

Article

A Strategic Double-Loop Learning Method for Organisational Decision-Making toward Servitisation

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Abstract: In recent years, manufacturing industries have been expected to achieve servitisation—namely, a shift from product sales to product-service systems—in order to achieve sustainable production and consumption patterns. In order to achieve servitisation, manufacturing firms should grasp the business environment and encourage organisational learning to develop the knowledge for servitisation in their environment. The existing knowledge management studies enable the empirical acquisition and reuse of knowledge from past case studies and make efforts to support organisational learning. However, they do not cover the guiding of firms engaged in servitisation to learn appropriately for their business environment. The learning required for manufacturing firms engaged in servitisation is learning that focuses on questioning and modifying existing product-oriented premises—double-loop learning. This paper proposes a method to support strategic double-loop learning within manufacturing companies engaged in servitisation. This method evaluates the compatibility between the implicit premises that manufacturers refer to as the rationale for their decision toward servitisation and the external environment and enables to formulate a practical strategy for double-loop learning. The proposed method was applied to the case of a cassette tape music player to demonstrate its usefulness. This study suggests theoretical foundations for future research into knowledge management for traditional manufacturing companies' decisions concerning servitisation, and suggests that these should be carried out dynamically according to the business environment.

Keywords: product-service system; servitisation; organisational decision-making; double-loop learning; organisational change; knowledge management



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1. Introduction

In recent years, product-service systems (PSS) have attracted attention as a new business model for achieving sustainable production and consumption patterns that combine economic growth with reduced environmental impact [1]. Rather than assuming sell-out business for a product, PSS add services for its use and maintenance, thereby increasing the efficiency and effectiveness of resources. By doing this, environmental sustainability is expected to be achieved through reduced consumption of materials and energy, increased responsibility of manufacturers for end-of-life products, and the development of more durable and frequently used products [2–4]. PSS have also received attention from the business side, namely manufacturing companies, from the viewpoint of economic sustainability. Manufacturers are facing product commoditisation due to complex factors such as market globalisation. In this context, the PSS are expected to bring economic benefits such as increased competitiveness, reduced costs, increased convenience and flexibility for customers, and improved corporate identity [2,5]. Thus, by moving from traditional delivery systems to integrated product and service solutions, PSS are expected to reduce environmental impact and benefit PSS providers and consumers economically and socially [6].

Shifting the traditional business of selling products into PSS business is referred to as servitisation [7,8] and despite its great potential, could generate a number of problems from

an organisational transition perspective [9,10]. In particular, in the context of servitisation, a shift from the existing knowledge domain related to products to the knowledge domain related to services is required, which creates new learning needs compared to other transformations (such as restructuring and mergers) [11]. This relates to the competing demands of exploiting established knowledge and searching for and constructing new groundbreaking knowledge [12], with additional conflicts such as the development of the core product business and the new sophistication of the service business [13]. Such conflicts are superficially portrayed as conflicts between product and service businesses, but products and services are interdependent, and manufacturing firms must constantly source, combine, manage and coordinate new knowledge from both parts of the business [14,15]. Moreover, since the appropriate form of PSS varies according to the business environment of the manufacturing company [16], the manufacturing firm is required to grasp the business environment and implement organisational learning that effectively acquires the knowledge for servitisation.

Organisational learning can be perceived as a management task that involves control and planning. In the existing literature on servitisation, organisational learning is known to foster a service-oriented organisational culture [17,18], to improve firm performance [19,20], and to be a starting point for service innovation [21]. In real organisations struggling to adopt approaches to put organisational learning into practice [22], the focal area is the creation, acquisition and internalisation of knowledge in an organisational and strategic way [22]. Previous studies have recommended the use of knowledge management methods to support organisational learning [23–25]. As an example, one method entails acquiring empirical knowledge based on past successes and failures in an organisation. This method also involves the sharing of this information across the organisation. Such knowledge is known as lessons learned (LL), defined as knowledge artifacts that convey experiential knowledge derived from the success or failure of a task, decision or process that, when reused, can positively impact an organisation's performance [26]. In knowledge-intensive organisations, it is particularly important to formalise such tacit knowledge so that it can be shared in the organisation [27]. The reuse of LL in organisations for learning is expected to have a positive impact on organisational performance [26] and reduce barriers to organisational learning practices [28,29]. LL was initially introduced by the United States Army in the mid-1970s as a result of a post-action review [26]. Since then, it has been introduced in various sectors and has been used to prevent the recurrence of mistakes made in the past [26,30,31]. One of the problems of LL-related systems is the reluctance of system users and the resulting loss of knowledge. Tan et al. addressed this problem by identifying the following requirements of system users based on a case studies: no significant cost or workload for knowledge input, a legal framework for managing knowledge copyrights, verification of knowledge accuracy, and standardisation of knowledge representation formats [29]. To fulfill these requirements, a combination of the use of Web-based knowledge management technologies (such as groupware, expert directories and knowledge bases) and methods for live capture, verification and reuse of knowledge at the point of knowledge generation is proposed [29]. In addition, difficulties in retrieving the acquired knowledge have been pointed out [32] and related technologies developed. Examples include the integration of building information modeling technology used by construction professionals to improve the efficiency and speed of retrieval [33], the classification and automatic extraction of knowledge by natural language processing of unstructured data of building accident cases [34], various retrieval options such as “filter search”, “similarity search”, and “tag-based search” to provide flexibility to the user for finding related lessons in different situations and improved retrieval [35].

Although few studies have addressed LL in the context of servitisation [36], Chirumalla et al. developed Web 2.0 to make video-based systems that enable manufacturing companies to organisationally share and learn the cross-disciplinary knowledge (e.g., mechanical design, electrical engineering, computer science, manufacturing, operations, maintenance, or service engineering) required for PSS development [37,38]. Furthermore, Chirumalla et al. derived the requirements for better-organised LL practice in the context

of servitisation; these requirements were based on two case studies of major manufacturing companies engaged in servitisation [36].

Existing research on LL is performed under the assumption that organisational performance can be improved by acquiring knowledge empirically from cases that have occurred within the organisation. However, these existing studies do not lead manufacturing firms to derive appropriate learning for servitisation in their business environment. The lack of such support is a fatal problem for manufacturing firms. For example, in manufacturing companies, focus is commonly placed on improvements related to lower price and higher quality without changing the concept of a product that was successful in the past. This may be due in part to anchoring in an organisational culture; this type of culture implicitly assumes that “low maintenance costs through high profit margins and selling out will lead to higher profits”, for example. This concept was formed in a business environment where a strategy based on mass sales of products could be accepted. Such traditional organisational cultures of manufacturing firms have been known to prevent servitisation [39–41]. In such a situation, an unconventional, service-oriented decision—particularly one which “emphasises the growth of profits from the provision of related services such as maintenance, rather than from the sale of products”—is difficult to make. In this way, the premises that exist within manufacturing firms are no longer compatible with the external environment in which the firms operate, and these premises undermine the rationality of decisions related to servitisation. As a result, it becomes even more difficult to acquire service-oriented knowledge, resulting in a loss of the opportunity to adopt servitisation. In this context, manufacturing companies are required to question their traditional premises in view of the external environment in which they operate, and to implement strategic learning activities that involve the unlearning of these traditional premises. This type of learning is called double-loop learning, which is defined as “learning that results in a change in the values of theory-in-use, as well as in its strategies and assumptions” [42].

Based on the aforementioned review, this study proposes a method to support strategic double-loop learning toward servitisation. This method evaluates the compatibility between the premises (e.g., beliefs and knowledge) referred to in organisational decision-making (decision premises) and the external environment and enables to formulate practical strategies for double-loop learning within manufacturing companies engaged in servitisation. With this method, manufacturing companies can identify and modify the incompatibility between the premises underlying organisational decision-making and the business environment. This supports manufacturing firms to make rational decisions toward servitisation according to the business environment, and supports their gradual transformation into service-oriented organisations.

The subsequent sections of this paper are organised as follows. In Section 2, the theoretical foundation of the proposed method is developed. In Section 3, a method is proposed that identifies the incompatibility between the premises of organisational decision-making and the external environment, and it also sets a practical guideline for double-loop learning. Section 4 demonstrates the application of the proposed method in the case of a portable music player, Section 5 discusses and concludes this paper, and finally, future works are shown in Section 6.

2. Theoretical Foundation

In order to construct a method to support double-loop learning within manufacturing companies engaged in servitisation (i.e., to achieve the purpose of this study), the theoretical foundation on which the method is based should be clarified. This section firstly reviews previous research on organisational learning with a focus on organisation theory. Then, this section describes the theoretical foundation of the proposed method, which includes a framework for evaluating the compatibility of organisational decision-making premises in regard to the business environment as well as a practical policy for double-loop learning based on the evaluation results.

2.1. Organisational Learning

Organisations learn corporately and become progressively more rational. Such a process is known as organisational learning, which is defined as “detecting the error and fixing process” [42] or “the process of improving actions through better knowledge and understanding” [43]. Organisational learning is considered important for organisational change; it plays an important role in the realisation of innovation in companies [44,45]. For organisations operating in an unpredictable environment, organisational learning is crucial to enable them to respond to unforeseen events more quickly than their competitors [46].

In general, organisations practice organisational learning using the results of their decisions. In other words, the results are evaluated in terms of the goals of organisational decisions; the organisation interprets the results as successes when they exceed the required level and as failures when they fall short, thereby iteratively reconsidering the means to achieve the goals [47]. In this process, organisational learning does not change the premises of the organisation (e.g., goals, policies, norms, etc.). However, with these premises as a given, the organisation often modifies only the means to achieve more rational problem-solving. Argyris refers to this as single-loop learning [48,49]. This corresponds to employees understanding and fixing the problem without looking back at the premises used for this particular transaction [50], and is activated during transactional problems at work [51].

However, in the long term, single-loop learning alone is insufficient to enable an organisation to adapt to and sustain itself in a dynamic environment. In organisations that practise only single-loop learning, implicit premises—such as organisational goals and norms—become increasingly rigid over time; incompatibility with the changing environment also becomes more severe [52]. Therefore, organisations need to not only modify their means, but they must also review their premises—such as the goals of decision-making and the framework of perception—and explore new possibilities that differ from those of the past. In the context of servitisation, this means that manufacturing companies should reconsider the premise that their business goals are to sell products. Moreover, they should explore the possibility of developing their business with a view to service provision. This has been discussed under terms such as higher-level learning [43] and double-loop learning [48,49], which is the process of changing the premises (e.g., beliefs, values and culture) specific to the organisation. In this study, double-loop learning has been used. Argyris and Schön, the proponents of this concept, define double-loop learning as “learning that results in a change in the values of theory-in-use, as well as in its strategies and assumptions” [42]. For an organisation to sustain itself in the long term, the key is not only to learn from traditional premises, but to question and modify them as necessary [43]. Double-loop learning is therefore an opportunity for organisations to go beyond transactional problems at work and bring about dramatic change, such as the development of new ways of working [53]. Therefore, double-loop learning is considered to have a transformational instead of a transactional nature [50]. Especially in situations where the complexity of the environment of the organisation is increasing, it is argued that managers of organisations need to adopt double-loop learning, and take a holistic view that includes the external environment in order to achieve sustainable growth in capacity, revenue and the bottom line [54].

Double-loop learning is performed according to the doubts that frontline organisational members have about the premises of the organisational activities (e.g., beliefs, values and culture) [55]. These premises are then modified by the management. Such double-loop learning involves modifying the knowledge and value base entrenched in the organisation, which may involve the process of unlearning [56]. However, such premises—including beliefs and values—are institutionalised in the organisation [57] and are deeply rooted in the manufacturing enterprise. The more long-lasting and successful the experience, the more difficult the premises are to reject. Moreover, long-held management beliefs inhibit employees’ consideration of these premises [58,59]. Thus, double-loop learning cannot be achieved by the efforts of individuals in the organisation alone. Hence, such double-loop learning must be practiced organisationally by manufacturing companies engaged

in servitisation. Manufacturing companies engaged in servitisation are enablers of the implementation of double-loop learning. As such, strategic practice should be supported.

2.2. A Framework for Evaluating the Compatibility of Organisational Decision-Making Premises

This section constructs a framework for evaluating the compatibility between the external environment and the premises (e.g., beliefs and knowledge) referred to in organisational decision-making (decision premises). Section 2.2.1 organises the concepts to be addressed in this study. It also clarifies the concept of decision premises, which are the target of evaluating the compatibility of the business with the external environment in the proposed method. Section 2.2.2 clarifies the perspective to evaluate the compatibility between decision premises and the external environment.

2.2.1. Evaluation Target

- Decision-making and decision premise

According to Simon, human beings are generally subjects who perform actions under cognitive constraints caused by their limited cognitive resources [60]. This action is derived from decision-making (i.e., the process of drawing a choice from various premises). The premises that guide the choice in decision-making are called decision premises [60].

- Organisational decision-making

A manufacturing company has various processes, such as conceptual design, testing, modification, and improvement. Various decisions are made in each of these processes. In the decision-making process leading up to commercialisation, new choices are derived based on the decisions made in the previous processes. In turn, further decisions are made. These multiple decisions are composed of a chain of decisions made by individuals. This study defines organisational decision-making as the decision-making of an organisation as a whole; this is composed of a chain of individuals making decisions. Furthermore, the decision premises of organisational decision-making are the sum of the decision premises applied by each individual involved in the organisational decision-making.

From the above, it can be argued that the decision premise of organisational decision-making can be described in terms of the decision premise taken by the individuals involved in the organisational decision-making.

- The typology of decision premise

Here, the details of the decision premise held by an individual are clarified. According to Simon, the decision premise consists of two parts: the fact premise, which is expressed in the form of “is”, and the value premise, which is expressed in the form of “should” [60]. The fact premise is the belief of the subject who possesses it (i.e., the assertion of a fact). As such, the fact premise is not always true. For example, the assertion that “all birds fly” is a fact premise. However, it is not true; it is empirically known that some birds cannot fly (e.g., penguins cannot fly). Moreover, the assertion that “tomorrow’s weather will be rainy” is a fact premise about a future event; this fact premise cannot be tested at that moment in time. Thus, a fact premise can be false, or it can be indeterminate, but it is an empirically testable assertion at the very least; this assertion either actually occurs or does not occur in the real world [60]. Value premise, on the other hand, is an assertion about normative matters. For example, norms and goals based on values, ethics and corporate visions are typical of value premises. In contrast to fact premises, empirical testing of the truth of a value premise is not possible [60]. The components of a decision premise, their testability and their truth-value are shown in Figure 1.

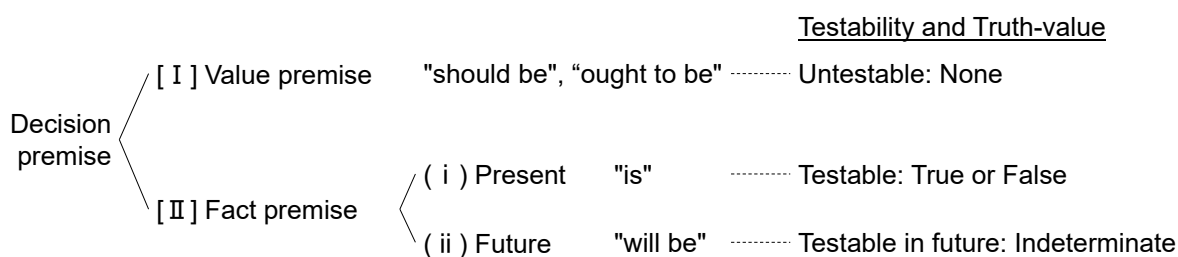


Figure 1. The typology of decision premise and testability.

- Evaluation target

To summarise the above discussion, the value premise is a decision premise that cannot be empirically tested in principle. Fact premises about the future include predictive matters, but they are indeterminate decision premises whose truth cannot be determined until the future comes. A fact premise regarding the present is a decision premise whose truth can be empirically determined at the present time. Namely, the decision maker can only empirically determine the truth of the fact premise about the present.

Accordingly, this study takes into consideration that only the fact premise about the present—the truth of which can be empirically determined—can objectively evaluate the compatibility with the external environment. As such, this is treated as the target of evaluation in this study; value premises and fact premises about the future are excluded from the evaluation in this study.

2.2.2. Evaluation Perspective

This research takes into account the assumption that a form of decision-making with a high degree of compatibility between the subject's decision premises and the business environment achieves servitisation and contributes to a realisation of PSS that is adaptable to the business environment. This section clarifies the basis for this assumption. The perspective of the evaluation of the compatibility with the business environment is subsequently clarified.

As previously established, this paper defines a decision maker as a subject who makes a decision under a certain set of decision premises. Here, decision premises are assumed to be formed within the subject from their perception of the external environment (reality). With this assumption, the decision of a subject with a certain decision premise can achieve success as long as the decision premise is compatible with the actual external environment. In the context of servitisation, this means that a proper PSS can be realised only when the decision premises of the servitisation-related decision are compatible with the business environment. That is, if the decision premises are not compatible with the business environment, the PSS becomes difficult to realise.

When the external environment changes, a divergence is formed between the decision premise and the actual external environment. For example, new technologies that emerge in the actual external environment should be recognised in order to sustain the business. However, as long as the entity does not incorporate the relevant information concerning the external environment, the decision premise will continue to lack the relevant information. In addition, when a new institution is introduced (e.g., deregulation), the entity should update its decision premise. However, if it does not do so properly, this will result in an incorrect decision premise. As previously mentioned, the decision premise may be insufficient or incorrect due to environmental changes.

This study defines the incompatibility of organisational decision-making premise with the external environment as follows: a fact premise exists that includes either an “insufficiency” or a “false” when compared with the external environment. That is, there are two perspectives from which to evaluate a decision premise: whether or not it is insufficient when compared to the external environment, and whether or not it is consistent with the external environment. Therefore, satisfying these two requirements is the necessary condition for realizing servitisation.

2.3. The Policies to Set the Strategy of Double-Loop Learning

This study also defined the fundamental approach in deriving the policy of double-loop learning practice (Table 1) in order to resolve the incompatibility with the aforementioned external environment. This definition is based on Prahalad and Bettis' assertion that there should be a clear distinction between two policies of organisational learning: learning by 'adding' knowledge or beliefs, and learning by 'changing' knowledge or beliefs by adding them after unlearning them [61]. Specifically, there are three types of policy corresponding to false premises of individuals (shown as [F-I] in Table 1), false premises of organisations (shown as [F-O] in Table 1) and insufficiency (shown as [IS] in Table 1). "[F-I] changing (unlearning, exploring, and adding) a decision premise individually" is the double-loop learning policy for a case where there is a "false" in the fact premise hold individually; "[F-O] changing (unlearning, exploring, and adding) decision premise referring to experience organisationally" is the double-loop learning policy for the case where there is a "false" in the decision premise shared by the organisation; "[IS] adding decision premise individually/organisationally" is the double-loop learning policy for a case where there is "insufficiency" of the fact premise, even considering all decision makers' fact premises (Table 1).

Table 1. The policies to practice double-loop learning.

Title 1	Individual	Organisational
	[F-I]	[F-O]
False	Changing (unlearning, exploring and adding) decision premise individually	Changing (unlearning, exploring and adding) decision premise referring to experience organisationally
	[IS]	
Insufficiency	Adding decision premise individually/organisationally	

3. Proposed Method

This section proposes a method to support double-loop learning practices that objectively identify and modify incompatibilities between decision premises and the external environment in organisational decision-making. This method consists of four steps, as shown in Figure 2. In Step 1, "organisational decision-making analysis" identifies referred decision premises by analysing information on past organisational decision-making. In Step 2, "external environment analysis" clarifies information which the decision makers should possess by analysing the external environment of the organisation. In Step 3, "compatibility analysis" identifies incompatibilities between decision premises and the external environment based on the results of Step 1 and Step 2. In Step 4, "building double-loop learning strategy" creates a specific strategy for implementing organisational learning to improve the rationality of organisational decision-making for servitisation. The following describes the details of each step.

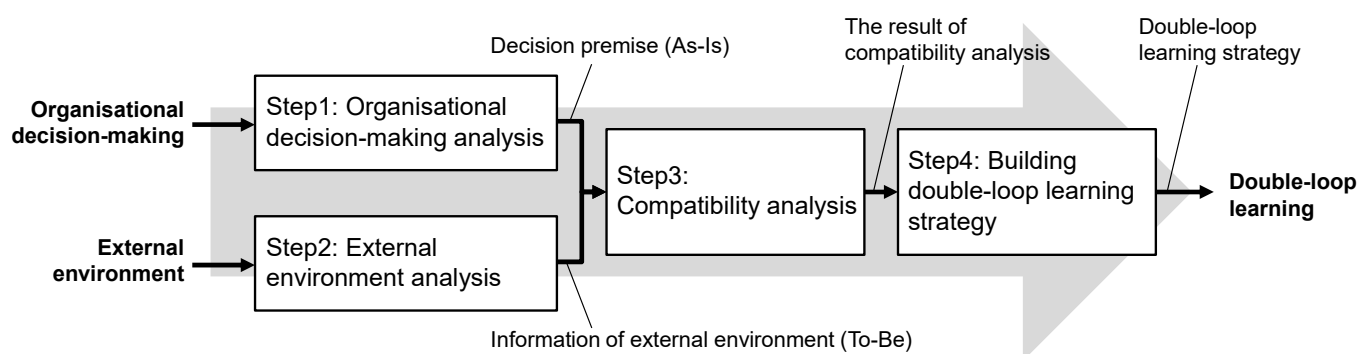


Figure 2. The overview of the proposed method.

3.1. Step 1—Organisational Decision-Making Analysis

This step corrects and externalises information about decision premises that are implicitly referred to during organisational decision-making.

3.1.1. Step 1-1—Collecting Information Related to Organisational Decision-Making

In Step 1-1, information related to organisational decision-making is collected for business selection. For example, the information may be collected by interviewing several individuals who were involved in the decision-making.

3.1.2. Step 1-2—Classification of Collected Information and Externalisation of Decision Premise

The decision premises applied by each decision maker and the results of their choices are externalised by organising acquired information in a proposed organisational decision-making description scheme (Figure 3). This scheme consists of the decision premise layer (upper layer) and the choice layer (lower layer). The choice layer chronologically describes the results of choices made during the project. The choices are described by white rectangular nodes, arranged in the order of their selection and connected by solid arrows. The decision premise layer describes the decision premise that forms the basis for each choice. Moreover, this layer consists of layers that represent each decision maker involved in the organisational decision-making. In these layers, the decision premises applied to each decision maker are labelled by a grey rectangular node, and the correspondence with the choices is represented by a dashed arrow. In the example shown in Figure 3, the decision premise “Users demand higher performance” regarding the business planning department is the basis for the choice “Improvement of hardware”. In the example described in Figure 3, the decision premise of “Users demand higher performance” regarding the business planning department is the basis for the choice “Improvement of hardware”.

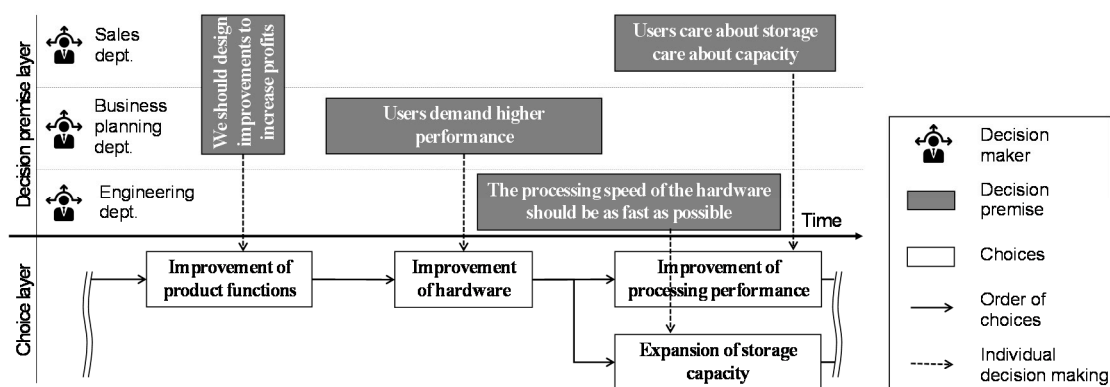


Figure 3. The organisational decision-making description scheme.

3.2. Step 2—External Environment Analysis

This step clarifies information related to the external environment that the decision makers should possess; this is based on analysis of the external environment. This analysis is highly relevant to the decision premises identified in Step 1.

3.2.1. Step 2-1—Set up External Environment for Organisation

First, the set-up environment is an environment that an organisation should consider during organisational decision-making, which bounds the range of information to be collected on the external environment. Specifically, the scope of the external environment is narrowed down from the viewpoint of whether or not it affects the decision premises identified in Step 1. For instance, since the “Users demand higher performance” decision premise is related to the “User requirements for products” user requirements, it is set as one of the external environments to be considered.

3.2.2. Step 2-2—Collecting Information on the External Environment

Information is collected about the external environment set in Step 2-1 from information sources such as market surveys and public information. This includes information on the technological trends of the external environment surrounding the target organisation, such as “the development of information infrastructure related to the 5th generation (5G) mobile communication system is accelerating”.

3.2.3. Step 2-3—Complementing External Environment Information

This step complements missing information by indirectly deriving information related to external environment from the information collected in Step 2-2. For example, the external environment information (i.e., “the market share of competitors’ products that emphasise design is increasing”) and information on user preferences (i.e., “users emphasise design”) is indirectly derived and interpolated into the external environment information.

3.3. Step 3—Compatibility Analysis

Step 3 evaluates the compatibility between decision premises and the external environment. This study defined incompatibility as the state in which the fact premises contained at least one factor (e.g., “insufficiency” or “false”) when compared to the external environment. Therefore, this evaluation is conducted by collating fact premises with the external environment. In light of this, this step initially classifies the decision premises and identifies the fact premises to be evaluated. Secondly, the external environment to be collated with the factual premises is identified. Finally, the compatibility with the external environment is evaluated by collating the factual premises with the external environment.

3.3.1. Step 3-1—Classification of Decision Premises in Organisational Decision-Making

As explained in Figure 1, decision premises consist of the value premise (“should be”), the fact premise about the present (“is”), and the fact premise about the future (“will be”). This step classifies and describes the value premise in cell [I], the fact premise about the present in cell [II]-(i), and the fact premise about the future in cell [II]-(ii) of the decision premise classification framework (Table 2). For example, because “We should design improvements to increase profits” in Figure 3 is asserted by using “should be” phrase, it is classified as a value premise and described in cell [I] of Table 2.

Table 2. The decision premise classification framework.

		As-Is (Decision Premise Identified in Step 1)	To-Be (Decision Premise Identified in Step 2)
Value premise		[I]	
Fact premise	Present	[II]-(i)	[III]
	Future	[II]-(ii)	

3.3.2. Step 3-2—Classification of Environment Analysis Results

The information obtained by the external environment analysis in Step 2 is classified. This study assumes that information obtained by the external environment analysis is related to the present state; it is classified and described in [III] of Table 2, which can be compared with the decision premises described in [II]-(i).

3.3.3. Step 3-3—Compatibility Analysis

Decision premises that are incompatible with the external environment are identified using the following rules based on the definition of incompatibility in Section 2.2.2.

- Decision premise in [II]-(i) that is inconsistent with [III] → decision premise that contains a “False”
- Decision premise described only in [III] → decision premise with “Insufficiency”

It should be noted that decision premise [I] in Table 2 is untestable, and decision premise [II]-(ii) are indeterminate. As such, these decision premises are not subject to evaluation in this study.

3.4. Step 4—Building Double-Loop Learning Strategy

Step 4 brings forth a specific strategy to resolve each incompatibility identified in Step 3. Each type of incompatibility is classified into [F-I], [F-O], and [IS] in Table 1, which shows the organisational learning policy defined in Section 2.3. A specific strategy is derived based on the corresponding organisational learning policy. For example, when only a certain individual has a decision premise that contains an error (false), this step derives a specific double-loop learning strategy based on the policy of “changing (unlearning, exploring and adding) decision premises individually” described in the cell [F-I] of Table 1.

4. Simulating the Application of the Proposed Method

4.1. Summary of Case Study

This paper provides simulated descriptions to verify the proposed method; publicly available information is used for this purpose [62–64]. This study analyses the organisational decision-making process of a major manufacturing company (Company A), which developed the world’s first cassette tape portable music player and dominated the market for decades. Company A launched the first cassette tape-based portable music player in 1979 and made a novel decision to remove the recording function—which was the main function of tape recorders at the time—and add a stereo audio playback circuit instead [62]. This portable music player dominated the market share for nearly 20 years [62]. However, after Company B developed the HDD-type player in 2001, Company A’s product rapidly lost its dominant position in the market [63]. Although the hardware performance of Company B was lower than that of Company A, Company B designed its business focusing on the semantic value required by users [64], taking into account the design, UI and usability of the music distribution service [63].

This case study refers to the development history of Company A’s first cassette tape portable music player [62], the external environment of Company A’s entry into the digital music player market at the time, including the diffusion of digital music players and technical issues [63], Company A’s strategy to compete with Company B [63], and existing literature containing information on the differences in hardware performance (functional value) and semantic value [64]. This case study focuses on the organisational decision-making of Company A—which began in the portable cassette music player market—following its entry into the portable digital music player market. This application assumes that the organisational decision was driven by the digitisation of media. However, it failed to achieve servitisation and thus lost the market to Company B. In short, Company A was not compatible with the business environment. Based on this assumption and the application of the proposed method, this section illustrates the derivation of the double-loop learning strategy by identifying incompatibility between the decision premises of organisational decision-making and the external environment.

4.2. Application Result

4.2.1. Step 1—Organisational Decision-Making Analysis

Step 1-1—Collecting Information Related to Organisational Decision-Making

Firstly, information on organisational decision-making in this case study was collected. In the application, information was collected based on existing studies [62–64] that analysed and discussed this case.

Step 1-2—Classification of Collected Information and Externalisation of Decision Premise

Next, it is assumed that Company A’s business planning department and engineering department were strongly involved in organisational decision-making up to the sale of the products. As such, this study organised the collected information and described it

in the organisational decision-making description scheme (Figure 4). For instance, the choice “Differentiation strategy based on our strengths” was selected based on “We should compete with company B’s product” and “Our company’s traditional strengths should be exploited”, the common decision premises of planners and designers.

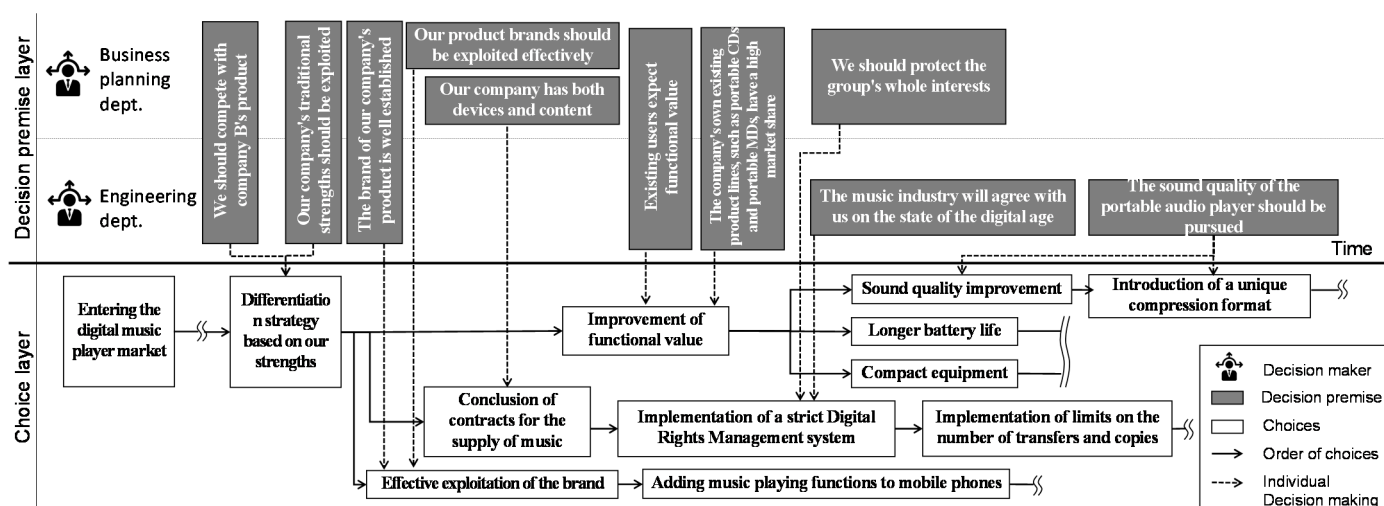


Figure 4. The result and description of organisational decision-making in the portable digital music player case (Excerpt).

4.2.2. Step 2—External Environment Analysis

Step 2-1—Set up the External Environment for the Organisation

This step initially sets “market of digital music players”, “copyright law related to digital content”, and “technological trends of portable music players” as the external environment that Company A should consider. This is due to the fact that the case study scope entails organisational decision-making following entry into the digital music player market.

Step 2-2—Collecting Information on the External Environment

Information related to the external environment was collected by referring to information available in existing studies [62–64]. The results are summarised in Table 3. For instance, information regarding the digital music player market, such as “Company B’s products, which promote semantic value, are gaining market share” was collected. With regard to the copyright system for digital content, information such as “There are no legal restrictions on the copying of music for personal use” was collected.

Table 3. The result of external environment analysis (Excerpt).

External Environment to be Considered	Information on the External Environment
Market of digital music players	<ul style="list-style-type: none"> - Company B’s products, which promote semantic value, are gaining market share - Users expect semantic value
Copyright law related to digital content	<ul style="list-style-type: none"> - There are no legal restrictions on the copying of music for personal use - The users recognise that “it is natural to be able to use music freely without restrictions on copying” - Music is difficult to own in physical form and easy to copy
Technological trends of portable music players	<ul style="list-style-type: none"> - There are few technologies that technically limit piracy - There have been many advances in music file storage technology - The capacity of the storage media is increasing

Step 2-3—Complementing External Environment Information

Based on the external environment information collected above, missing information was complemented by acquiring additional related information. The results are shown in green text in Table 3. For instance, the external environment factor “Users expect semantic value” was added by considering the increase in the market share of Company B’s products, which appeal to semantic value.

4.2.3. Step 3—Compatibility Analysis

Step 3-1—Classification of Decision Premises in Organisational Decision-Making

The externalised decision premises in Step 1 were classified into a value premise (“should be”), a fact premise about the present (“is”), and a fact premise about the future (“will be”). Table 4 shows a portion of these results.

Table 4. The result of categorisation of decision premise in the portable digital music player case (Excerpt).

		As-Is (Decision Premise Identified in Step 1)	To-Be (Decision Premise Identified in Step 2)
Value premise	a.	We should compete with Company B’s product	
	b.	Our company’s traditional strengths should be exploited	
	c.	Our product brands should be exploited effectively	
	d.	We should protect the whole interests of the group	
	e.	The sound quality of the portable audio player should be improved	
Fact premise	Present	f. The brand of our company’s product is well-established	k. The stricter the copyright protection technology, the worse the usability of the music management software
		g. Our company has both devices and content	l. Users expect semantic value
		h. Existing users expect functional value	m. The users recognise that “it is natural to be able to use music freely without restrictions on copying”
		i. The company’s own existing product lines, such as portable CDs and portable MDs, have a high market share	
	Future	j. The music industry will agree with us on the state of the digital age	

Step 3-2—Classification of Environment Analysis Result

The external environment information clarified in Step 2 was subsequently described in the To-Be column of the decision premise classification framework (Table 2). Table 4 shows a portion of these results.

Step 3-3—Compatibility Analysis

In Step 3-3, the decision premises that were incompatible with the external environment were finally identified by comparing the elements in the Fact premise/Present rows of the As-Is and To-Be columns in Table 4. In this table, decision premises that contain inconsistencies between elements (False) are shown in red text, and critical environment information that Company A lacks (Insufficiency) are shown in blue text. For example, “h. Existing users expect functional value” contains an error when compared with “l. Users expect semantic value”. Such a decision premise, which captures customer requirements in terms of functional value, is a typical product-oriented paradigm. This paradigm could undermine the rationality of business choices related to servitisation.

4.2.4. Step 4—Building a Double-Loop Learning Strategy

The double-loop learning strategy to modify the incompatible decision premises identified in Step 3 was acquired by referring to Table 1. Specifically, the decision premises that included a “false” and the environmental information lacking in the decision premises with “insufficiency” were classified into [F-I], [F-O] and [IS] in Table 1. Thereafter, a specific strategy was derived from the corresponding double-loop learning policies (Table 5). In the case of [F-O], the double-loop learning policy of “changing (unlearning, exploring, and adding) decision premises referring to experience organisationally” corresponds to the decision premise “h. Existing users expect functional value”. Consequently, a strategy consisting of the following three steps was derived (H in Table 5).

Table 5. The result of building the organisational learning strategies (excerpt).

Categorised Decision Premise		Organisational Learning Strategy
Individual false [F-I]	-	-
Organisational false [F-O]	h. Existing users expect functional value	H. Sharing evidence that users are not seeking functional value as they once did (unlearning), identifying evidence that users are seeking semantic value (exploring), and communicating this across the company (adding)
Insufficiency [IS]	k. The stricter the copyright protection technology, the worse the usability of the music management software	K. Trial use of music management software with and without strict copyright protection technology in the engineering department to encourage the formation of its decision premise
	m. The users recognise that “it is natural to be able to use music freely without restrictions on copying”	M. Further investigating and sharing with the company the evidence behind its decision premise

1. Gather information that supports the fact that users are not looking for functional value, and share it with members involved in the design of this project (unlearning)
2. Search for additional information to logically support the results of the external environment analysis that users pursue semantic values (exploring)
3. Modify the decision premise by disseminating the revealed user requirements to the relevant stakeholders (adding)

In this way, this method provides the ability to derive a concrete strategy for implementing double-loop learning for servitisation by considering the specific means corresponding to “unlearning”, “exploring” and “adding”, as included in the policy of organisational learning (Figure 1).

5. Discussion and Conclusions

5.1. Discussion on Application Result

This paper has demonstrated that the proposed method externalises the decision premises applied in organisational decision-making. Through the description of the portable music player business case, the paper objectively identified the incompatibility (i.e., “false” and “insufficiency”) of the fact premises about the present with the external environment. Furthermore, the application of the case study confirmed that a practical strategy of double-loop learning can be created to modify the identified incompatibilities using the proposed method.

The validity of the application results was also confirmed. In this case study, the decision premise “h. Existing users expect functional value” (shown in Table 4) was evaluated as “false”. This “false” evaluation is assumed to be caused by anchoring in the

success of the cassette tape portable music player; the product dominated the market for 20 years as a result of its strategy of pursuing functional value. This means Company A's failure in regard to servitisation can be attributed to their tackling of servitisation under the product-oriented premise; this is no longer compatible with a business environment where users are considered mainly in terms of product functions. Indeed, Company A could not grasp the change in the users' preferences or pursue their semantic values related to usability and convenience. As such, the company lost its market share to Company B's products. This interpretation is consistent with the fact that Company B appealed to the semantic values of its customers [64], and this validates the results of the compatibility analysis (Step 3).

Furthermore, it was confirmed that this method provides the ability to derive a practical strategy of organisational learning in order to modify the identified incompatibilities. For example, item h in Table 5 shows a concrete strategy for implementing double-loop learning with unlearning, which is particularly difficult for large manufacturing companies. Strategy H shown in Table 5 is a specific strategy that modifies the premise that pervades the whole organisation: "h. Existing users expect functional value". As described above, the proposed method has the potential to derive a practical strategy for double-loop learning with the unlearning of decision premises. By referring to this strategy, the managers of Company A could have strategically put into practice the double-loop learning which the entire organisation requires.

5.2. Managerial Implications

Because the form of PSS that is suitable for each manufacturing firm varies according to the business environment [16], firms that engage in servitisation are required to make rational business choices based on the business environment [65]. In order for traditional manufacturing firms to rationally make such service-oriented business choices, double-loop learning is necessary; this concept changes the implicit product-oriented premises that are incompatible with the business environment. However, this is difficult to achieve if it is only practiced at the individual level. To solve this problem, the proposed method assists in deriving a strategy to practice double-loop learning for the entire organisation to modify such premises. Concretely, the method identifies incompatibilities between the decision premises of organisational decision-making and the external environment. Additionally, it supports the derivation of a practical strategy that can be used with double-loop learning according to the types of incompatibilities. By referring to the strategy derived by the method, managers can implement double-loop learning practices in a company-wide manner (i.e., to change product-oriented premises to service-oriented ones based on the external environment). In this manner, by repeating the double-loop learning activities, the rationality of business choices related to servitisation is gradually enhanced. As such, PSS can be realised. Through the above process, the proposed method is expected to support the servitisation of manufacturing firms. It is also expected that this method will contribute to the realisation of sustainable production and consumption patterns.

5.3. Theoretical Contributions

This study contributes to knowledge management research on supporting organisational learning by managing tacit knowledge and empirical knowledge. Previous studies have attempted to support organisational learning through the sharing of tacit and experiential knowledge (i.e., sharing LL and preventing the same type of mistakes as in past cases) [26,30,31]. Additionally, some research have been performed in the context of servitisation [36–38]. On the other hand, learning by reusing LL acquired in previous manufacturing companies is often equivalent to single-loop learning, and this is not necessarily useful in realizing servitisation. Considering this problem, this study argues that—when managing knowledge to support the servitisation of manufacturing companies—dynamic changes in the business environment should be met with attention. Only the knowledge that is compatible with this environment should be reused. In contrast, the

knowledge that is not compatible with this environment may need to be unlearned. This study presents a dichotomy between value premises and fact premises, and in particular focuses on fact premises related to the present. Based on this idea, the manager should be able to formally identify incompatible decision premises. In this sense, this study can be considered as a pilot study, particularly one that argues that manufacturing companies engaged in servitisation should question their organisational premises, including knowledge acquired in the past, and propose a method to support double-loop learning in order to practically modify them. Consequently, this study contributes to knowledge management research on servitisation, because it suggests theoretical foundations for future research confirming that knowledge management for traditional manufacturing companies' business choices concerning servitisation should be conducted dynamically according to the business environment. Thereby, it contributes to the realisation of servitisation that will ensure economic sustainability, and by realisation of PSS, indirectly lead to environmental and social sustainability.

6. Limitations and Future Research Works

The proposed method is expected to contribute to the creation of a structure for double loop learning in organisations, and it does so by formalising the procedure to set the strategy for double loop learning. However, there are still some issues that must be solved in regard to its operation. First of all, the definition of the scope of collecting information on the external environment in Step 1 remains unclear. Therefore, depending on the user's ability to analyse the external environment, unreliable or insufficient collection of the external environment information or bias in the content of the collected information may become issues. As a result, compromises may occur in regard to the result validity of the decision premises, compatibility evaluation and the respective practical strategy for double-loop learning. In order to cope with this problem, the rationale for the derivation of the organisational learning strategy should be clearly described by recording the scope of analysis regarding the external environment (frame), the sources of information, and so on. In this way, anyone will be able to refer to it. Thus, the validity of the rationale for the derived strategy can be verified through multiple managers. This makes it possible to implement double-loop learning with a clear rationale. Secondly, since the information processed in the proposed method is qualitative, the results may vary depending on the skill level and interpretation of the practitioner. For example, if there are several identified incompatibilities, the manager must consider which one should be modified first. However, this prioritisation is difficult when considering using the proposed method on its own. As an example, the analytic hierarchy process (AHP) [66]—which is a method to support multi-criteria decision-making—can be used along with the proposed method to deal with this problem. Among actual manufacturing companies, additional guidelines for the operational use of the proposed method should be considered in the future.

In addition, an issue remains regarding the limited evaluation target of this study. In this study, the truth of value premises was regarded as untestable. However, their existence is not denied. Since a value premise is an important decision-making premise related to the vision and philosophy of manufacturing companies engaged in servitisation, it is necessary to find a way to test its truth to the greatest possible extent. The testability of the proposition expressed by the “should be” (value premise) has been discussed in the philosophy of science [67]. As such, it is necessary to examine the method of practically testing the truth of the proposition by referring to the knowledge in this field. Since such a value premise involves ethical matters, it is difficult to evaluate objectively. Therefore, future research needs to explore how to form a common understanding or consensus among the subjects and society about the validity of value premises. In addition, fact premises about the future—which are not determined to be true or false—are excluded in this study. On the contrary, the fact premise includes the prediction of the effect brought about by the business choice related to the servitisation. The decision makers who make business choices related to servitisation cannot determine the truth of these premises. That

being said, they should confirm the certainty or risk of each choice by using simulation techniques or scenario planning. They should also understand that the relevant truths should be verified in subsequent organisational activities. Thus, future research needs to deal with how to handle and counter uncertain events in servitisation and provide practical methods to support it.

In this study, a case study of a portable music player with a cassette tape was used for the case examination. Although our case study supports the usefulness (value) of the proposed method, a general conclusion about the usefulness and validity of the proposed method cannot be drawn solely from this case study. This is due to a methodological problem, and it is caused by the fact that the method presents how-to knowledge as opposed to scientific knowledge [68]. The value of the proposed method is confirmed by the derivation of useful results through the application of the method to a continuous series of real scenarios. If the usefulness of the method is questioned, it should be addressed by appropriately considering and improving it.

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