Redefining "Monozukuri" and "Hitozukuri" in the Context of Information Technology Education

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Abstract

"Monozukuri" is a Japanese philosophy of creating quality products and services. With the emergence of digital products and services, we revamp its definition in the context of information technology (IT) while maintaining the quintessential aspects of this traditional philosophy. Through our literature review and expert interviews, we redefine a conceptual definition of Monozukuri relevant to IT education and explore "Hitozukuri" as a set of observable human characteristics, attitudes and behaviors. The reciprocal connection between Monozukuri and Hitozukuri leads to Monozukuri-based pedagogy, which may assist educators seeking to incorporate the concept of Japanese craftsmanship into IT curricula.

Keywords: IT education, mindset, Monozukuri, Hitozukuri, pedagogy

1. WHAT IS "MONOZUKURI"?

Monozukuri is a century-old, Japanese philosophy in craftsmanship. The word "mono" stands for product, while "zukuri" translates to making or creating. The combination of the two words means "making things," which is the culminating result of a craft, a mindset, and a philosophy blended with work ethics driven by continuous improvement for perfection (Roser, 2017). The precise meaning of Monozukuri is challenging to articulate, as different practitioners and manufacturers often amalgamate a variety of contextual and cultural purposes to their products or services. Its implicit meanings extend beyond the process of making things. In general, the term blends the physical attributes of a product (e.g., aesthetic, usefulness, well-design, craftsmanship quality, etc.) and the personal aspects of its maker (e.g., pride, commitment, passion, etc.) into the process of making things.

Although this philosophy has existed in Japan for more than a century, the term regained popularity in the 1990s when Japan faced stiff global competition. In response to Japan's weakened economy, its government revived the term by encouraging modern Japanese manufacturers to apply the principles of Monozukuri to their products and services.

Utilizing an old tradition of craftsmanship with advanced manufacturing was a sensible and culturally justifiable strategy, capturing the culture and spirit of Japanese manufacturing prowess and skill. According to Cole and Nakata (2014), the term aligns with "management dogma" and "national strategy" (p. 33). Moreover, the manifestation of Monozukuri can only be realized by the education and training of skilled workers who support "Monozukuri Core Technology"—the design, manufacture, and repair of Monozukuri products (Cole & Nakata, 2014, p. 33). Building a product the "Monozukuri Way" also has a spiritual influence, as its process instills a sense of pride, commitment, continuous learning, and well-being onto the product's maker.

The process of Monozukuri ultimately leads to "Hitozukuri," or the cultivation of a quality person. The word "hito" means human, and the suffix "zukuri" translates to making or creating; therefore, Hitozukuri translates to "making human". When used with Monozukuri, the word Hitozukuri refers to the process of cultivating a craftsman's spirit (or human capital) through continuous learning, apprenticeship, mentoring, and self-reflection. The synergic interplay between Monozukuri ("making things") and Hitozukuri (redefined as "cultivating future masters") is the major cornerstone of the Monozukuri philosophy. In sum, the process of creating a quality product has a positive influence on the mind and spirit of an individual making the product, and vice versa.

Knowing the reciprocity of the making-things-human relationship, we ponder the questions of applying this philosophy to information technology (IT) education—for example, the relationship between a developer writing a computer program, a software architect designing an IT artifact, or a systems analyst analyzing an information system. In this exploratory study, we seek to redefine the term and examine its potential use in IT education.

2. MONOZUKURI IN EDUCATION

Monozukuri philosophy is often found in Japanese engineering disciplines. Because engineering disciplines often involve a process of analyzing, designing, and building artifacts, Monozukuri can be incorporated into multiple phases of product development. For instance, by drawing skills and knowledge from various disciplines (i.e., electronics, mathematics, robotics, engineering, and computer science) and providing a set of predetermined hardware and software, researchers Yamasaki and Nakagawa (2005) helped students learn the concept of Monozukuri by building a humanoid robot, an idea they defined as "creations in Japanese [that] contributes understanding and interesting classes for students" (p. 248). Berque and Chiba (2016) guided undergraduate students in computer science, human-computer interaction, robotics, Japanese language, and cultures through a three-week cross-cultural course that exposed students to multiple Monozukuri sites/artifacts in Japan.

In the area of IT, Thiptarajan and Lertrusdachakul (2018) proposed "Monozukuri-based Learning" for business IT programs as a combination of project-based, self-directed learning with Kaizen (the concept of continuous, small incremental improvements). The detailed results showed that satisfaction with software tools was the highest for the internet technology class and the business information systems classes (Thiptarajan & Lertrusdachakul, 2018).

Although the existing definitions of Monozukuri aid manufacturers as well as practitioners, allowing them to blend the philosophy with different organizational contexts, its academic definition remains a challenge. The contextual-based and holistic meanings of Monozukuri are less useful to IT education and future empirical studies. Applying Monozukuri to IT education therefore requires a concise, measurable definition of the term. Our intention here is to explore its potential in IT education. The following sections describe these ongoing efforts.

3. EXPERT INTERVIEWS

Without a clear, concise definition, educators cannot measure and implement effective Monozukuri interventions, and thus hinder the progress of future research. We searched existing literature to help us redefine its definitions and potential academic uses. We also interviewed nine local Monozukuri experts who were accessible to us. Our experts included one senior Japanese advisor to a university and eight university senior professors/deans with significant industrial experience and/or consultancy in Monozukuri. They were educated in Japan and had considerable experience training, teaching, and educating private companies as well as students in the "Monozukuri Way." We devised a set of interview questions sent to them prior to a one-on-one, face-to-face interview. Each individual, face-to-face interview lasted for 30 to 90 minutes, which occurred from May to June 2019. Four experts did not engage in a face-to-face interview: one was interviewed via

video call, while others provided their responses via email or online questionnaires. Appendix A describes the list of interview questions.

During the interviews, we took turns asking questions and jotting down the participants' narratives. After the interviews, we compared notes, then interpreted and summarized the experts' answers. We then searched for a common definition and counted similar wordings/phrases. The result from the interviews did not reveal a concise definition of Monozukuri, but it alluded us to four distinct, yet complementary, tenets: Monozukuri, Hitozukuri, Spiritual, and Pedagogical. With this new insight, we propose a conceptual framework linking these interrelated components into a comprehensive model described in the next section.

4. THE FOUR TENETS OF MONOZUKURI EDUCATION

The current definitions of Monozukuri are multifaceted and spiritual, involving an inner, continuous journey that transforms a novice into an expert. The journey of a Monozukuri craftsman constitutes both physical and non-physical attributes. In some cases, "the maker" imbues his/her final product with one's soul or spirit by adding a sense of pride, skills, and commitment to excellence.

Existing literature supports these multifaceted and spiritual views of Monozukuri. Saito, Salazar, Kreafle, and Grulke (2013) related Monozukuri to "excellence, skill, spirit, zest, and pride in the ability to make things, good things, very well" (p. 170). Babu (2016) bridged the tangible and non-tangible aspects of Monozukuri products as "an elevated sense of ownership" through dedicated "lengthy apprenticeship practice" with pride, creativity, passion, and respect, along with "the balance between production, resources, and the society" (p. 97). Others referred to Monozukuri as "the *spirit* of manufacturing" (Toma & Naruo, 2017, p. 570) or as "an object/thing created within the Japanese philosophy of life and spirit" (Macpherson, Lockhart, Kavan, & Iaquinto, 2015, p. 5). Berque and Chiba (2016) called Monozukuri "the spirit or determination to produce excellent products and the ability to constantly improve the products" (p. 4). In a recent article, Monozukuri DNA referred to "a collective skill or spirit of making that inhabits the bodies of Japanese craft and technology-makers" (Kovacic, 2018, p. 576).

While the "journey" of a craftsman integrates both physical and spiritual components, our proposed framework illustrates the separation of physical and non-physical aspects of Monozukuri, which may help set the stage for future empirical research and educational studies.

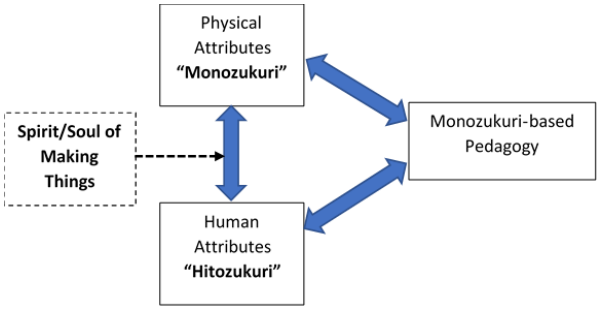

Figure 1 Monozukuri-Hitozukuri Pedagogical Model

Figure 1 shows that Monozukuri and Hitozukuri are modulated by the **Spirit and Soul of Making Things**—the less observable construct that indirectly captures the efforts of the maker, including the level of commitment, passion, and craft into building a quality object. Spirit and Soul of Making Things serves as the "glue" between Monozukuri and Hitozukuri, thereby increasing the intangible (or spiritual) values of the object itself. However, the Soul and Spirit of Monozukuri may be difficult to articulate, as this concept relates to the maker's intense feelings about one's skills through prolonged "interactions" with the product. In this lengthy processing of making, the maker has identified one's self with the product; the maker may "imbue" the product with one's signature, image, emblem, or stamp of approval, signifying that he/she has created a physical object of deep interest and highest quality. For instance, Warren Robinett, the creator of the "Adventure" video game for Atari 2600, credited himself by creating a secret pathway revealing the creator's name, as he felt that game developers were not always given credit for their work. Perhaps the Spirit and Soul of Making Things can be realized through a specific set of hidden attributes unique to information products or services.

The **Physical Attributes** of Monozukuri are the quality of the products and services themselves (e.g., aesthetics, functions, reliability, usability, and other tangible properties). These attributes or properties support the literary meaning of the word Monozukuri itself—making high-quality products and services through multiple iterations or continuous improvements.

From the standpoint of "making things," the focus of Monozukuri has been on the ability to continuously build high-quality physical products

and services (Cole, 2013). The interrelated processes leading to a high-quality product involve a "design-based view" along with the business improvement capabilities to channel the "design information" to the intended audiences (Fujimoto, 2007). This design-based view can be applied to the processing of artifact design in information systems research. For example, in the context of IT, these physical attributes can be realized through both functional and non-functional requirements. Another example is the auditing and evaluating of an information system, including the use by its intended stakeholders.

On the opposite end, the **Human Attributes** of Hitozukuri concentrate on the approaches needed for engraining values and characters into the learners. The Toyota Way of manufacturing captures this idea: building quality products (Monozukuri) fosters human capital (Hitozukuri). A Monozukuri-based product is a reciprocal integration between the process of making things and the bedrock of a craftsman. As mentioned earlier, Spirit and Soul of Making Things binds Monozukuri and Hitozukuri as a complementary integrative component; the higher one's "heart and soul" that go into the product, the higher the reciprocal integration—a synergy between "things" and "makers" will produce high-quality Monozukuri-based products or services.

Our last component is **Monozukuri-Based Pedagogy**, which focuses on engraining the philosophy into the curriculum. Monozukuri-based pedagogy involves an approach that "contributes understanding and interesting classes for students" (Yamasaki & Nakagawa, 2005, p. 248). This component aligns with the Instructional Design (ID) aspects of educational research. To realize a Monozukuri-based pedagogy, educators can rely on the existing methods of Instructional Designs (ID) (i.e., problem-based, project-based, competency-based, or research-based) as a delivery method.

Monozukuri-based pedagogy requires teachers to involve students in "doing" things (hands-on experience) and in "building" personal values and characters. In an attempt to engrain "Monozukuri-based Learning" among business IT students enrolled in a first-year Internet Technology class, Thiptarajan and Lertrusdachakul (2018) found that continuous improvements could be realized through a series of interrelated courses and projects that required collaboration among students from different courses and academic years to build a Content Management System (CMS) website. The projects were also designed to match students' interests, experience, and skill levels. Their students reported satisfaction with the software tools, worked collaboratively, took on efforts to improve their work, and showed pride and joy as they presented their final deliverables (Thiptarajan & Lertrusdachakul, 2018). However, measuring values, behaviors, and attitudes (the human attributes of Hitozukuri), including a method of assessment, is still an overarching challenge. The next section expands on our proposed framework in an attempt to tackle this challenge.

5. CHARACTERISTICS OF STUDENTS EDUCATED IN THE MONOZUKURI WAY

This section extends our proposed framework by focusing on the Monozukuri and Hitozukuri attributes in the context of IT.

The Definition of Monozukuri in Information Technology Education

The simplest and most straightforward definition of Monozukuri thus far is "the spiritual process of building things with added knowledge [and] problem-solving skills to produce high-quality products." Another expert suggested that the word comprises three pillars: focused interests, value-added activities, and technological savviness; these pillars allows any product or service to differentiate itself from competitors. Monozukuri is all about creativity and multiple skill sets with a quality first mentality. Several experts advocated that Monozukuri has a tight connection with Hitozukuri, Kaizen mind (continuous improvement), and personal well-being. They also pointed to the aspects of cultural context, environmental sustainability, customer-centric, problem-solving, and teamwork. Therefore, we propose our definition of Monozukuri in IT as "*the creation and design of an IT artifact through the processes of continuous improvement, innovative problem-solving, user-centric focus, and teamwork intended to enhance its quality and positive user experience.*"

With this new definition, the challenges of capturing quality IT artifacts (i.e., IT products and services) depend on how system developers and designers apply different system development methodologies, software tools, and modeling techniques, leading to the use, success, and intended outcome of the information system. These qualities echo the Information Systems Success Model of DeLone and McLean (1992) (i.e., information, service, systems), while adding other aesthetic or user-experience designs.

With this definition we can assess Monozukuri-based IT artifacts using four criteria: (1) functional and quality attributes; (2) continuous improvement; (3) contextual awareness (i.e., cultural, societal, and environmental); and (4) enhanced user experience. Our definition demands continuous user feedback for product improvement, acceptance tests of system requirements, a symbiotic relationship between Monozukuri and Hitozukuri, and a context or operating environment that enhances user experience. In this manner, the intention of its developer, the purposes of its existence, and the context of how and why it is built become the criteria in which Monozukuri-based IT artifacts should be evaluated.

The Characteristics of Hitozukuri in Information Technology Education

As mentioned earlier, the Monozukuri Way also fosters human capital—Hitozukuri. Since Hitozukuri is the reciprocal realization of Monozukuri, we can derive these Hitozukuri attributes or characteristics from our expert interviews. Using what we summarized and compiled from the experts' narratives, the list below reveals the frequency count (*n*) of similar wordings and phrases. These characteristics are ranked based on their occurrences, from the highest to the lowest.

- Practice continuous improvement (15)
- Engage in teamwork (13)
- Use analytical skills/critical thinking in problem solving (12)
- Apply tools, technologies, or techniques to problem solving (10)
- Take pride in their work (10)
- Have grit; not give up easily (9)
- Be joyful in learning or doing work (9)
- Use creativity in their work; creative thinking (9)
- Effectively communicate with others (9)
- Build high-quality products (8)
- Seek process-oriented activities (7)
- Understand product development process (7)
- Produce high-quality deliverables (6)
- Be passionate about their work (6)
- Seek continuous self-improvement (6)
- Seek direct, real experience (6)
- Learn by doing (5)
- Be culturally aware (5)
- Identify oneself with the product (5)
- Add value in their final products or deliverables (5)
- Self-reflect on own learning and mistakes (5)
- Be motivated and determined to get things done (5)
- Integrate culture, art, technology, and knowledge in their work (5)
- Be detail-oriented or have attention to detail (5)
- Be proactive in their learning or work (4)
- Be willing to experiment; trial and error (4)
- Have respect for others (4)
- Have discipline (4)
- Be a keen observer (4)
- Accept responsibilities (4)
- Be innovative (4)
- Develop a sense of autonomy (4)
- Be goal-oriented (4)
- Find ways to make things better than before (3)
- Use experience to cultivate new knowledge (3)
- Be a leader or exemplar (3)
- Have a desire to know/learn more (3)
- Be environmentally aware (3)
- Cultivate self-directed learning (3)
- Be punctual in product delivery (3)
- Do research on new ideas (3)
- Differentiate oneself or one's product from others (3)
- Be involved in learning something new or experimenting (3)
- Engage in life-long learning (3)
- Be professional (3)
- Devote/commit time to learning or building quality products (3)
- Be an active participant (3)
- Profess their mistakes/errors and provide solutions (2)
- Think positively (2)
- Have humility (2)
- Build innovative products (2)
- Be honest or fair in their work (2)
- Be original; be novel (2)
- Have a sense of belonging with their peers and institutions (1)
- Abide by quality standards (1)

Several of these characteristics are more important than others. According to our experts, we found that the top-ten most essential characteristics are continuous improvement, teamwork, problem solving skills, pride, grit, joy, creativity, communication skills, and building high-quality products. Other important attributes include knowledge about product development processes, passion, continuous self-improvement, and hands-on experience.

Our findings support the existing literature. In his book, Blom (2015) articulates the six core values

of Monozukuri as trust, autonomy, mastery, meaningfulness, involvement, and connection, suggesting that a Monozukuri organization provides excellent product delivery along with continuous improvement to improve both the internal and external processes. Additionally, the "Monozukuri Manufacturing Principles" necessitate long-term thinking, sustainable and eco-friendly design, waste reduction, continuous improvement, societal responsiveness, and respect for shared cultures and values within communities (Ranky, 2007).

Our next question would be: How do we know that our students have successfully internalized these skills and values? The development of Monozukuri-based IT artifacts as well as the effectiveness of Monozukuri-based Pedagogy can support to some of these Hitozukuri attributes, and vice versa. A Monozukuri-Hitozukuri pedagogical method should engrain these characteristics into IT students.

6. IMPLICATIONS

Our exploratory research expands on the existing Monozukuri literature in several ways. First of all, we reconceptualize Monozukuri in the context of IT education. By proposing a new conceptual definition for creating quality IT artifacts, we can evaluate information products or deliverables through the lens of traditional Japanese "craftsmanship," using the four proposed criteria of quality Monozukuri-based IT artifacts: functional and quality attributes, continuous improvement, contextual awareness, and enhanced user experience. Second, to cultivate a "skillful" software developer or an "IT craftsman," Hitozukuri characteristics may serve as a guidepost. These characteristics may also be used as an informal, complementary assessment to course learning objectives. Third, our Monozukuri-Hitozukuri Pedagogical Model, which decompartmentalizes the philosophy of Monozukuri into four different interrelated components, may serve as a foundation to future empirical studies. We encourage subsequent discussion and dialogue among IT educators. Lastly, the process of item generation was highly interpretive based on the frequency count from the experts' narratives. We are still in the initial stage of item generation, which will lead to other statistical analyses (i.e., Q-sort or principal component analysis).

7. CONCLUSION

Monozukuri is the spirit, or the philosophy, of craftsmanship and has been one of the most significant drivers of manufacturing and process improvements in Japan. The goal of Monozukuri-based IT education is to nurture the development of Monozukuri attitudes, characteristics, and values among our students. We reconceptualize the word into four essential components, making the philosophy accessible to educators and researchers. Monozukuri focuses on the physical and functional aspects of IT artifacts, while Hitozukuri comprises the set of characters, attitudes, and behaviors of IT craftsmen. By separating the term into physical, human, spiritual, and pedagogical components, we hope to encourage the use of Monozukuri pedagogy in the context of IT education.

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9. REFERENCES

Babu, V. (2016, April 24). Japan's culture of craftsmanship. *Business Today*.

Berque, D., & Chiba, H. (2016). Exposing American undergraduates to monozukuri and other key principles in Japanese culture, design, technology and robotics. C. Stephanidis (Eds.), In Proceedings of the 18th International Conference, HCI International 2016, Part I, CCIS 617, p. 3–8.

Blom, S. (2015). *Monozukuri in practice: Achieving mastery*. Blom Consultancy.

Cole, R. E. (2013). Killing innovation softly: Japanese software challenges. Discussion Paper Series, UC Berkeley, Haas School of Business.

Cole, R. E. & Nakata, Y. (2014). The Japanese software industry: What went wrong, and what can we learn from it?. *California Management Review*, 57(1). 16-43.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research*, 3(1), 60–95.

Fujimoto, T. (2007). Architecture-based comparative advantage — A design information view of manufacturing. *Evolutionary and Institutional Economics Review*, 4(1), 55–112.

Kovacic, M. (2018). The making of national robot history in Japan: Monozukuri, enculturation and cultural lineage of robots. *Critical Asian Studies*, 50(4), 572-590.

Macpherson, W. G., Lockhart, J. C., Kavan, H., & Iaquinto, A. L. (2015). Kaizen: a Japanese philosophy and system for business excellence. *Journal of Business Strategy*, 36(5), 3-9.

Ranky, P. G. (2007). Eighteen "monozukuri-focused" assembly line design and visual factory management principles with DENSO industrial examples. *Assembly Automation*, 27(1), 12-16.

Roser, C. (2017, December 12). Monozukuri – Japanese work ethics. Retrieved from https://www.allaboutlean.com/monozukuri/

Toma, S-G., & Naruo, S. (2017). Total quality management and business excellence: The best practices at Toyota Motor Corporation. *Amfiteatru Economic*, 19(45), 566-580.

Saito, K., Salazar, A. J., Kreafle, K., & Grulke, E. (2013). Hitozukuri and monozukuri in relation to research and development in surface coating. In Automotive Painting Technology: A Monozukuri-Hitozokuro Perspective. Toda, K., Salazar, A., and Saito, K. (Eds.). Dordrecht: Springer, 2013.

Thiptarajan, K., & Lertrusdachakul, T. (2018). Integrating monozukuri-based learning for undergraduate program in information technology. In Proceedings of the 2018 Technology Innovation Management and Engineering Science International Conference (TIMES-iCON), p. 1-4

Yamasaki, F., & Nakagawa, Y. (2005). Education using small humanoid robot. In Proceedings of the 3rd International Symposium on Autonomous Minirobots for Research and Edutainment (AMiRE), p. 248-253.

Appendix A Interview Questions

Question 1: What is Monozukuri? Please provide a conceptual or practical definition.

Question 2: What is the set of key characteristics of a student who has a "Monozukuri's mindset"? Please list at least three characteristics.

Question 3: What is the set of key attitudes of a student who has a "Monozukuri's mindset"? Please list at least three attitudinal attributes.

Question 4: What is the set of observable behaviors of a student who has a "Monozukuri's mindset"? Please list at least three key behaviors.

Question 5: What is the set of key cognitive abilities of a student who has a "Monozukuri's mindset"? Please list at least three key cognitive attributes.

Question 6: What is the set of key affect of a student who has a "Monozukuri's mindset"? Please list at least three key affective attributes.

Question 7: What can be observed, evaluated, or assessed from a homework, assignment, product, service submitted by a student with a "Monozukuri's mindset"?