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Daily Care Information System Requirements: Professional Service-Driven Service Blueprint Approach

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Abstract

Background Long-term care (LTC) services are a professional service-driven (PSD) system; to deliver appropriate care services to residents, health care providers first need to collect appropriate patient data and make a professional assessment. A well-designed LTC information system should therefore consider the information requirements of multidisciplinary health care providers to adequately support their care services.

Objectives This study proposed a modified service blueprint—the PSD service blueprint—for visualizing interdisciplinary service providers' input and output information requirements, which correspond to their service activities.

Methods The PSD service blueprint comprises five layers and seven elements. We also present a case study to illustrate the blueprint's application to daily LTC services.

Results Our proposed approach could clearly illustrate the daily care activities, service providers (main actors), actors' input and output information, and suggestions for LTC information system–related applications.

Conclusion The proposed PSD service blueprint can not only gather interdisciplinary LTC service providers' information system requirements but also act as a mapping tool for visualizing the care service process.

Keywords
- long-term care
- information system requirements
- service blueprint
- design thinking

Background and Significance

Long-term care (LTC) services face several challenges due to population aging, which has become an ongoing trend in many developed countries. An information system (IS) can reportedly improve the efficiency and effectiveness of service provision procedures; therefore, developing and implementing a well-designed LTCIS may help LTC facilities enhance their service quality and performance.

In the past, the waterfall method, a system development life-cycle method, was frequently used in health care settings; the system development process for this model includes identifying problems and objectives; determining information requirements; analyzing system needs; designing the system; and developing, testing, implementing, and evaluating the system.[1–3] However, a major shortcoming of such methods is the difficulties in identifying all requirements prior to system development.[4]

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Information is an essential element in IS development[5]; therefore, information flow analysis has been applied in the health care field for identifying clinical information requirements. Patient flow analysis (PFA) is a flow mapping technique centered on patients for identifying patient flow and improving the care process.[6] The core of PFA is care process improvement; therefore, PFA is usually combined with other tools, such as time and motion studies or computer simulations, for enhancing efficiency.[7,8] Unertl et al[9] developed the information flow model for chronic disease care, highlighting that the patient is the information hub. Their method allows visualization of the interaction of information between related health care providers; however, it does not focus on plotting the health care workflow. Another model was developed by Wei and Courtney,[5] who applied information flow to identify information management functions, information sets, nursing processes, and care collaboration required by registered nurses (RNs) in LTC services. Their approach clearly maps the RN workflow and the actions of the related service providers, but it is limited in that the information requirements are centered on RNs.

Meeting user requirements is critical for IS development.[5] Identifying the different information requirements of various care providers can be challenging in the collaborative LTC environment. Design thinking (DT) is the application of design approaches by multidisciplinary teams to solve an existing problem; it is used in various fields.[10] The delivery of health care services almost always requires an interdisciplinary team, such as a combination of nurses, nurse practitioners, resident physicians, fellows, and attending physicians in the hospital setting.[9] DT has been applied in health care for developing innovative solutions to various problems such as the management of chronic obstructive pulmonary disease, diabetes, caregiver stress, and posttraumatic stress disorder as well as changes in system processes, such as nursing handoffs and drug–drug interaction alerts.[11] Wang et al[12] applied DT to design a data quality rule in a health care facility for identifying data errors. DT also has been integrated into IS development to better identify customer needs, requirements, and environments and to incorporate them into system analyses.[4,13]

DT is usually used for creating human-centered products that prioritize the development of empathy for users, and it involves working in collaborative multidisciplinary teams.[11,14] From the process perspective, the core of DT is empathy toward the end user based on contextual observation, user stories, or scenarios[15]; from a methodological perspective, the most suitable approach in the DT field is the service blueprint (SB) one. An SB helps visualize the service process from the user's perspective.[16–18]

SBs have been used in many industries to visualize the service process and interactions between customers and service providers.[18–20] Several field-specific modifications to SBs have been proposed for achieving greater consistency across disparate service fields, such as product–service systems, product-extension services, and online-to-offline services.[19,21–23] The existing SB approaches have weak interaction with collaborative teams. Although O'Connor et al[24] used an SB to design mobile devices, they used an original SB and focused only on the interaction between mobile devices and users. Holdford[25] used a pre-existing SB to clarify pharmacy service processes.

Those designing LTC systems should consider service providers' preferences.[26] LTC services are provided not only by an interdisciplinary team but also by a professional service-driven (PSD) team; all services are provided after an assessment is made by health care providers, such as physicians, nurses, social workers, and therapists. The pre-existing modified SB versions do not fit the LTC setting because LTC services are a PSD system in which all services are provided on the basis of professional assessment of residents' health status and application of residents' comprehensive health-related information to enhance care efficiency. In this study, we propose a PSD SB approach that suits the collaborative multidisciplinary nature of LTC. We also demonstrated the value of this approach through a case LTC facility by incorporating the facility's main daily care activities into the approach.

Methods

PSD SB Approach

LTCIS can assist with the health care team's daily operations; thus, both administrators and clinicians should actively participate in the selection process to ensure that the system reflects the requirements of their daily operations and practices. The system selection process should be an interdisciplinary effort that involves all relevant stakeholders in the proposed system.[3] LTC services are delivered by multidisciplinary professionals including health care professionals,[5,27] and an SB visualizes the service process and depicts the interactions among people, processes, and related resources.[19,20] Therefore, an SB is suitable for collecting information requirements related to service delivery by LTC professionals.

A traditional SB presents a service system through a flowchart that centers on the customer perspective and separates service activities into frontstage and backstage activities.[20,28] Such an SB not only depicts the service delivery process from the customer's viewpoint to present the service flow but also clarifies touchpoints and interactions across the entire service process to enable employees to understand the association between their tasks and other parts of the system. Thus, an SB helps service providers better understand their jobs and responsibilities.[19,20]

In an SB, a two-dimensional approach is used to portray the service process, with the horizontal axis representing the chronology of customer and service provider activities and the vertical axis act as demarcation among three distinct areas of actions (i.e., frontstage, backstage, and support process) or three distinct lines, including the (1) line of interaction, which differentiates customer actions from frontstage service provider actions; (2) line of visibility, which differentiates visible actions performed by frontstage employees from backstage activities; and (3) line of internal physical interaction, which differentiates backstage activities from the internal support process/related resources.[18,22,25]

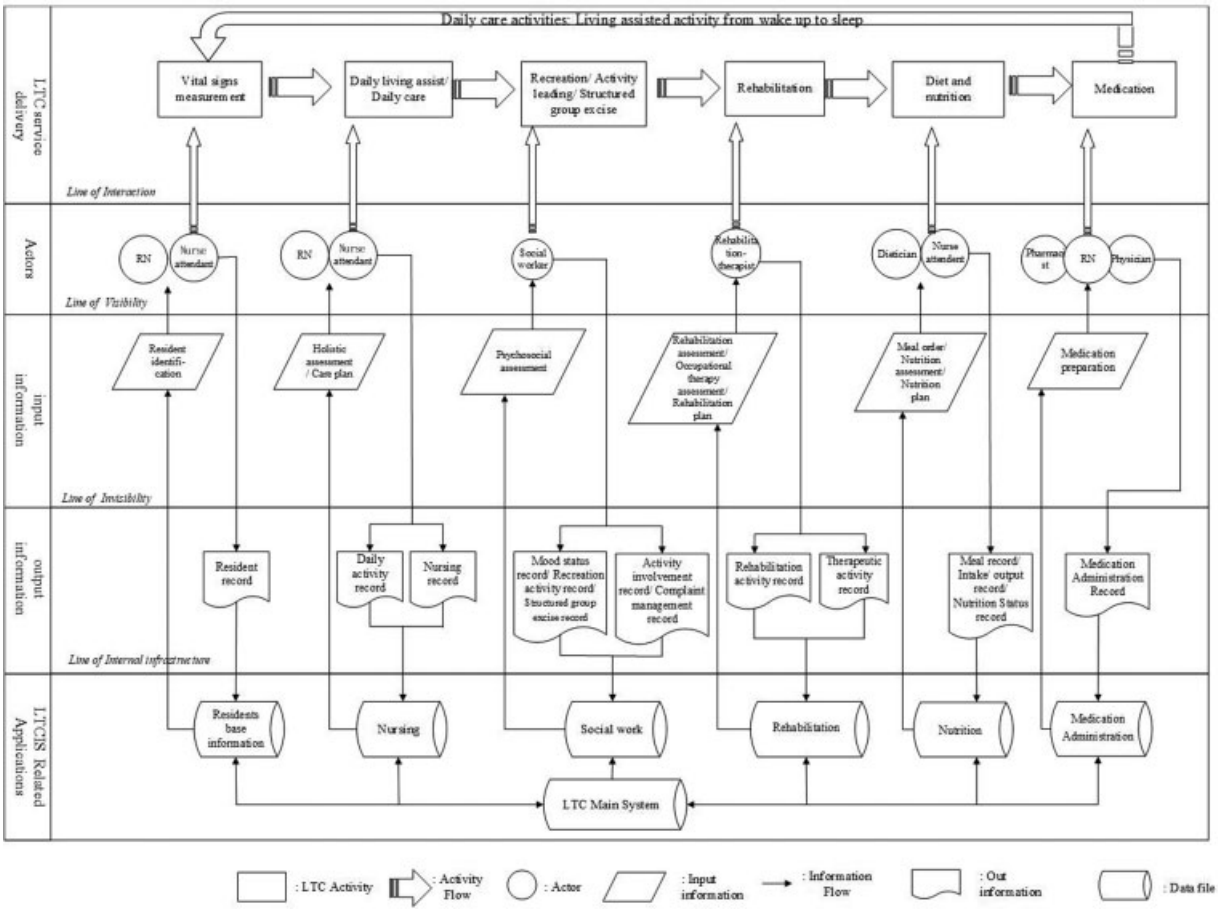

Fig. 1 Long-term care PSD SB—daily care activities. PSD, professional service-driven; SB, service blueprint.

To render the PSD SB approach more comprehensive, enterprise architecture (EA) is referenced in this study. EA is software system architecture that provides a high-level view for holistically managing the interaction of an enterprise with its IS.[29–34] It separates the essential elements of software as business process, information, application, and technology and infrastructure.[29,33,35–37] It is also concerned with identifying stakeholders' requirements when the whole architecture is being developed.[36–40]

The proposed PSD SB approach uses some essential EA elements to translate the three distinct areas of action (or lines) of the SB into five layers: LTC service delivery, service providers (actors), input information, output information, and LTCIS-related applications. Thus, seven elements (symbols or parts of symbols in a flow diagram) are used for visualization (►**Fig. 1**): LTC activity, activity flow, service providers (actors), input information, information flow, output information, and related data files. To emphasize the interaction of process and information, we split our information layer into layers for input and output information. The details of the five layers are provided as follows:

LTC Service Delivery Layer

This layer is similar to the business or process layer of EA; all LTC services are visually profiled in this layer. LTCIS focuses on integrating and supporting the work of various service providers.

The purpose of LTC services is to help individuals maintain or improve their physical functions and life quality. These services include assistance related to the activities of daily living (ADLs), instrumental ADL, and health maintenance tasks. RNs have identified the LTC facility's care process, which comprises assessment, outcome identification (decision making), planning (care plan development), implementation, and evaluation. LTC facilities may use any of the various instruments available for assessment of resident health status.[41] Comprehensive geriatric assessment is a validated method for assessing the health status of frail residents of LTC facilities, documenting cognition, mood, mobility, function, appetite, weight, bowel and bladder function, medical conditions, and medications.[42] The nursing process is an information-driven process that involves history taking and comprehensive assessment of residents (demographic data, medical history, health assessment, and care needs) and their nursing care plan (comprehensive assessment, nursing goals, interventions, and evaluation).[5,43]

Actors Layer

Services in LTC facilities are provided by RNs, physicians, nurse attendants, social workers, physical therapists,

dieticians, and pharmacists.[27] The actions of all the essential actors (stakeholders) are considered in this layer; however, RNs and the nursing process are the ones that are crucial to the LTC service flow.[5]

Input Information Layer

This layer involves information retrieval and verification. Before providing LTC services, service providers must retrieve relevant details from related applications for validation, such as basic information of residents, their care plan, and assessment data.

Output Information Layer

This layer creates and maintains records. LTC service providers are required to create records after history taking and assessment; this process is called "output information" in the PSD SB approach.

LTCIS-Related Application Layers

Input information is retrieved from LTCIS-related applications upon request from LTC service providers. The IS creates or stores output information in the related applications after service providers have finished their activities.

Seven Elements

- *PSD activity:* A rectangle represents a service provider activity. For example, LTC RNs play a key role in tending to daily care, and social workers are responsible for leading individual or group activities, such as structured group exercise. The rectangle expresses such critical work activities (for symbols, please see ►Fig. 1).
- *Activity flow:* A thick arrow represents an activity flow. A PSD system requires the cooperation and teamwork of various service providers. The thick arrow symbolizes this interaction.
- *Actors:* A circle represents a service provider. Although LTC service providers include RNs, physicians, nurse attendants, social workers, physical therapists, dieticians, and pharmacists, the major actors in the nursing process are RNs and nurse attendants.
- *Input information:* A parallelogram represents the input reference information used by actors when performing services, such as an RN performing a holistic assessment or checking a care plan during daily care.
- *Information flow:* A thin arrow represents an information flow. Information is generated or required by various PSD activities and actors and includes input information, output information, and data files.
- *Output information:* The document symbol represents output information. This information is created after an actor performs a service. In LTC settings, critical output information includes resident records, daily care activity records, nursing records, etc.
- *Data files:* The database symbol is represented in the data file within the IS. The main functions of LTC facilities include nursing, social work, rehabilitation, nutrition, and medicine administration. All input information can be retrieved from the data file, and all output information is stored on the data file.

Illustrated LTC Service Activity and Demonstrated LTC Facility

LTC services include diverse health care, personal care, and supportive services that meet the needs of older adults or adults with limited self-care ability. Commonly provided services are social work, mental health care, therapies (physical, occupational, and speech), nursing, pharmacy, and diet and nutrition services.[44] Those services could be delivered through different types of activities such as assistance with ADLs (e.g., dressing, bathing, and toileting); instrumental IADLs, (e.g., recreation/activity leading/structured group exercise); and health maintenance tasks such as vital sign measurement, rehabilitation, diet and nutrition assistance, and medication administration.

We selected daily LTC service activity to discuss a required activity performed by an interdisciplinary health care team; this activity included assistance with ADLs and IADLs.

To illustrate our PSD SB approach, we applied it at case facility: Noble Healthcare and Rehabilitation, Taipei, Taiwan (referred to herein as N). The case demonstration method has been used in studies on product service systems, product extension service systems, and online–offline systems.[20–22,45] A case study is an empirical research method that chiefly involved using contextually rich data from real-world settings to investigate a focused phenomenon.[46] Case studies investigate a particular phenomenon and generally employ multiple data sources.[47] Data collection is a crucial step in a case study.[47] We not only reviewed the literature to obtain a complete picture of daily LTC activities but also conducted unstructured interviews to gain a comprehensive understanding of daily living services in an LTC facility.

Our LTC case facility: N was founded in 2003 at Taipei, Taiwan. At this LTC facility, the care process consisted of following government requirements and passing a regular 4-year evaluation in 2017. The governing body of N is required to employ full-time RNs and nurse attendants for LTC; in addition, N hires part-time dieticians and has contracts with rehabilitation therapists, physicians, and pharmacists.

The daily LTC activities corresponding to key actors (health care providers) are as follows: vital sign measurement, nurse attendant or RN; daily living assistance, nurse attendant or RN; recreation, social worker; rehabilitation, rehabilitation therapist; diet and nutrition, nurse attendant and dietitian; medication, RN. Regarding medication, RNs are the key actors in administering medicine and completing medication administration records according to a physician's medical prescriptions at an LTC; physicians (contracted) visit residents at an LTC facility every month and update medical prescriptions; pharmacists (contracted) review and dispense medicine according to a physician's prescriptions every week at an LTC facility. We were unable to gain permission for interviews with the pharmacist (contracted) and physician (contracted); an RN and senior administrative staff members were familiar with the physician and pharmacist service flow at N, so the senior administrative staff members were

recruited as interviewees. Finally, the interviewees were nurses, nurse attendants, social workers, dieticians, and senior administration staff (who helped to clarify the physician and pharmacist service flow).

The interview questions are as follows: Could you share your daily LTC service protocol at N? Which information needs to be checked prior to performing your service? Which information do you need to record or input into the system when finishing your service? Do you have any suggestions related to your job? Data collected from the case study interviews were used to inform the PSD SB for LTC environments. The interviewees and interview results are summarized in ►Table 1.

Results

The daily care activities summarized from the LTC-related literature and interview results are presented in ►Table 1 and ►Fig. 1, which are based on the PSD SB approach. The input and output information entries that are underlined in ►Table 1 are required per Taiwanese government regulations. ►Fig. 1 presents the following five layers and seven elements:

LTC Service Delivery Layer

When residents wake up in the morning, LTC facility health care teams regularly perform daily care activities, including vital sign measurement, daily living assistance or daily care, recreation, rehabilitation, diet and nutrition assistance, and medication assistance.

Actors Layer

The important actors in case N are RNs, nurse attendants, social workers, and rehabilitation therapists. Regarding diet and nutrition activity, the nurse attendant plays a major role in delivering meals according to the meal order, and dieticians (part time) play a secondary role in providing nutrition assessment and a nutrition plan for each resident every 3 months. Regarding medication, RNs play the major role for completing medication administration records; physicians (contracted) visit residents only once a month, and pharmacists (contracted) review and dispense medicine once a week.

Input Information Layer

- Measurement of vital signs: Nurse attendants or RNs checked residents' identification information and measured vital signs afterwards.
- Daily care or daily care assistance: RNs or nurse attendants checked residents' holistic assessment data and nursing care plans before providing or assisting with residents' daily care.
- Recreation: Social workers checked residents' psychosocial assessment records to, for example, determine the recreation program content and design structured group exercises.
- Rehabilitation: These tasks involved rehabilitation therapist–led assessments, occupational therapy assessments, and rehabilitation for determining the ideal rehabilitation approach.
- Diet and nutrition: Nurse attendants checked the residents' meal orders for delivering meals, and dieticians refer to residents' current status and prior nutrition assessments and nutrition plans for setting up appropriate meal orders.
- Medication: RNs checked medication preparations to administer medicine.

Output Information Layer

LTC service providers created and uploaded related records after performing pertinent services:

- Measurement of vital signs: These were updated in the residents' information file after each measurement.
- Daily care or daily care assistance: Nurse attendants or RNs updated the nursing records and daily active records for each resident.
- Recreation: Social workers updated recreation activity records, activity involvement records, mood status records, group exercise records, and (if relevant) complaint management records in the information file of each resident.
- Rehabilitation: Rehabilitation therapists updated rehabilitation activity records and therapeutic activity records.
- Diet and nutrition: Dieticians assessed the nutritional status of residents and developed a nutritional plan and meal order. Nurse attendants prepared meals according to the meal order and updated the meal records and intake–output records.
- Medication: Physician (contracted) reviewed or updated residents' prescriptions when visiting facility N every month. Pharmacists (contracted) dispensed the medicine to facility N every week. Nurses completed a medication administration record after delivering medications.

LTCIS-Related Application Layer

An LTCIS should incorporate residents' basic clinic demographic information and related nursing, social services, rehabilitation, nutrition, and medication services to support daily living services. An IS should not only provide relevant input information but also update the records after service delivery. All applications are interconnected within the main system at an LTC facility. Because the nursing process is the core of LTC, the nursing applications function in the IS should include a comprehensive geriatric assessment function, nursing plan, nursing records (output information), and evaluation sheets.

Discussion and Future Works

SBs can be used to explore service requirements; many modified SB techniques have been proposed for investigating product–service systems, product-extension services,[21,22,45,48] in-flight services, meal order services, and online-to-offline services.[19,20,23,49] These modified SBs permit only weak interaction among service providers and thus do not adequately consider multidisciplinary service

Table 1 Summary of the interview results

Key actors and interviewees	Activities	Time/frequency	Input information	Output information
Nurse attendant/registered nurse (RN) Interviewees: nurse attendant and RN	Vital sign measurement (blood pressure, respiration rate, pulse rate, and body temperature)	1. Before 9:00 a.m. and 4:00 p.m. every day. 2. Emergency situation	Vital sign measurement	Resident care record
Nurse attendant/RN Interviewees: nurse attendant and RN	Daily living assistance (e.g., tube feeding, changing posture, and condition observation)	Every 2 hours	1. Holistic assessment 2. Care plan	1. Nursing records 2. Daily care records
Social worker Interviewee: social worker	Recreation activity leading, structured group exercise	Twice a week (individual activities according to the evaluations)	Psychosocial assessment	1. Mood status record 2. Recreation activity record 3. Group exercise record 4. Activity involvement record 5. Complaint management record
Rehabilitation therapist (contracted) Interviewee: rehabilitation therapist	Rehabilitation	Twice a week (individual activities according to the evaluations)	1. Rehabilitation assessment 2. Physical and occupational therapy assessment 3. Rehabilitation plan	1. Rehabilitation activity record 2. Therapeutic activity record
Nurse attendant/nutritionist (part time) Interviewee: nurse attendant and nutritionist	Diet and nutrition	1. Three meals and snacks per day 2. Nutrition assessment	1. Meal order 2. Nutrition assessment and nutrition plan	1. Meals record 2. Intake/output record 3. Nutrition status record
RN/pharmacist (contracted)/ physician (contracted) Interviewee: RN and senior administration staff	Medication administration	1. Check every day according to doctor's advice and medicine list 2. Contracted physician: once a month 3. Contracted pharmacist: once a week	Medication preparation	Medication administration record (MAR)

Note: Input and output information that are underlined are required by the Taiwanese government.

settings. PFA can map health care processes by redesigning the process or incorporating related technologies to improve care efficiency[6,50]; however, PFA chiefly concerns service workflow analysis and lacks service requirement analysis. The characteristics of LTC services are different from those of other service fields; LTC is a PSD system in which service delivery is guided by assessments with health care providers, and such services are always interdisciplinary.[9,27] Thus, traditional SBs, modified SBs, and PFAs all have limitations when applied to the IS requirements of LTC facilities. Our proposed PSD SB can not only help visualize health care delivery processes but also identify the information requirements of interdisciplinary service providers. These advantages of the PSD SB can be attributed to three characteristics: (1) an SB visualizes the nature of service processes.[18–20] (2) It incorporates four essential elements of EA—process, information, application, and technology.[29,33,35,36] (3) An "actors" layer can be added to an SB to help identify related interdisciplinary LTC service providers. The PSD SB is easily interpretable and can be used to gather and visualize multidisciplinary LTC service providers' IS requirements. Future studies should verify our results in different PSD settings in the health care industry.

Medical information technology has been rapidly progressing. Electronic medical records (EMRs) and electronic health records (EHRs) are shared with individuals in many developed countries[51]; online data sharing is one approach for establishing a patient–health care provider relationship.[52] The application of Internet of Things (IoT) technology has increased considerably, especially in vital sign monitoring.[53] Raban et al[54] reported that health care facilities can use EMRs as reminders to check and remove medication patches. Accordingly, LTS IS can be further integrated with EMRs or EHRs and connected with a main LTC system through a data exchange interface for relevant applications. Wearable devices can be integrated into the input information layer through a transmission interface or an application that connects such devices to a main LTC system to reduce staff workload.

Many wearable devices use the IoT for data communication.[55] Verdouw et al[56] proposed six viewpoints, one of which is the IoT layer viewpoint in which the layers are specifically defined for an IoT-based system, including IoT application functions, capability to support application functions, network connectivity data for specific application, and device and gateway capability. Given that Unified Modeling Language (UML) is one of the common EA mapping tools for EA practitioners and that Verdouw et al[56] clearly defined the IoT layer, we will work to combine our PSD SB approach with Kruchten's $4+1$ views,[57] the concept proposed by Verdouw et al,[56] and UML-related diagrams. We also will demonstrate the application of this approach to an LTC facility to visualize the information requirements for enhancing the PSD SB's acceptance.

Conclusion

LTC services are based on assessments by health care providers, and they are performed by an interdisciplinary health care team. When developing a robust LTCIS, developers must consider an LTC's characteristics. The study referred to DT, SB, and EA, proposed a PSD SB, and illustrated the LTC daily care activity, the major LTC care service, at facility N. The proposed PSD SB comprises five layers (service delivery, actor, input information, output information, and LTCIS-related applications) and seven elements (LTC activity, activity flow, actors, input information, information flow, output information, and LTCIS-related applications). The PSD SB could help visualize the service processes of various actors, demonstrate actors' input and output information requirements, and present suggested LTCIS-related applications. Therefore, we believe that the PSD SB approach can not only explore the interdisciplinary service team's IS requirements but also serve as a new mapping tool for visualizing service processes.

Clinical Relevance Statement

A well-designed IS allows LTC facilities to enhance their service quality and performance in response to population aging. The study proposes a modified SB approach that not only collects the system requirements of health care providers but also serves as a new visualization method for PFA of the LTC process.

Multiple Choice Questions

1. Which of the following is not an essential issue to be considered before developing a long-term care system?
   a. Identify all relevant stakeholders.
   b. Collect all relevant stakeholders' system requirements.
   c. Include registered nurses as important stakeholders in a long-term care setting.
   d. Finish constructing information system as soon as possible to improve care quality.

   Correct Answer: Option d. An information system (IS) helps users improve their effectiveness and efficiency. Therefore, regardless of whether an IS or a long-term care system is developed, identifying the relevant stakeholders and collecting their information system requirements are critical issues. Moreover, registered nurses play a vital role in long-term care settings. However, if an IS is developed quickly without consideration of stakeholders' system requirements, the system will fail to meet such requirements.

2. Which of the following is an advantage of incorporating the SB approach into IS development?
   a. An SB is effective for collating interdisciplinary service providers' information system requirements.
   b. An SB can map the service process.
   c. An SB can visualize the service process, interactions among service providers, and their required information.
   d. All of the above.

   Correct Answer: Option d. Originally, the SB was a method for visualizing the service process; the SB approach separates the service system into the front of stage,

such as service receivers, service processes, and service providers, and the backstage, such as an information system (IS). Therefore, SBs can also visualize the interactions between frontage personnel and an IS—especially in terms of service providers' IS requirements.

Protection of Human and Animal Subjects

This study followed the code of research ethics and conformed to the Taiwanese government's requirements. The study did not collect any relevant identifying information on the humans involved, and the interviews conducted were anonymous. The purpose of the interview was to gain information on service flow, required input information, and output information/records. Before the interview, the researcher verbally informed all interviewees of the research purpose, research procedure, benefits, the risks faced in participating in the interview, and their right to join and even drop out of the study at any time.

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None.

Conflict of Interest

The fourth author, Mr. Sang, is currently working for the LTC facility from which we collected our data. He was excluded from the data collection process to avoid bias. He played the role of a consultant by providing our research team with knowledge on LTC policy in Taiwan.

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