



BizOps for Digital Transformation in Industries

An Industrial Internet Consortium Whitepaper

Chaisung Lim (Korea Industry 4.0 Association/Konkuk Univ.), Kai Hackbarth (Bosch.IO),
Kordel Kim Isabel (Bosch.IO), Gwihyeon Seo (Korea Industry 4.0 Association),
Jeff McCann (Dell Technologies).

TABLE OF CONTENTS

- 1 Introduction..... 3**
- 2 BDXI Process and IIC..... 4**
- 3 BDXI Process and IIoT SOs and SPs..... 5**
- 4 What is BizOps for BDXI?..... 5**
- 5 Common Features of BDXI Process 6**
- 6 Variants of BDXI Processes 10**
- 7 BDXI Examples 11**
- 8 The Benefit of BDXI Identified from a BDXI Case 13**
- 9 Relevance of BDXI with IIC Testbed Results Report 14**
- 10 Process Conflicts with Management Systems..... 15**
- 11 Relevance with BSIF 16**
- 12 BDXI Process and Digital Transformation 17**
- 13 Initiatives to Help Guide BDXI Processes 18**
- 14 Conclusion and Outlook 19**
- 15 Bibliographical References 20**
- 16 Authors and Legal Notice 21**

1 INTRODUCTION

This whitepaper discusses innovation processes for Industrial Internet of Things (IIoT) solutions¹ that integrate *information technology* (IT) and *operating technology* (OT) in the IIoT solution operator undergoing digital transformation. The IIoT solution operator (henceforth “SO” or “operator”) is a firm that deploys and operates IIoT solutions found mostly in asset-intensive industries such as manufacturing, smart city, health care, agriculture, energy, transportation and retail. The firm is a customer of an IIoT solution provider (henceforth “SP” or “provider”).

This paper:

- examines reasons why SOs, especially those undergoing digital transformation (DX), need such an innovation process, called the “BizOps for Digital Transformation in Industry (BDXI)” process and
- advocates that the BDXI process should be powered by a BDXI framework that helps to manage the innovation process from idea to launch.

BDXI process is an innovation process integrating IT and OT in SOs undergoing DX in products, operational processes and business model innovation. Due to increasingly fast technical changes enabling DX, the SOs undergoing DX face the challenge of fast innovation in which “test fast, learn fast, scale fast” matters (Kane et al. 2019). In innovation, experimentation lies at the core of innovation process (Thomke; Von Hippel; Franke, 1998; Thomke, 2003). BDXI process is a fast, open and customer-centric innovation, given the constraints and complexity of IT/OT integration and constraints of the physical world. The physical world is not as malleable as the software world. It is difficult to connect IT and OT systems without intensive effort and investment.

BDXI framework is an innovation framework—an explicitly described framework that offers a guide to a reader to implement BDXI process concretely.

This whitepaper:

- defines commonly appearing features of BDXI processes of firms, of creation of solutions achieved by integrating OT and IT,
- identifies examples of BDXI process and BDXI framework driving the process,
- identifies conflicts of BDXI processes with management systems and
- discusses the relevance of the BDXI process with other IIC documents, such as the *Testbed Results Report* (Durand and Lim 2020), *Business Strategy and Innovation Framework*

¹ Solutions that feature physical-digital boundaries and where OT domain knowledge is relevant to physical devices and processes

(Morrish et al. 2016) and *Digital Transformation in Industry White Paper* (Morrish and Zarkout [Ed.] 2020)

Finally, the paper proposes several IIC initiatives to help guide BD XI processes.

The target industries for application of the BD XI process are smart cities (societal infrastructure, including roads and buildings), manufacturing, agriculture, retail and logistics, transportation, health care and energy.

Examples of relevant organizations or departments applying the BD XI process would be the IT department, working together with the domain-specific project team, customer experience data collection department, product and service sales department, department of planning for digital strategy and business model, or the smart products and services development department.

2 BD XI PROCESS AND IIC

This section discusses the impact of BD XI process on IIC member organizations, namely SOs and SPs.

The mission of the IIC is “To deliver transformative business value to organizations, industry and society by accelerating adoption of a trustworthy internet of things”. Transformative business value can be achieved by SOs through a successful innovation process focused on integration of IT and OT domains.

For SOs undergoing digital transformation, successful implementation of innovation processes integrating IT and OT domains is crucial. A good way to empower this change and manage the quality of innovation is through well-established innovation processes, integrating IT and OT, which can be driven by an innovation framework.

Managing quality of production is crucially important for competitiveness. To build competitive production processes, organizations have deployed frameworks for managing quality of production, Six Sigma being the most popular example (Zhang et al. 2009) with most *Fortune 500* companies having adopted Six Sigma (Goh, 2002).

Managing quality of innovation is becoming increasingly important for competitiveness. To build competitive innovation processes, organizations need to have frameworks for managing quality of innovation. FastWorks is a typical example of such an innovation framework, developed and deployed by General Electric for changing in-house innovation processes (General Electric 2015, Merfeld 2014, Power 2014, Ulrich 2020). The framework is publicly available, but its details are not published. It also requires customization to adapt it to the needs of various organizations.

3 BDXI PROCESS AND IIOT SOs AND SPs

SOs, who operate mostly with industrial goods and services, need to adopt an innovation process to integrate IT and OT. SOs' dominant innovation process is likely to be OT-focused, implemented by OT workers with hardware-focused engineering knowledge. Because of the rising share of IIoT technology, the operators need to integrate OT with IT. The existing process focused on OT would be a slow and closed process, not allowing fast and open integration of IT. In innovation, SOs could emulate currently popular innovation frameworks of the IT firms.

SOs face problems in the application of best practices of innovation frameworks of IT firms because of the complexity of the innovation process of integrating IT and OT and the constraints of the physical world in which they operate. Software in IT world can be created and tested quickly, at low cost, but integrating IT and OT takes more time to test. SOs are likely to have organizational structures emphasizing hierarchy. The structure aims at perfect quality. They tend to be slow innovators, and slow to experiment with prototypes of imperfect quality. They may produce a wrong offering due to the lack of feedback of customers on prototypes of intended solutions because they prefer to show an offering when the design is perfectly created and tested.

If the SO's innovation process can be clearly defined, SPs would avoid possible mistakes caused by a misunderstanding of the process of their customers (SOs).

4 WHAT IS BIZOPS FOR BDXI?

In BizOps for Digital Transformation in Industries (BDXI), BizOps means "BizDevOps" integrating IT and OT, applicable to innovation of business models, products and operation processes.

The meaning of "Industries" in BDXI is SO industries where integration of IT and OT matters in creating innovative outcomes in business models, products and operation processes innovation: smart city, manufacturing, agriculture, retail and logistics, transportation, health care and energy industries. Therefore, the full meaning of BizOps for Digital Transformation in Industries is "BizDevOps of integrating IT and OT, applicable to innovation of business models, products and operation processes, for digital transformation in IIoT operator industries."

The BDXI can be the one similar to DevOps in Figure 1 by Porter and Heppelman (2015). DevOps integrates IT, research and development and operations. For an SO, the product development process should go beyond DevOps for IT development and integrate IT and OT. DevOps needs to be more tightly integrated with business than before because smart products tend to be linked with a new business model.

So far, BizDevOps has been an approach to software development that encourages developers, operations staff and business teams to work together so that the organization can develop

software more quickly, be more responsive to user demand and ultimately maximize revenue. This approach can be applied to the IIoT operator industry undergoing digital transformation.

Development work should be carried out by close cooperation between a collocated team of developers, operations staff and business teams. However, SOs find that insights from existing BizDevOps are insufficient to integrate IT and OT. BizDevOps should include participation of OT engineers, hardware developers, hardware operation staff and hardware business teams too. We think it is necessary to make BD XI as a kind of BizDevOps extended to apply to innovation activities of integrating IT and OT.

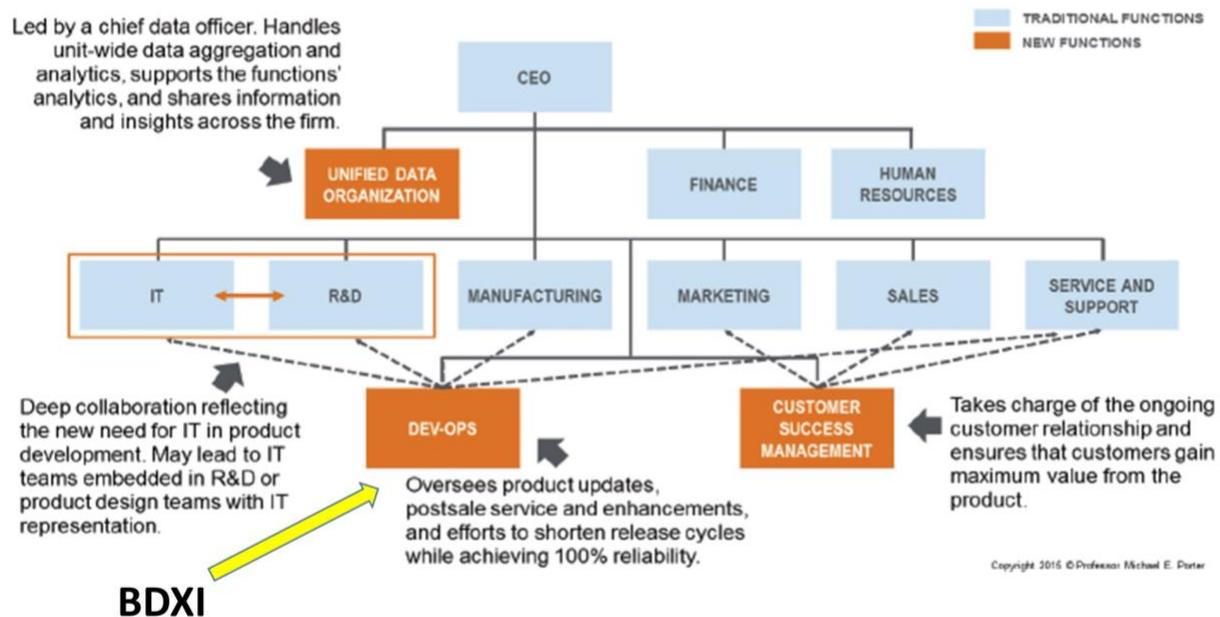


Figure 1: BD XI position in a smart connected product producer firm
 Source: Porter and Heppelman (2015) modified

5 COMMON FEATURES OF BD XI PROCESS

Even though firms have different needs regarding their innovation processes, common features of BD XI processes of firms can be identified. The clearest and commonest feature is selective adoption of best innovation practices from design thinking, lean start-up and agile methods, and BizDevOps approach.

The following process in Figure 2 is an example BD XI process sharing some common features of the BD XI processes that can be found in firms.

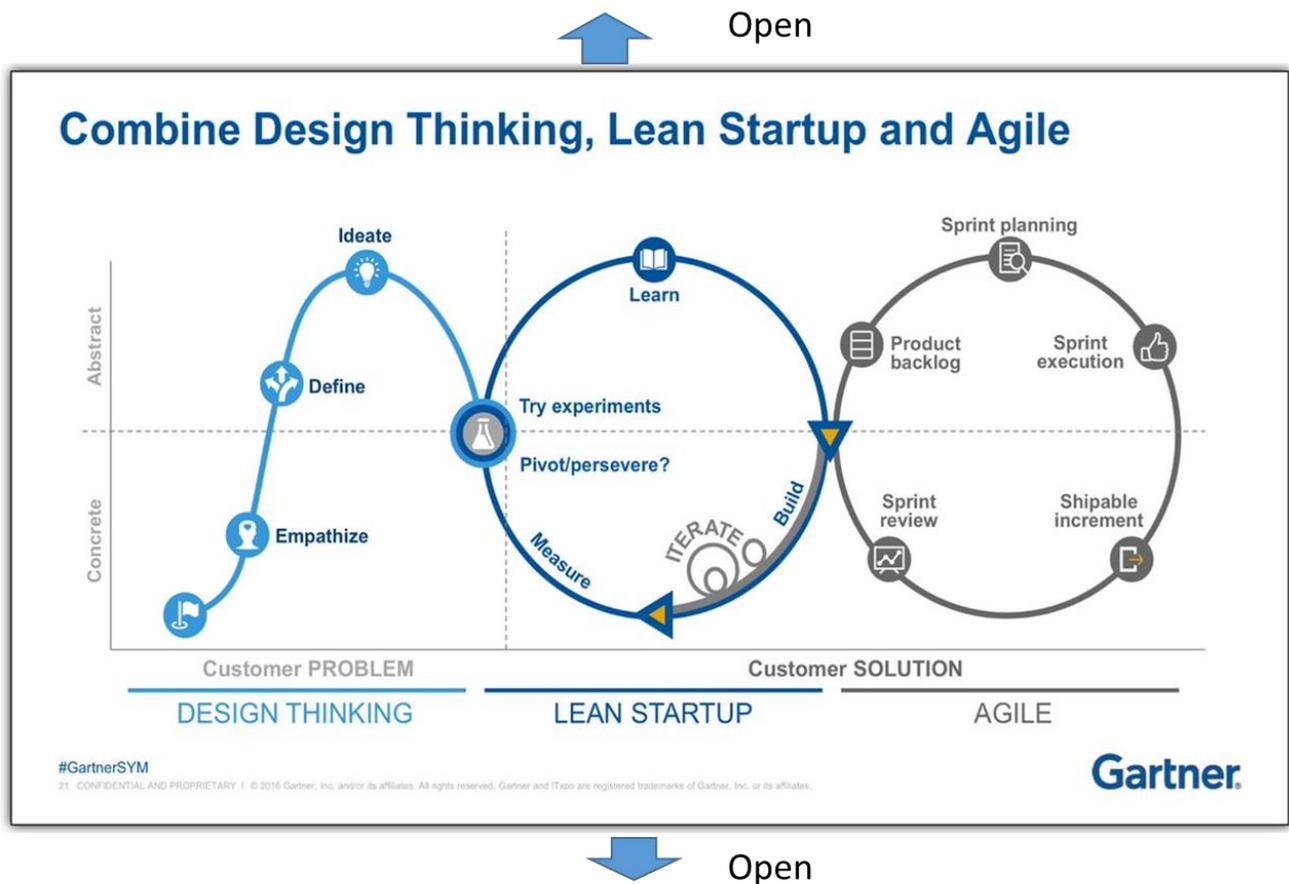


Figure 2: BDXI process integrating design thinking, lean startup and agile development
 Note: Gartner (2016) modified with “open” word added and arrows

The process reflecting design thinking, lean start up and agile approach can be simplified, as shown in Figure 3. The process includes understanding the customer, with empathy on the customer’s life, solution ideation and creating a minimum viable product, testing and learning from validation of a solution from the customer and initiation of the solution into action. This can be summarized as discovering customer needs, developing solutions and learning whether the solutions are feasible and putting them into action.

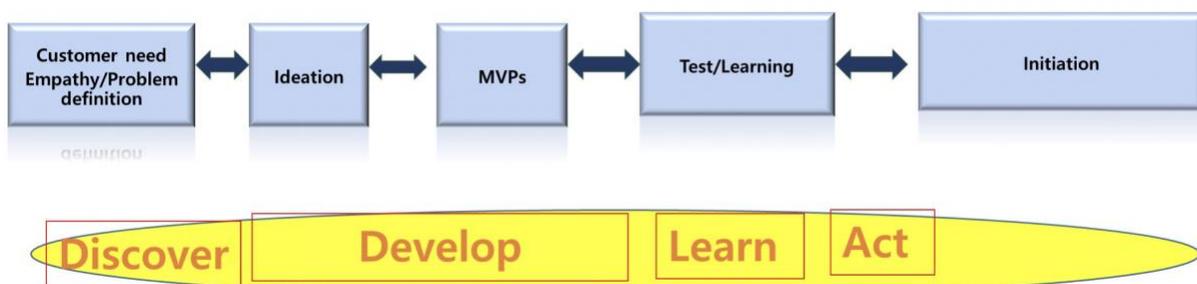


Figure 3: Simplified BDXI process

The second common feature of the BDXI process that can be found among firms undergoing digital transformation is that it is open, encouraging collaboration among different divisions and among different firms, ranging from developers to operations staff and business teams. The BDXI process facilitates dialogue between IT and OT people who would otherwise be constrained by organizational silos. This is a challenge to SOs with the “closed mind set” of asset-intensive industries.

The open process is stimulated by extensive use of IT, leveraging connected things and people, facilitating open access to data or information of partners, customers and suppliers in both IT and OT. To solve low interoperability and high integration complexity of integrating SO’s IT and OT systems, the process of open dialogue among “previously strange” actors matters. With the emergence of an ecosystem in which companies collaborate across vertical and horizontal positions in the value creation, openness matters. The BDXI process addresses the problems of the “closed mind set” typical of hardware-driven organizations.

The third feature of the BDXI process is that it is a customer-centric process, achievable under the constraints of the physical world. First, this customer-centric innovation process is achieved by application of design thinking, lean startup and agile process, respecting customers’ needs or outcome through empathy and frequent feedback of customers. Second, the customer-centric innovation process is achieved by continuous exploration of feasibility of application of new technology in delivering a solution to the customer.

The customer-centric process includes checking the validity of applying new IT and new OT in creating a solution to the target problem of IIoT solution operators, given constraints of the physical world. The customer-centric process of checking the validity is made possible by horizontal communication between IT organization and OT organization (including its interaction with engineering organization) on minimum viable products (MVPs) utilizing new technology.

The fourth feature of the framework is the facilitation of fast innovation processes while accepting constraints of the physical world. This is enabled by fast experimentation with MVPs and other agile methods, such as parallel sprints.

For example, if a data analytic solution provider follows design thinking, lean start up or any other innovation framework, the SP is likely to fail in achieving a customer-centric innovation process. Because even though the SP interacts with the customer through empathy and fast creation of MVPs, the SP would not understand customer needs. Due to the lack of domain knowledge of the data analytics SP, they cannot identify the targeted problem of their customer.

Because the SO does not understand the value of the opportunities offered by the new data analytic technology and cannot decide a target problem to which data analytic technology shall be applied in the OT domain at an early stage, the operator would have difficulty in offering the requirement of the data analytic solution for solving a problem in the OT domain. This means that the operator cannot express what they want to the data analytics SP.

With an SO who "does not know what they want", the SP cannot start the empathy stage of understanding what the SO wants. The provider might have to wait until the SO realizes what the firm wants. This aspect was discussed in the IIC's report on testbed results in *Durand and Lim* (2020) (Section 8 discusses some part of the report.)

The BDXI process should be customer-centric, where the SP, mainly with IT jobs people, comes to understand the OT domain problem and the SO, mainly with OT jobs people, wake up to the opportunities offered by IT technology. SPs must be able to deal with physical world constraints of the SO and help the SO's understanding of IT technology, all while cherishing empathy with the working style of the operator. This will align IT with OT.

The SO, being unable to know "what the firm wants", should study opportunities offered by a new IT. The operator should also experiment with the new technology in exploring the target problem to be applied. When the target problem is decided, the operator offers requirements of the solution with or without interaction with the IT provider.

When creating an IT solution, the operator needs to embrace quick and imperfect deliveries of MVP solutions. The operator needs to find a cost efficient and fast way of testing MVP solutions.

There can be conflict on fast experimentation between IT jobs and OT jobs people. The experimental approach of the IT jobs people world can be applied to a limited extent due to physical world constraints and the lack of cooperation of the OT jobs people. OT jobs people, who prefer the perfectly planned scheme, need to allow more frequent experiments, which are necessary for MVPs.

Over the process, there would be OT alignment towards IT and IT alignment towards OT.

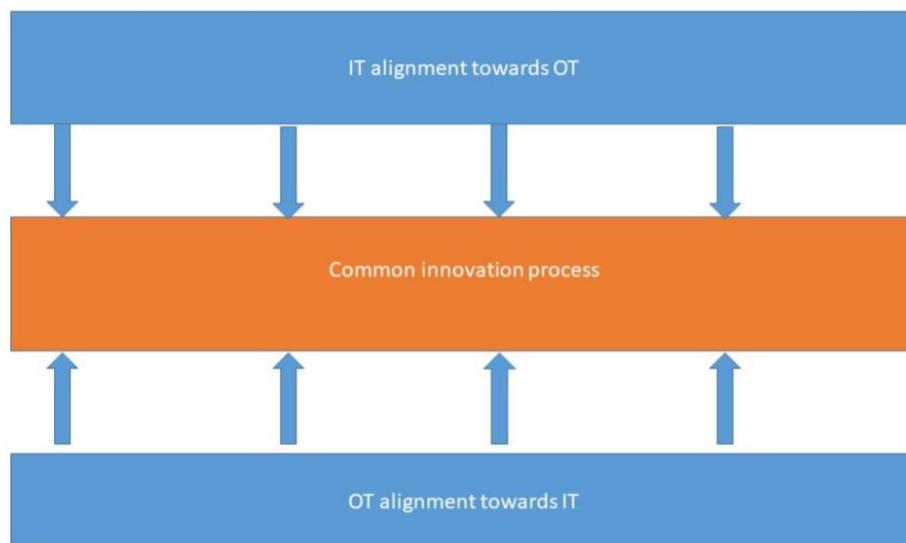


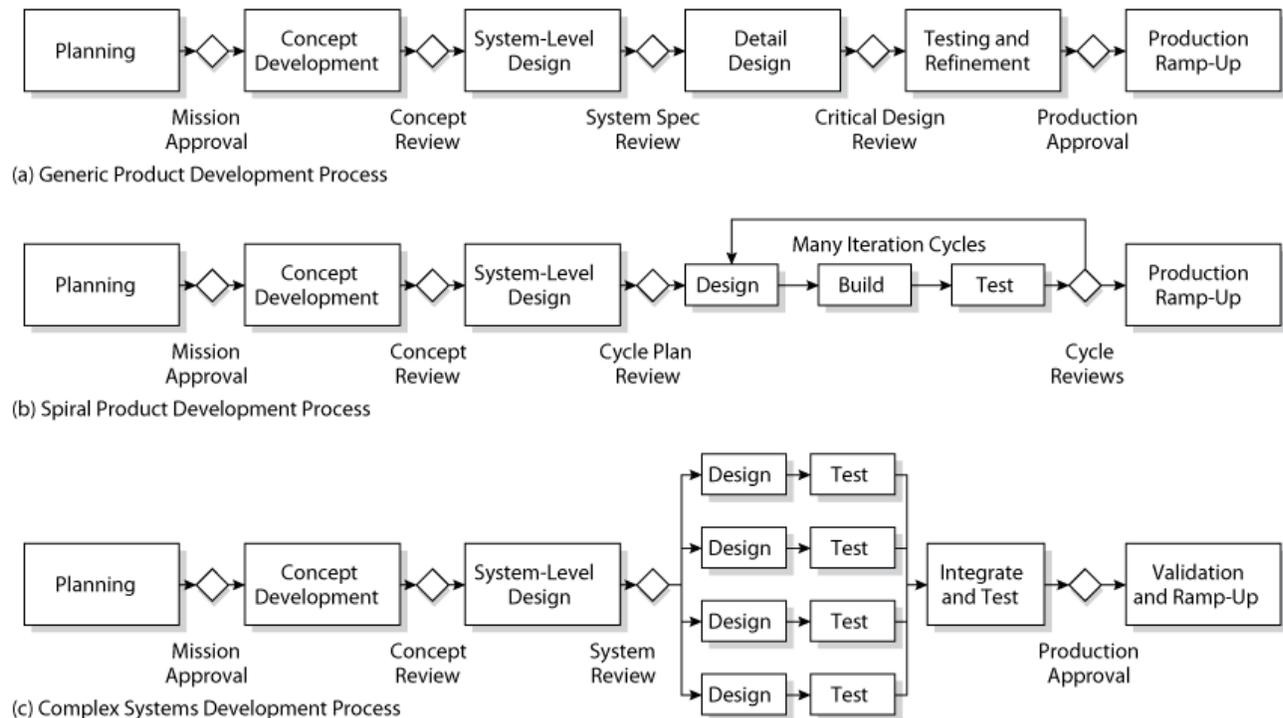
Figure 4: Differentiated feature of BDXI

6 VARIANTS OF BDXI PROCESSES

The BDXI process can be varied, depending on the category of the industry and the size of the firm. Depending on the size and the industry, the process can be complex or simple. In a large firm, a solution can be created by integrating various types of processes, implemented by various teams that are interacting with each other in a complex way. These processes can be varied in accordance with the type of industry.

An SO in the discrete manufacturing industry can have a process different from that of an SO in a continuous manufacturing industry. We can speculate that the BDXI process would be different by looking at examples of the different types of product development processes. The product development process shares some commonality with BDXI process in that it is the process of creating a solution. In Figure 5 from Ulrich and Eppinger (2012), we can see that there are different types of the process. We could see a spiral product development process in the software company while also seeing a complex product development process in the shipbuilding or aircraft manufacturing company.

Because the BDXI process can be different in accordance with the size and the industry of the SO, there can be rich variants of the processes.



From *Product Design and Development* by Karl Ulrich and Steven Eppinger (McGraw-Hill/Irwin)

Figure 5: Various processes of product development

7 BDXI EXAMPLES

GE's FastWorks: The most publicly known case of BDXI framework is GE's FastWorks, which was created through the application of the lean start up principle (Ries 2017). GE's FastWorks is an innovation framework for creating a solution, integrating lean start up, design thinking and agile methods. It reflects GE's tradition of making its own framework by integrating world best practices and knowledge on management and engineering. Six Sigma, adopted by GE, is one of the examples of the frameworks inheriting the tradition.

FastWorks' process starts from understanding customer needs with empathy, creating a potential solution, checking leaps of faith (assumptions of potential solution design), creating MVPs for verifying high priority assumptions identified in "leaps of faith" process and making "learning metrics" from recorded feedback of customers. After a review of learning metrics created from the fast feedback of customers, "pivot" or "persevere" is decided. Persevere means continued iteration based on existing product or production process ideas. You pivot when you realize that your initial idea is wrong, so you change and iterate from there.

The publicly available information on FastWorks shows some examples of the process of integrating IT and OT, such as paired programming and design thinking workshops, inviting staff from both IT and OT jobs.

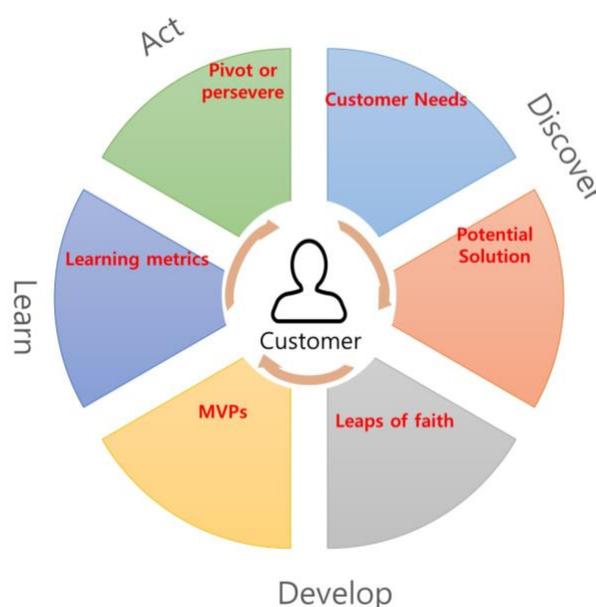


Figure 6: Fastworks of GE as an example

Bosch BDXI case: The "MVP as a service" can be regarded as a BDXI framework. Bosch regards the classic approach of product development of new IoT solutions as not promising for success.

As markets are moving fast, development must be adapted to the uncertain, volatile environment in which companies act.

Bosch's MVP as a service approaches new solution development with an elaborated process that considers user, business and technology aspects from the beginning. Assumptions are made transparent and validated, and the solution is tested with the customer early on, iteratively. This minimizes the risk of not meeting the market and user needs when launching the new solution. As the driver for innovation in new IoT solutions is more the technology push rather than the market pull, an iterative integration of market and user feedback is crucial for market success.

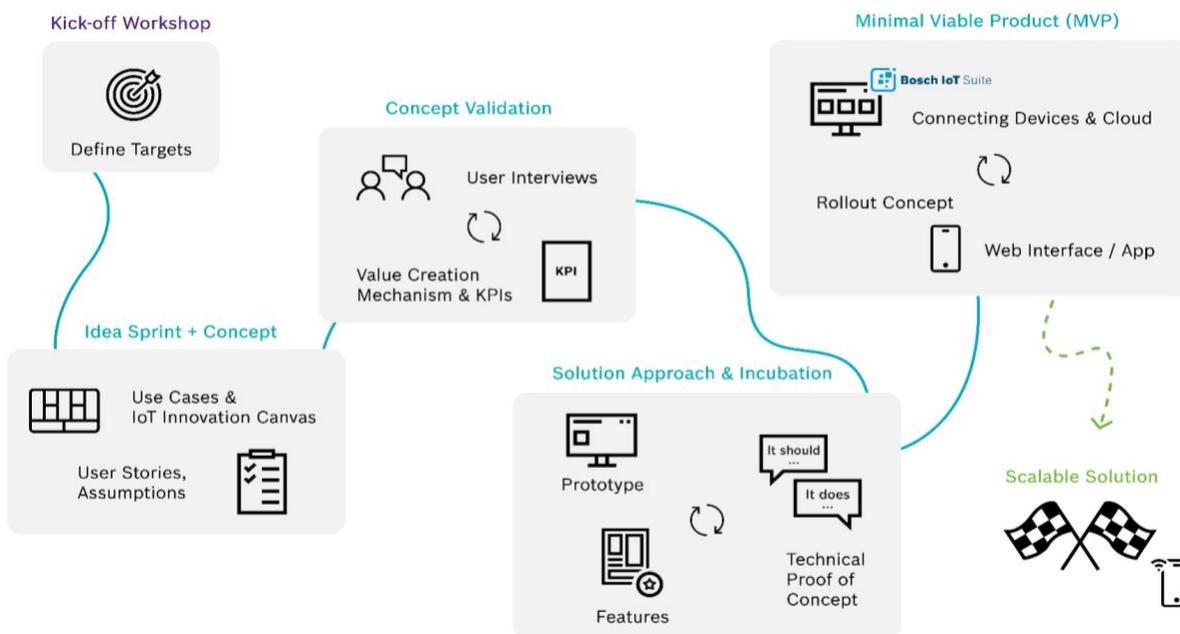


Figure 7: Process of building MVPs

After clarifying terms, goals, timelines and outcomes of the development process, design thinking, UX methods, and IoT-specific ideation frameworks, are used for a first ideation of the concept. This is then transformed into a format that can be validated systematically. First, use cases, and addressed problems are identified and a validation plan is set-up. During validation, customer feedback is key to getting quick and efficient iterations. Using lean startup methods, key metrics are developed, and the concept is tested and measured. Low fidelity prototypes are essential to making the solution feasible for testing.

During the validation phase, customer feedback is integrated back into the solution where the testing and measuring begins again. At this point, it is crucial to embrace changes and be open to iterate at any time. The solution is iterated until the assumptions regarding user needs (desirability), technical requirements (feasibility) and business potential (viability) of the solution

are validated. Initiation before validation of business, user and technological assumptions, leads to failure.

Overdone testing and validation can lead to failure too. In OT, fast testing and 80/20 approaches are uncommon. It needs to be clarified from the beginning that fast progress is more important than validating all assumptions.

In the solution incubation phase, the first problem/solution fit is already validated. Prototypes of higher fidelity are then used to continue the testing so that relevant features can be identified that meet the user needs and the customer's willingness to pay. This is done to identify the elements an MVP should contain, staying lean on the cost side but also solving a customer problem. The MVP can check some of the feasibility of the conceptual design, but it does not check all the technical feasibility of the conceptual design.

Reaching the MVP phase, the technical solution, prototype and business concept are transformed into a product that can already be used and bought, but that contains only the minimum functionalities for solving a customer problem. Device and data center decisions are made, and a rollout concept is elaborated. The interface is finalized for usage.

The next step is to scale the solution with extended functionalities and additional target groups.

Overall, the described IoT solution development approach is elaborated to fit the development of innovative new solutions with a high uncertainty and risk. Experience shows that starting with an MVP instead of a scaling concept at the beginning is the most promising way to become economically successful with the solution. The MVP process works efficiently for aligning business, technical and user aspects, with the different mindsets from IT and OT perspectives.

8 THE BENEFIT OF BDXI IDENTIFIED FROM A BDXI CASE

BDXI can produce better outcomes for customers because of a rigorous process. The FastWorks teams could have spent a lot of time on customer discovery or they could decide on the basis of customer validation data with rapidly learning cycles. They could rely on the main stakeholders of a project with horizontal relationships, rather than hierarchical decision making that could slow down the pace of an innovation project. It would also have shorter product cycles with quicker IT implementation and faster customer responses.

For example, in the new NovaLT16 turbine, the development period was reduced to 30 months from five years (General Electric 2015). In the case of diesel engine development, the development period was reduced from five years to two years. The engine to be developed was a large multi-platform engine, which could operate in various situation, with 20 ~ 30% energy efficiency. The initial engine, MVP, was developed for a sub-market of the multi-platform engine market, stationary power generator market. It was created through simple technology forecast and minor improvement of an existing engine less than six months and sold to a customer. GE

could create the engine for the multi-platform engine market through creating subsequent MVPs and making improvements of the MVPs by reflecting feedbacks from customers (Ries 2017, 147-152).

9 RELEVANCE OF BDXI WITH IIC TESTBED RESULTS REPORT

The testbed results suggest that using the BDXI process, respecting physical world constraints of a solution operator is to be preferred. Following an initial phase process of design thinking or lean start up process and emphasizing empathy with the customer would not result in a fruitful outcome. With a lack of domain knowledge of the IIoT solution operator, the solution provider cannot identify the targeted problem of their customer, even though the solution provider has a deep empathy for the customer.

Durand and Lim (2020) discusses the preparation phase, an initial stage of BDXI process. In the preparation stage, an SP should allow time till the SO is prepared to interact with the SP. The report shows that the SO needs time to study the technology that a solution provider intends to offer and to be able to identify a target problem. The SO gradually wakes up to opportunities of new technology in the preparation stage. Some operators undergo the preparation phase by interacting with the SP and studying the technology. They are initially passive without knowledge of the technology, according to the report.

The target problem cannot be identified without trials and errors because of the complexity of integrating IT and OT under constraints of the physical world of the operator. Defining the target problem also requires time. In the urban water supply testbed, despite the SO's engagement in the development of the testbed, the wrong target was chosen. Later, they realized that visibility should have been the target because providing visibility to remote assets offers substantial value.

The "Infinite Testbed" was intended to validate the concept of an IoT platform as opposed to a business challenge in a specific domain. Initial conversations were exclusively technical. Later, business benefits were identified, and organizational transformation required for IIoT begun to be discussed. Definition of business benefits needed timing. This implies that there should be a period allowing an operator to study and explore the possibilities of new technology as the provider waits for operators' response in setting up operational objectives or business benefits. The report shows that operators are not always able to formulate their requirements upfront. They need time and constant collaboration, readjustment and discussion with providers.

If the SP follows the traditional model of design thinking or lean start up, they are likely to fail to understand what the operator wants.

10 PROCESS CONFLICTS WITH MANAGEMENT SYSTEMS

Because the BDXI process for integrating IT and OT is new, the BDXI process is likely to conflict with existing processes and the management system. These need to be identified and removed.

For example, organizational incentives and structures can be in conflict with the rapid experimentation process of BDXI. After the training of engineers on FastWorks, when asked of their intention, engineers responded that they did not want to implement the FastWorks process.

Implementing FastWorks means generating more prototypes and improvement upon them for engineers. According to GE's management system, creating many prototypes and carrying out many "reworks", get negative evaluations for engineers (Ries 2017). This means that FastWorks conflicts with their human resource evaluation system.

Fast iteration of FastWork cycles allows for pivots, meaning an increased number of projects stopped or changed due to the change of goals or projects. This conflicts with GE's funding system that has fixed targets, fixed amounts and annual budget system (Ries 2017).

BDXI performance can be positively influenced by resolving conflicts, as shown in Figure 8.

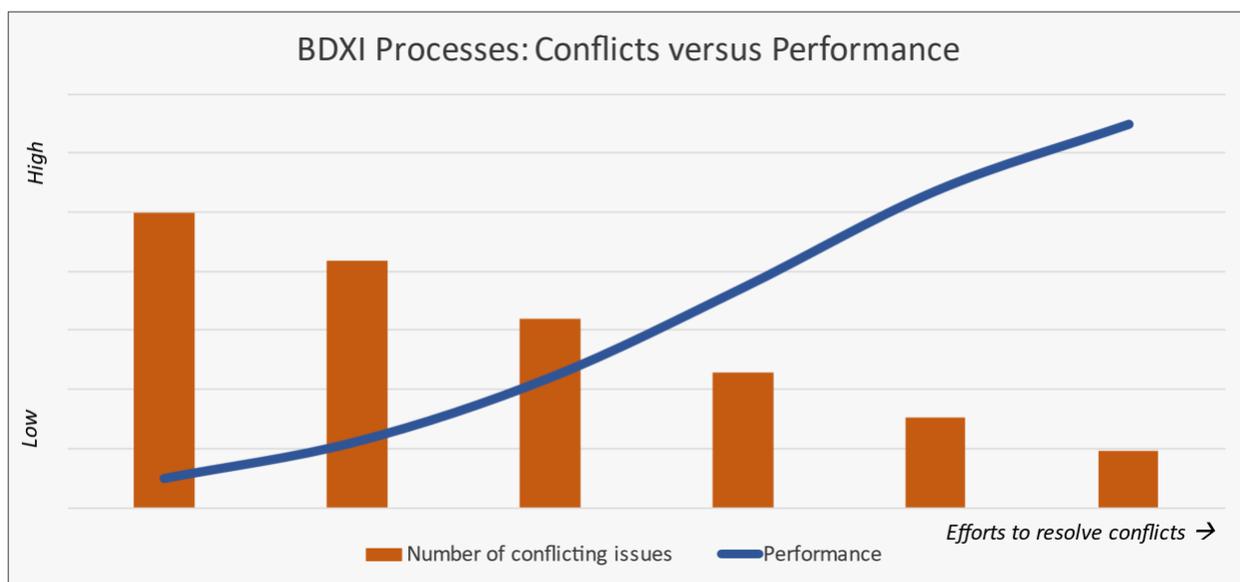


Figure 8: BDXI Processes: Conflicts versus Performance

So, GE realized the conflicts and GE's management system was gradually changed to resolve the conflicts. The FastWorks evolved from FastWorks 1.0 to FastWorks 2.0 and FastWorks 3.0. Fast works 2.0 and 3.0 were made possible with changes of the management system (Goldstein 2016).

Changes of the management system are made possible by the changes of a firm's strategy. All the application of BDXI processes and identification of conflicts and solution of conflicts by

changing management system can be made possible by a strategy that can be achieved with the following mind sets. First, a digital mindset integrating IT and OT while continuously experimenting with new IT and OT technology and second, a customer-centric mindset to find innovation processes that can be achieved with fast experimentation and open collaboration.

Considering that IIC member firms would face ample cases of conflicts of the BDXI process with their management system, information on the cases of other firms would be useful. IIC could offer a space for sharing cases of the conflicts. The cases shared could be a good resource for a firm with possible conflicts of BDXI processes with their management system.

To help IIoT solution operators, IIC needs to offer a space to share information on BDXI process or BDXI framework and common features of the BDXI process or BDXI frameworks. The space would be useful for the IIoT solution providers. Because solution providers' solution's deployment is linked to the operators' innovation process, the providers need to understand the operators' innovation process as they interact with their customers.

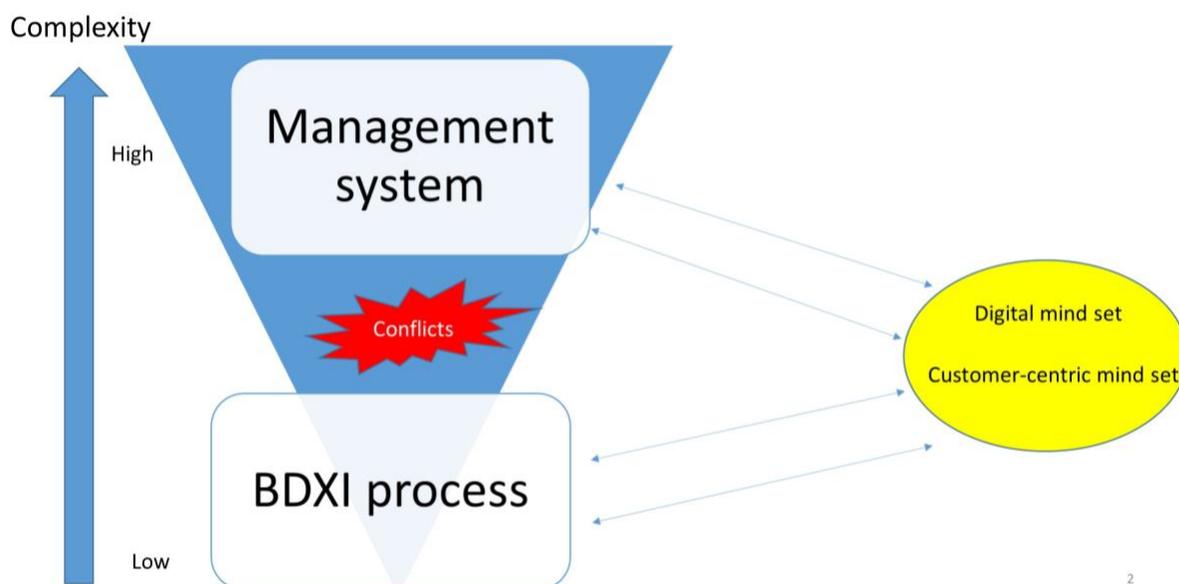


Figure 9: Management System and BDXI

11 RELEVANCE WITH BSIF

The Business Strategy and Innovation Framework (BSIF) (Morrish et al. 2016) is a framework for IIoT business model innovation. Even though BSIF discusses integration of OT and IT, the complex process of innovation has not been discussed in detail.

This business model can be made possible with product innovation and production process innovation. The example of a product innovation could be a smart connected air compressor

enabling a firm to offer a “pay per use” business model. The example of production process innovation would be smart manufacturing process innovation, using IIoT, enabling a firm to shift a mass customized production business model to a mass personalized production business model.

The BSIF has a process called ideation, preparation, evaluation and the initiation for IIoT business model innovation. BD XI offers a framework for dealing with detailed complex processes of IT/OT business model innovation, product innovation or manufacturing innovation.

BDXI makes the iterative approach of the BSIF more specific. In the case of IIoT strategy, strategic planning can include using elements of BD XI from the beginning, such as reviewing empathy level and formulating everything in user stories or planning with backlogs (taken from the agile aspects of the BD XI). From this approach, an experience oriented or outcome-based business model innovation strategy can be set up. With this approach possible, offering the link, which can be easily missed, between strategy and implementation can be created.

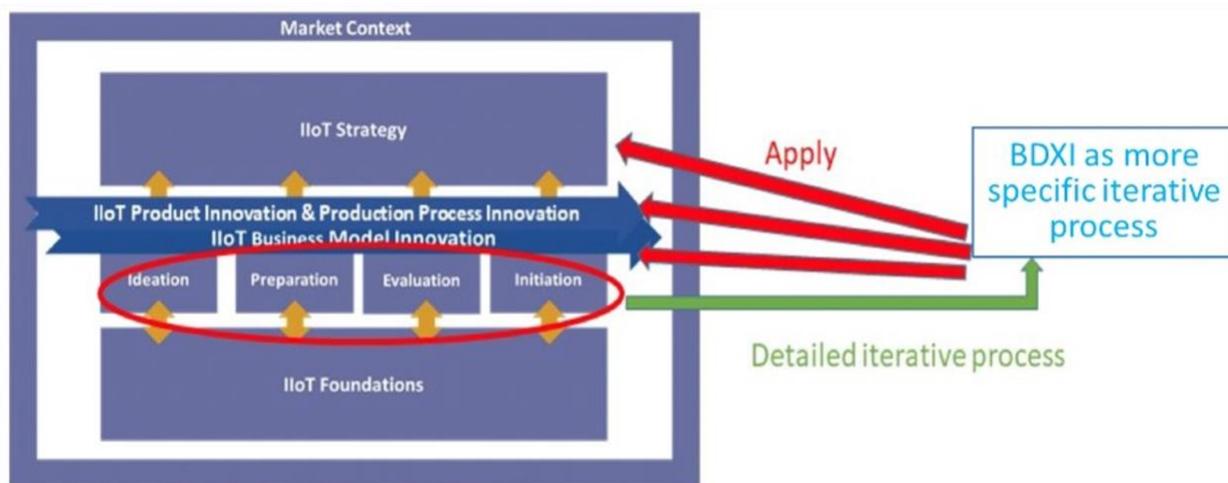


Figure 10: Business Strategy Innovation Framework and BD XI
 Source: Morrish et al. (2016) modified

12 BD XI PROCESS AND DIGITAL TRANSFORMATION

BD XI process can be a part of the processes of the business factor of (industrial) digital transformation of a diagram of Digital Transformation Work Group of IIC.

The BD XI process can be a new innovation process, integrating IT and OT for the firms undergoing industrial digital transformation, in which firms leveraging connected things transform processes and operations to produce better outcomes, following the definition of *Digital Transformation in Industry* (Morrish and Zarkout [Ed.] 2020). The process is argued to be different from the existing process of the firm.

The literature on digital transformation regards MVP and fast feedback from customers as essential elements digital transformation. You can find discussions similar to the following sentences in the literature:

- “Instead of taking the traditional, linear approach to rolling out new initiatives, companies should quickly bring new ideas to market, gather customer feedback, and refine the concept iteratively. Many accomplish this by means of the minimum viable product (MVP) process of prototyping” (Fæste; Scherer; Gumsheimer, 2015),
- “Innovate by fast experimentation (divergent experimentation, convergent experimentation, MVP, paths to scaling up” (Rogers 2016, 11),
- “test fast, learn fast, scale fast” (Kane; Philips; Copulsky; Andrus, 2019). Because of the differentiated features of the BDXI process, they are likely to conflict with the management system.

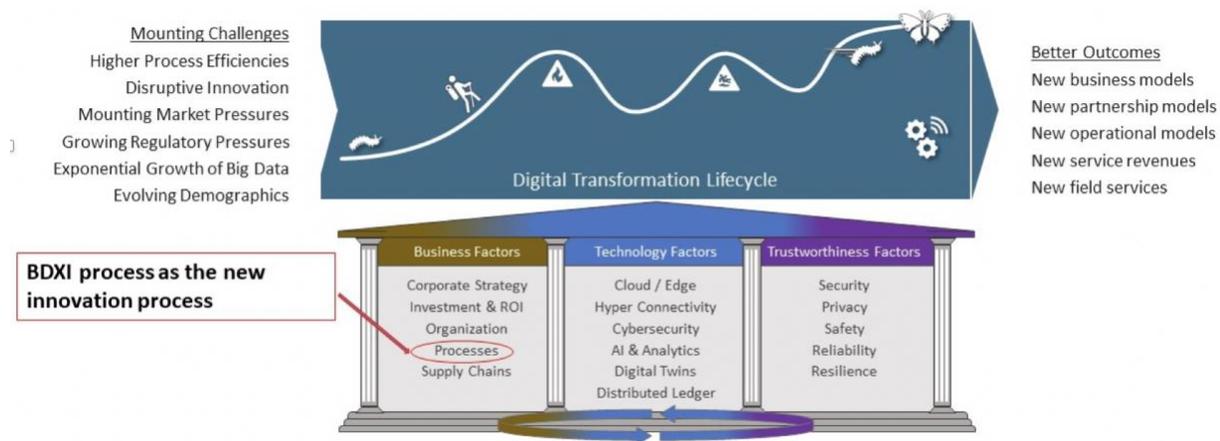


Figure 11: BDXI and digital transformation
 Source: Morrish and Zarkout (Ed.) (2020) modified

Successful performance of the BDXI process can be reached through elimination of conflicts of the process with the management system. Therefore, one could argue that there can be progress in digital transformation of a firm through changes of the management systems, solving the conflicts. If you look at a case of GE, GE had this kind of phase change through resolving conflicts of FastWorks with their management system (Goldstein 2016).

13 INITIATIVES TO HELP GUIDE BDXI PROCESSES

In the future, we shall focus on activities for sharing insights and practices of the BDXI process over the industrial digital transformation and offering documents (such as frameworks for reports) for facilitating sharing insights and practices of BDXI processes.

Every firm wants to have information on other companies' BD XI cases as benchmarking efforts, but no firm wants to reveal it. IIC can offer an open space for sharing insights and the cases of member firms. The possible activities for sharing insights and cases are the following:

- presentation of a BD XI tool or BD XI processes by IIoT solution operators leading BD XI best practices such as GE and Bosch,
- presentation of the SP's best practices in supporting the SO's BD XI process. SPsrs could publicize their best practices, while introducing SO using the solution,
- presentation of an idea of improving speculated designs or some features of the BD XI tool by a member. The member can offer an idea of improving the BD XI tool for gaining reputation of ones' own expertise on the BD XI tool,
- discussion on the IIC's *community forum* on sharing insights or introducing cases of BD XI,
- presentation of BD XI simulation software by an SP. The software could reflect the best practices of BD XI and advance practices of BD XI. This can be made possible by cooperation with a software supplier firm who would be interested in making the software,
- revision of this white paper summarizing the presentation of members and the insights and cases shared over the community forum,
- a framework paper for BD XI or audit of BD XI that shall reflect the best practices,
- standards requirements for innovation management, such as ISO 56000 and
- a workshop for sharing accumulated cases and insights of BD XI and sharing cases of the conflicts of BD XI with management system.

14 CONCLUSION AND OUTLOOK

This paper identified a BD XI process as a new innovation process for integrating IT and OT of a firm undergoing digital transformation.

This paper was prepared to suggest that SOs need to adopt new innovation process integrating IT and OT to achieve a better outcome. The currently available innovation frameworks, such as design thinking and lean startups, which have been used widely among the software firms, are likely to be adopted as innovation frameworks driving the new innovation process.

These framework-driven processes would have problems because the environment for the SO's innovation process is different from the software firms. While SO's operate mostly with industrial goods and services, the software firms operate mostly with software, devices, infrastructures and services. The innovation process of the SO and integrating IT and OT is more complex than the process of integrating IT only.

The SOs should create their own innovation processes suitable for the complexity of integrating IT and OT and for the constraints of the physical world. The BD XI process is a fast, open and customer-centric process, reflecting the features of design thinking, lean start up, agile

development methods, BizDevOps, given the constraints of complexity of integrating IT and OT and physical world constraints. Over the process there will be OT alignment towards IT, and IT alignment towards OT. The new process can be settled by creation and diffusion of the BD XI process, which could be driven by BD XI frameworks, and resolving conflicts of the BD XI process with existing processes and with organizational structure and others of IIoT solution operators.

The paper has been confined to defining the BD XI process and discussing how IIC can support SO's efforts to settle the new innovation process that are crucial for digital transformation. The new innovation process of the digital transformation is a huge topic influencing almost every department of a firm.

The topic of the future works would be clarifying common and variant features of BD XI process among different groups of IIoT SOs. There should be further studies on examples of personas of BD XI and BD XI processes and personas of various firms undergoing digital transformation with implementation of BD XI processes in different industries.

Further topics include further discussion on the influence of organizational incentives and structures on the innovation processes through collecting cases of conflicts between the process and the organizational incentives and structures, and the role of several departments, innovation project teams, workshop group and roles of CEO, CDO and CIO affected and influencing the process.

15 BIBLIOGRAPHICAL REFERENCES

Durand, and C. Lim (2020) *A Compilation of Testbed Results: Toward Best Practices for Developing and Deploying IIoT Solutions*, Industrial Internet Consortium (IIC): Boston.

Fæste, L.; Scherer, M.; Gumsheimer, T. (2015) *How to Jump-Start a Digital Transformation*, 25 November 2020.

General Electric (2015) GE Report, General Electric: Boston.

Goh, T. N. (2002). *A Strategic Assessment of Six Sigma, Quality and Reliability Engineering International*, 18(5): 403-410.

Goldstein, V. (2016) *How to Grow New - Lean Startup Week 2016*, Nov11, 2016, accessed on 17 July 2019.

Kane, G. C.; Philips, A.; Copulsky, J.; Andrus, G. (2019) *The Technology Fallacy*. The MIT Press: Cambridge, Massachusetts.

Merfeld, D. (2014) *GE is in a Startup State of Mind*. *Research-Technology Management* 57(6): 26–32.

Morrish, J., Figueredo, K., Haldeman S. and Veronika Brandt (2016) *The Industrial Internet of Things, Volume B01: Business Strategy and Innovation Framework*, Industrial Internet Consortium (IIC): Boston

Morrish, J., Zarkout, B. (ed.) (2020) *Digital Transformation in Industry White Paper*, with A. Ferraro, C. Lim, S. Lin, J. Morrish and B. Zarkout as authors, Industrial Internet Consortium (IIC): Boston.

Power, B. (2014). *How GE Applies Lean Startup Practices*. Harvard Business Review, April 23.

Ries, E. (2017) *The Startup Way*, Penguin Random House: New York.

Rogers, D. (2016) *The Digital Transformation Playbook: Rethink Your Business for the Digital Age*. Columbia University Press: New York.

Thomke, S. H. (2003) *Experimentation matters: unlocking the potential of new technologies for innovation*. Harvard Business Press: Boston.

Thomke, S.; Von Hippel, E.; Franke, R. (1998) *Modes of experimentation: an innovation process—and competitive—variable*. Research Policy, 27, n. 3, p. 315-332..

Lichtenthaler, U. (2020) *A Conceptual Framework for Combining Agile and Structured Innovation Processes*, Research-Technology Management, 63:5, 42-48, DOI: 10.1080/08956308.2020.1790240

Zhang WH, Arthur V, Gilbreath GH. (2009) *Six Sigma: A Retrospective and Prospective Study*. Production and Operation Management Society 20th Annual Conference [serial on the Internet] [accessed 13 December 2020].

16 AUTHORS AND LEGAL NOTICE

This document is a work product of the BizOps for Digital Transformation in Industry (BDXI) Contributing Group in the IIC, co-chaired by Chaisung Lim (Korea Industry 4.0 Association/Konkuk Univ.), Kai Hackbarth (Bosch.IO).

Authors: The following persons contributed substantial written content to this document: Chaisung Lim (Korea Industry 4.0 Association/Konkuk Univ.), Kai Hackbarth (Bosch.IO), Kordel Kim Isabel (Bosch.IO), Gwihyeon Seo (Korea Industry 4.0 Association), and Jeff McCann (Dell Technologies).

Contributors: The following persons contributed valuable ideas and feedback that significantly improved the content and quality of this document: Zarkout, Bassam (IGnPower).

Technical Editor: Stephen Mellor (IIC staff) oversaw the process of organizing the contributions of the above Authors, Editors and Contributors into an integrated document.

Copyright© 2018 ~ 2021 Industrial Internet Consortium, a program of Object Management Group, Inc. (“OMG”).

All copying, distribution and use are subject to the limited License, Permission, Disclaimer and other terms stated in the *Industrial Internet Consortium Use of Information: Terms, Conditions & Notices*. If you do not accept these Terms, you are not permitted to use the document.