insights* into market dynamics, customer experiences, and operational performance. Figure 1 depicts a statistical control chart and many of the types of data that are routinely collected and analyzed by leading organizations today.

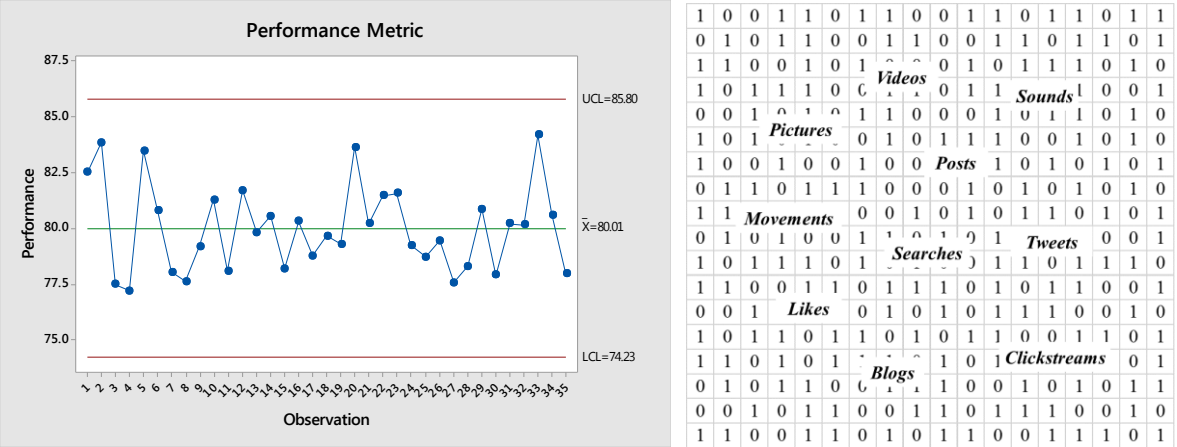

Figure 1. Statistical Control Chart and Some Contemporary Types of Data

Strategic management activities typically precede hoshin kanri activities each year leading to widespread organizational actions. Osada (1998) described how strategic planning activities can be combined with hoshin kanri activities to create Strategic Management By Policy (SMBP). Figure 2 depicts some of the major activities in SMBP. The process depicted in Figure 2 is shown for illustrative

purposes only and is intended to identify some of the key activities that occur in strategic planning and hoshin kanri processes. This paper focuses on the *Develop Policies* Step of the hoshin kanri process.

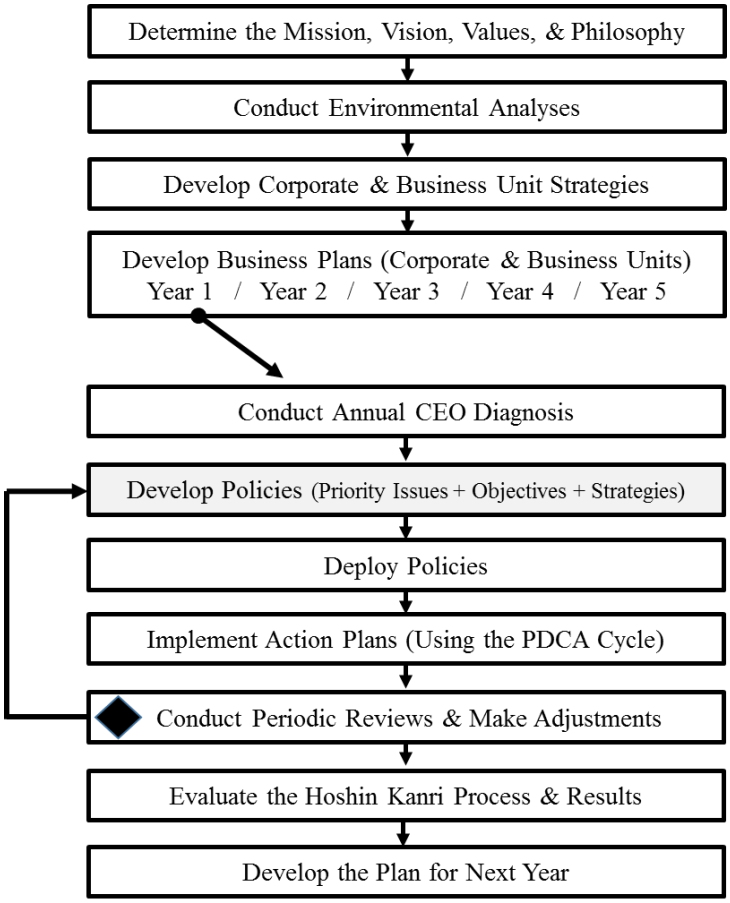

Figure 2. Illustrative Strategic Management By Policy (SMBP) Process

Figure 3 depicts a basic organization chart, vertical and horizontal catchball, and the output of hoshin kanri in the form of one policy. Kume (2009) defined a *policy* as being composed of priority issues, objectives, and strategies. A *single policy*, for the purpose of this paper, is composed of a priority issue; a related objective; the strategies to accomplish the objective; and the specific action plans associated with the strategies. Policies are sometimes developed and deployed in the organization structure through vertical and horizontal catchball activities ("*back and forth*" communication) involving extensive discussion and negotiation. The baseball icons in Figure 3 suggest that the catchball activities for developing objectives and strategies are analogous to *playing a game of catch with a baseball* in that ideas are "*thrown back and forth*." Hoshin kanri is therefore a formal system to accomplish organizational performance-related objectives which is consistent with the *rational system perspective* of organizations described by Scott and Davis (2007): "*organizations are collectivities oriented to the pursuit of relatively specific goals and exhibiting relatively highly formalized social structures*."

This paper will discuss one of the simplest cases in which only one policy is developed and deployed in an organization having a basic organization chart like that shown in Figure 3. Several important decisions must be made in the development of a single policy:

- What is the priority issue?
- Who is accountable for the policy?
- What should be the objective (the *what* or *target*)?
- What should be the strategies (the *how* or *means*) for accomplishing the objective?
- What should be the action plans for each strategy?

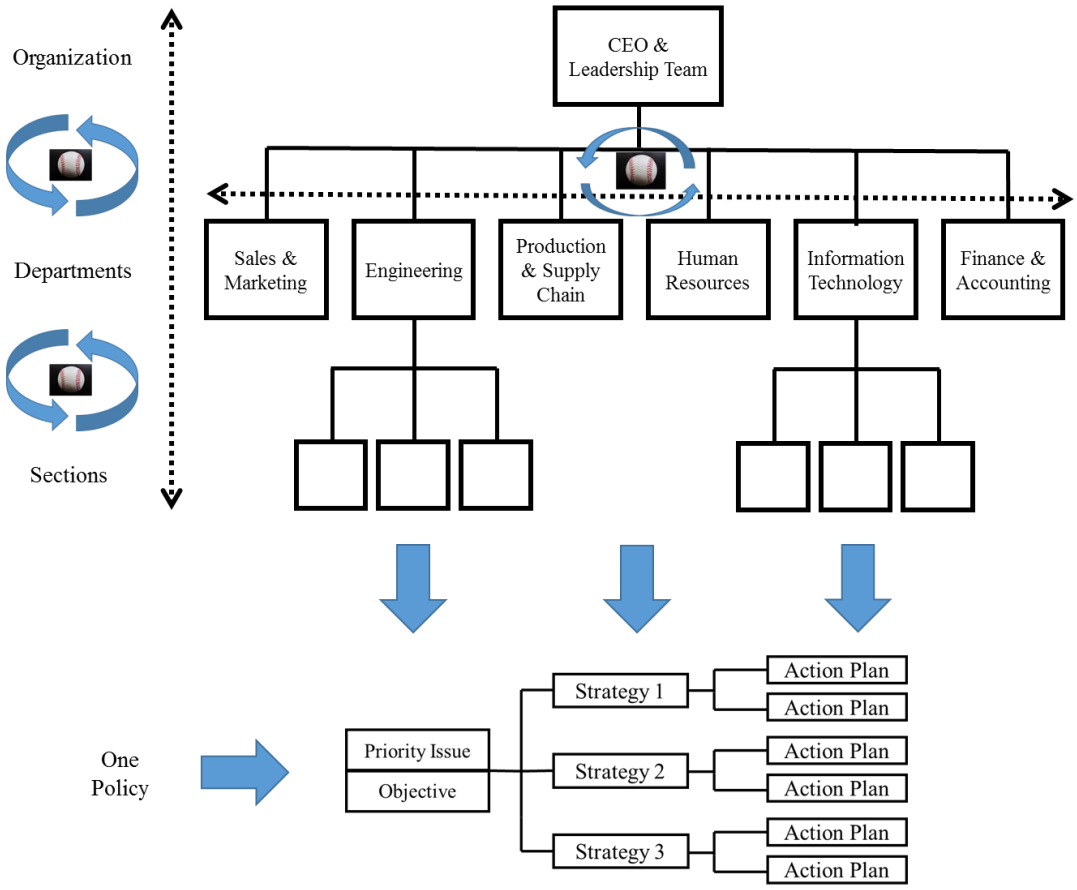

Figure 3. Basic Organization Chart, Catchball, and One Policy

As an illustrative policy example, suppose that an organization is receiving an unacceptable number of customer complaints for a particular product—Product X. The priority issue could be stated as "unacceptable number of customer complaints on Product X." The related objective could be to "Increase the Net Promoter Score (NPS) for Product X from 32.5 to 50.0 by June 30, 2018." Two strategies for accomplishing the objective could be (1) Decrease *defective parts per million* on Product X from 12,533 to 1,000 by April 30, 2018 and (2) Add two new *attractive features* to Product X by April 30, 2018. Action plans would then be developed for each strategy.

Data are used to make decisions during policy development. Leaders hope that policy development decision-making processes are effective and efficient. *Effectiveness* in decision-making relates to whether the *appropriate* priority issue, objective, and strategies were developed. *Efficiency* in decision-making during policy development relates to whether the minimum amount of resources were used.

1.3 Big Data

It was stated earlier that big data is now used by some organizations to gain *deep insights* into market dynamics, customer experiences, and operational performance. Figure 4 depicts a progression from *Zero Data* to *Big Data* to illustrate different data-based decision-making situations.

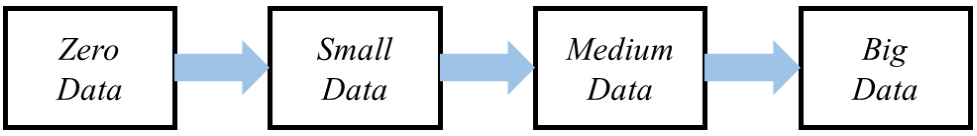

Figure 4. Zero Data to Big Data

Zero Data refers to management system items such as the mission, vision, values, philosophy, and priorities of an organization. The label *Zero Data* does not mean that "no data" is used to establish such items, but rather to suggest that these items are sometimes created using subjective personal judgments. *Zero Data* reflects the purpose and strategic direction of an organization which should guide data collection and analysis activities. A *Small Data* example would be when data is collected and analyzed for one lost-time employee accident. A *Medium Data* example would be when the data collected from a sample survey of 2,000 customers is analyzed. A "Three V" framework for describing big data in the form of three features was described by Laney (2001). It included having a large volume of data (*volume);* different types of data (*variety*); and data arriving in real-time (v*elocity*). Others have added a fourth "V" in *veracity* resulting in the "Four V" Framework which now commonly appears in the literature (see, e.g., Zikopoulous *et al.* (2015)). Liedtke (2016) described a research-based definition of big data: "***Big data*** is a relatively large amount of data (*volume*) consisting of multiple types (*variety*) from multiple sources possibly arriving in real-time (*velocity*) of varying degrees of accuracy (*veracity*) requiring exploratory data analysis and integrative analytical methods." This definition emphasizes the Four V features and what is done with the big data. The Four V features are shown in Figure 5.

A big data *situation* in which the Four V features are present is separate from the *application of analytical tools* such as data mining, data reduction, classification, correlation analysis, and clustering.

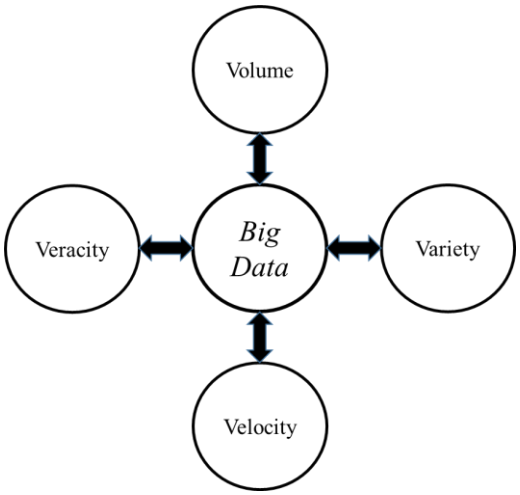

Figure 5. The "Four V" Features of Big Data

Asada (2014) described how Komatsu has developed its KOMTRAX system which creates and analyzes big data to support the development and provision of *dantotsu* (unique and unrivaled) products, services, and solutions. Komatsu has access to a massive volume of data of various types arriving in real-time from its network of machines operating for its customers throughout the world. The *veracity* of the KOMTRAX data is not public knowledge. It is possible for a faulty sensor to create *bad data*.

There appears to be a bias towards explicit knowledge with big data and so we should keep in mind that "becoming digital" is not sufficient because there also exists tacit knowledge. According to Polanyi (1966): "*. . . we can know more than we can tell.*" Nonaka and Takeuchi (1995) discussed the importance of explicit and tacit forms of knowledge and described four *knowledge conversion modes*: socialization, externalization, combination, and internalization. All modes will be important in a big data situation.

2 Big Data in Hoshin Kanri

2.1 Integrating Big Data and Hoshin Kanri

We can gain insights into how big data might be used in hoshin kanri by exploring the Four V big data features in each major step of the hoshin kanri process. This paper begins that exploratory process with the *Develop Policies* Step of hoshin kanri. This is depicted in Figure 6. The development of policies is vitally important because leaders must address the *critical* priority issues facing the organization and

then develop and deploy the appropriate objectives and strategies to successfully address the targeted priority issues. What if there is a massive amount of data (*volume*) of various types (*variety*) arriving in real-time (*velocity*) of questionable accuracy (*veracity*) during the development of policies in hoshin kanri? The potential benefit is that you might have better policies because you will use more data of different types (unique insights) and be more flexible in response to environmental changes. Also, you might *think more critically* about your data because you know your data could be inaccurate.

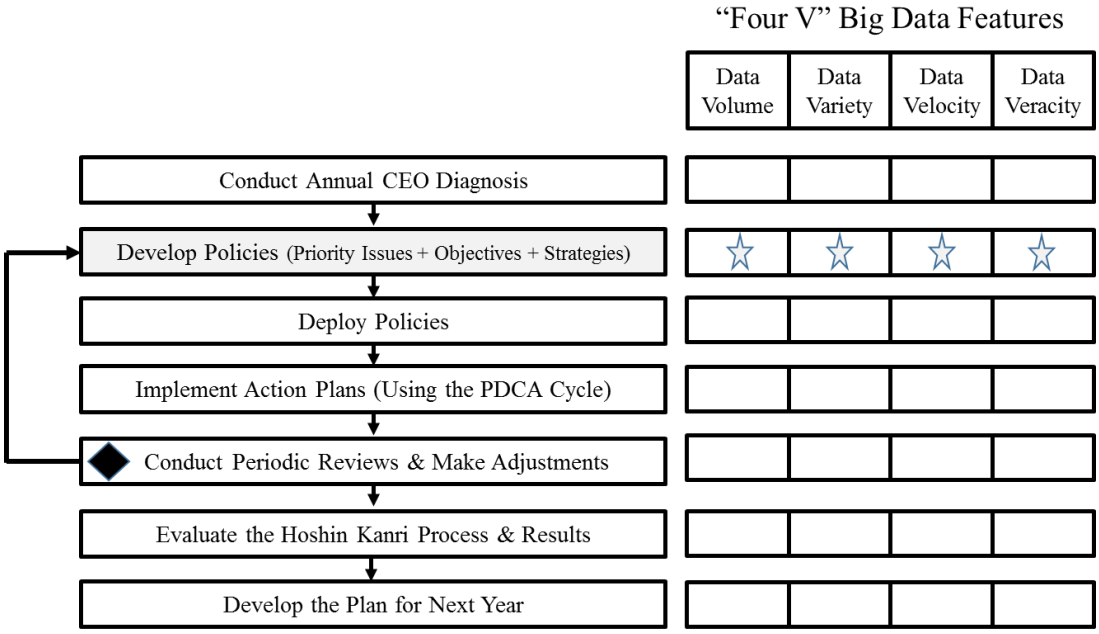

Figure 6. Basic Hoshin Kanri Process vs. The Four V Big Data Features.

Each of the Four V big data features will now be discussed in the context of *developing policies*.

2.2 Volume of Data

The first "Four V" feature of big data is *volume*. What if leaders had access to a massive amount of data during the development of policies in hoshin kanri? The potential benefit is that leaders would have more data to use in the analysis and selection of priority issues and the subsequent development of objectives and strategies. However, the data must be stored somewhere, secured, and be made accessible to the appropriate decision-makers when they need it for policy development. The ICT system must have adequate bandwidth and processing speed in order to perform the necessary operations such as performing calculations, downloading data, uploading data, processing data, and transferring data. One risk is that decision-makers will be *overwhelmed* by the magnitude of data available during the development of policies.

Conclusion #1: An organization must develop a big data ICT infrastructure in order to effectively and efficiently use big data during the development of policies in hoshin kanri.

Suggestion #1: Develop the big data ICT infrastructure for hoshin kanri.

2.3 Variety of Data

The second "Four V" feature of big data is *variety*. What if leaders had access to numerous types of data during the development of policies in hoshin kanri? The potential benefit is that leaders would acquire *unique deep insights* by analyzing numerous types of data. Early reference books on TQM described two types of data: measurement data and countable data (see, e.g., Ishikawa (1982)). The three TQM-oriented toolboxes such as the *7 Basic Tools* (see, e.g., Ishikawa (1982)), the *7 New QC Tools*

(see, e.g., Mizuno (1988)), and the *7 Strategic Tools* (see, e.g., Osada (1998)) are arguably best suited to analyze and synthesize measurement data, countable data, and language data. However, they don't appear adequate for analyzing and synthesizing some of the types of data that are becoming common in organizations today such as clickstreams, videos, pictures, and sounds (see Figure 1). If leaders have access to more varieties of data during the development of policies in hoshin kanri, then they will need a new toolbox. This toolbox could be called the *7 Big Data Tools*. It will require new ways to analyze and synthesize data and extensive training and education. The *7 Big Data Tools* can be improved through rigorous application and careful observation as to their effectiveness. Ishikawa (2015) identified some mechanisms for integrating big data and social media which could serve as a valuable reference.

Conclusion #2: An organization must expand the current TQM tool boxes in order to effectively and efficiently use big data during the development of policies in hoshin kanri.

Suggestion #2: Expand the current TQM tool boxes for big data in hoshin kanri.

7 Big Data Tools (example only): Algorithm, Data Mining, Machine Learning, Software Coding, Social Media, Search, and Applications ("Apps").

2.4 Velocity of Data

The third "Four V" feature of big data is *velocity*. What if leaders had data arriving in real-time during the development of policies in hoshin kanri? The potential benefit would be that leaders could be flexible in policy development and make more *just-in-time* decisions on priority issues, objectives, and strategies. The model of "collect all the data and then develop policies" might not be appropriate with big data. A different model might be "continue to collect big data and modify the policies as necessary." Decision-makers will probably need to re-evaluate policies quickly to determine which are still necessary and appropriate. There is risk associated with data arriving in real-time. You might be distracted by a *trending topic* only to later learn that it was just a *passing fad*. Also, you could adjust too quickly in the form of *tampering* if you were treating common causes of variation as special causes of variation (see, e.g., Deming, (1986)). Akio Toyoda (2011), President of Toyota Motor Corporation, announced the *Toyota Global Vision* on March 9, 2011. An earthquake occurred off the northeast coast of Japan on March 11, 2011 which created a tsunami. The effects on Japan were devastating and the future plans of Toyota were suddenly in question. Liker and Convis (2012) described how Toyota still practices hoshin kanri. A logical assumption from that tragic incident is that Toyota's policies needed to be quickly re-evaluated, re-prioritized, and revised. You might sometimes need to let the events unfold before taking action after such an event. As organizations are developing policies, they might need to be scanning the environment in an attempt to detect weak and strong signals (see, e.g., Ansoff (1984)). This scanning and real-time data acquisition suggests there may need to be a combination of the *rational systems perspective* of organizations (mentioned earlier) and the *open systems perspective* of organizations also described by Scott and Davis (2007): "*organizations are congeries [disorderly collection] of interdependent flows and activities linking shifting coalitions of participants embedded in wider material-resource and institutional environments*." How can we make decisions during policy development quickly and take action at acceptable risk levels? There might not be time for extensive genchi genbutsu, nemawashi, and catchball activities. Once new data arrives, then there will need to be an assessment, deliberation, and a decision as whether to modify the priority issues, objectives, strategies, and/or action plans. One can imagine that there will need to be *fast catchball* activities with minimal handoffs. Clear roles, responsibilities, and decision rights will be important so as not to create decision-making bottlenecks. Policy development with high velocity data could lead to *deliberate* and *emergent* policies (see, e.g., Mintzberg (1994)). Mudd (2015) stressed the importance of asking the right questions and identifying decision drivers when attempting to solve complex problems quickly.

Conclusion #3: An organization must streamline decision-making processes to become more flexible in order to effectively and efficiently use big data during the development of policies in hoshin kanri.

Suggestion #3: Streamline big data decision-making processes in hoshin kanri.

2.5 Veracity of Data

The fourth "Four V" feature of big data is *veracity*. What if the data used in the development of policies in hoshin kanri was of varying degrees of accuracy? Big data is often messy (see, e.g., Mayer-Schonberger and Cukier (2013)). While organizations now have access to a massive volume of data of numerous types arriving sometimes in real-time, the data may not always be accurate. This will introduce additional risk into policy development decision-making processes and potentially lead to inappropriate priority issues being selected, inadequate objectives being developed, and ineffective and/or inefficient strategies being developed. The potential benefit—which might be counter-intuitive—is that leaders will view data more critically and with more *healthy skepticism* because they will know their data might be inaccurate. Decision makers must understand the veracity of their data in order to make informed decisions while taking into account inaccuracy risk.

The risk analysis activities conducted in policy development decision-making processes could occur using multiple perspectives: risk analysis of *data sources*; risk analysis of *data types*; risk analysis of *individual data values*; and risk analysis of *data summary statistics*. An FMEA could be conducted to quantify the potential and known data failure modes and then action plans could be developed and implemented to reduce the risks.

Conclusion #4: An organization must be able to quickly assess the veracity of data in order to effectively and efficiently use big data during the development of policies in hoshin kanri.

Suggestion #4: Develop and implement big data risk analysis processes in hoshin kanri.

2.6 Summary of the Suggestions

The preceding discussion on the use of big data in the *Develop Policies* Step of hoshin kanri identified several potential benefits, conclusions, and suggestions. Here are the four suggestions:

(1) Develop the big data ICT infrastructure for hoshin kanri.	ICT Infrastructure
(2) Expand the current TQM tool boxes for big data in hoshin kanri.	Big Data Tools
(3) Streamline big data decision-making processes in hoshin kanri.	Decision Flexibility
(4) Develop and implement big data risk analysis processes in hoshin kanri.	Data Risk

These highlight four potential focus areas for leaders of organizations if they want to start using big data during the development of policies in hoshin kanri.

3 Hoshin Kanri Big Data Team (HKBDT)

3.1 HKBDT Concept

The CEO and Leadership Team will need assistance if big data is to be used effectively and efficiently in hoshin kanri. This role can be fulfilled by a cross-organizational Hoshin Kanri Big Data Team (HKBDT). The HKBDT could carry out its responsibilities like a Cross-Functional Management (CFM) Team (see, e.g., Kurogane, (1993)). One major difference is that the HKBDT would manage *big data* (a potential "*function*") throughout the hoshin kanri process instead of the quality assurance process or value stream. The HKBDT is depicted in Figure 7. The HKBDT could have *horizontal responsibilities* across the Four V features and *vertical responsibilities* throughout the entire hoshin kanri process.

3.2 HKBDT Composition

The HKBDT would most likely need to be a cross-organizational team having at least one representative from each department as shown in Figure 7. If we refer back to the basic organization

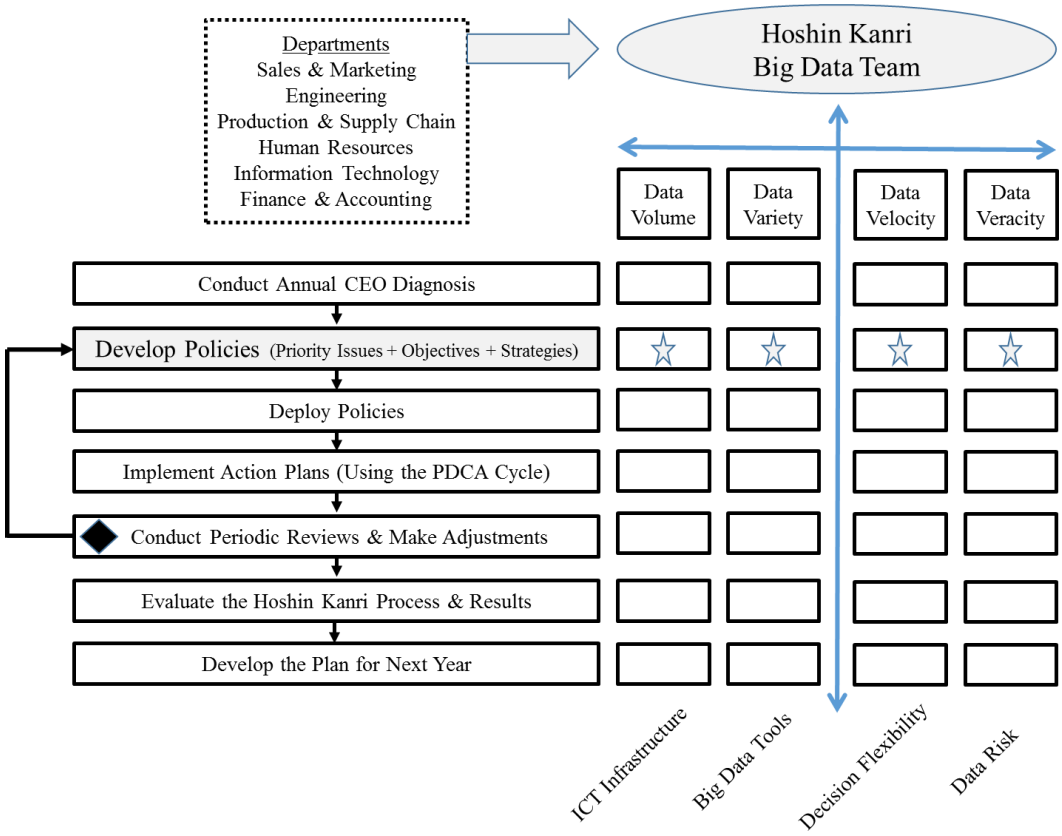

Figure 7. Hoshin Kanri Big Data Team (HKBDT) & Big Data Features

chart depicted in Figure 3, then the team would have at least one representative from Sales & Marketing, Engineering, Production & Supply Chain, Human Resources, Information Technology, and Finance & Accounting. The basic organization chart is for illustrative purposes only and is not meant to be prescriptive. The frequency and duration of HKBDT team meetings and the amount of time dedicated by HKBDT team members will vary depending upon the step of the hoshin kanri process and the number of policies. The HKBDT could be a permanent team, but its membership is subject to change each year.

Some organizations will need to develop *analytic talent* such as data scientists who possess some unique skills compared to *traditional* statisticians (see, e.g., Granville (2014)). Depicted in Figure 8 are some of the potential knowledge domains that might be useful for the HKBDT members to possess. Not every team member needs to be an expert in all of the knowledge domains. However, the team should consider having at least one team member who is an expert in each knowledge domain.

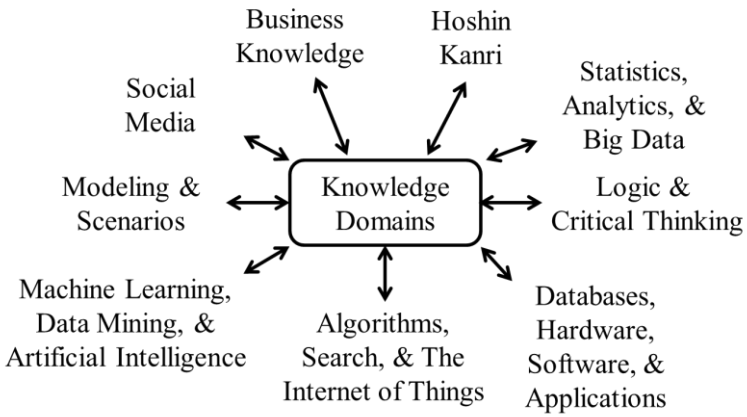

Figure 8. Potential Knowledge Domains for the HKBDT

3.3 Potential HKBDT Responsibilities

The HKBDT could potentially have many responsibilities during the development of policies in hoshin kanri (and during the other steps of hoshin kanri):

- Provide decision support to the CEO and Leadership Team
- Help develop, implement, and manage the big data ICT infrastructure
- Analyze and synthesize big data using the 7 Big Data Tools
- Train and educate employees on the 7 Big Data Tools
- Help streamline big data decision-making processes for decision flexibility
- Help develop, implement, and manage big data risk analysis processes
- Oversee the management of the big data warehouse and data base management system
- Coordinate big data decision-making, catchball, and other policy development activities

There is a risk if one department dominates the HKBDT and/or if a department is not represented on the big data team. It will be important for the HKBDT to have a *system view* of the organization when carrying out its responsibilities versus a specific *departmental view* (see, e.g., Deming (1986)).

4 Future Directions

4.1 Future Research

Big data in hoshin kanri is in the *concept stage* and so there is much research that needs to be conducted. This paper explored the use of big data during the *Develop Policies* Step of hoshin kanri. Case study research could be conducted to study this phenomenon of interest and the use of big data in the other major steps of the hoshin kanri process such as the *Conduct CEO Annual Diagnosis* Step, *Deploy Policies* Step, and *Implement Action Plans* Step. Deming Prize winners with strong ICT capabilities would be good candidates for the research. Here are some research questions to be answered:

Research Question #1:
What type of ICT infrastructure is necessary to store and process the massive volume of big data that will be used during the development of policies in hoshin kanri?

Research Question #2:
What are the most valuable tools that could be used to analyze and synthesize big data during the development of policies in hoshin kanri?

Research Question #3:
How can organizations streamline decision-making processes for developing policies in hoshin kanri?

Research Question #4:
How can organizations reduce the risks associated with using big data in the development of policies in hoshin kanri?

Research Question #5:
What are the most important responsibilities that a HKBDT should have during the development of policies in hoshin kanri?

4.2 Future Organizational Practices

Organizations can start to experiment with big data in hoshin kanri by using big data in one or more steps of the hoshin kanri process. Again, Deming Prize winners with strong ICT capabilities would be good candidates for this type of experimentation. It might be useful for an organization with multiple business units to try different combinations of the major factors such as HKBDT composition; ICT infrastructure; tools used; and others. Such an organization who is willing to experiment could create a big data hoshin kanri roadmap and then use the PDCA cycle to continuously improve year-after-year.

The four earlier suggestions related to the Four V big data features plus the suggestion to form the HKBDT would be a good place to start for designing the *"big data in hoshin kanri*" experiment:

(1) Develop the big data ICT infrastructure for hoshin kanri.	ICT Infrastructure
(2) Expand the current TQM tool boxes for big data in hoshin kanri.	Big Data Tools
(3) Streamline big data decision-making processes in hoshin kanri.	Decision Flexibility
(4) Develop and implement big data risk analysis processes in hoshin kanri.	Data Risk
(5) Form the HKBDT and start to experiment using the PDCA cycle.	HKBDT

4.3 Vision 2030

What might be possible with the use of big data in hoshin kanri in 2030? There will continue to be advances between now and 2030 in ICT components such as data storage, data processing, mobile devices, cloud computing, artificial intelligence, machine learning, algorithms, sensors, and social media to name a few. Some companies to watch might be the robotics company Fanuc which is headquartered in Japan. Fanuc is in the process of connecting its robots throughout the world according to Inagaki (2016): "With more than 400,000 of its robots already reigning on the world's factory floors, Fanuc has a new goal for the digital era: connecting the brains of industrial robots." Komatsu deserves continued attention as it continues to develop its KOMTRAX system which was mentioned earlier (Asada (2014)). McLaren (Higginbotham (2015)) is at the forefront of applying big data analytics to Formula 1 racing. IBM—with its Watson supercomputer—is a global leader in big data analytics and cognitive computing (see, e.g., Kelly and Ham (2013)). Toyota is in an ideal position to use big data in hoshin kanri because it has a long successful history of TQM and it continues to invest heavily in the application of technology in its vehicles. Finally, Major League Baseball is an interesting industry to observe because it is one of the most advanced industries in the use of big data (see, e.g., Sawchik (2015)).

The future is hard to predict, but we will no doubt be amazed at the advances in ICT, big data, and hoshin kanri when we perform our hansei in 2030. Let's start to prepare for the future—now.

Acknowledgements

I would like to thank Dr. Hiroshi Osada, Professor at Bunkyo University and Professor Emeritus of Tokyo Institute of Technology, for introducing me to the Strategic Management By Policy process and for encouraging me to explore analytics and big data.

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