Three Dimensions Model: Stage for Service innovation in Hospital

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Abstract
Hospitals have seen considerable change in terms of incorporating advanced technologies. The emergence of new technologies such as nanotechnology, biotech, and information communication technology encourage hospitals to find new ways of working, both by inventing their own technologies and importing them. It helps hospitals to be organizations that embrace innovation. This study divides health-service innovation in the hospitals into four types, product innovation, service innovation, process innovation, and business model innovation, and proposes new service development processes divided into three dimensions: fuzzy front end, service development, and commercialization. Each dimension has 10 steps and each step has a positive relationship to the next.

Keyword: Hospital innovation, Service development, Service innovation

1. Introduction
Innovation is a key driver of success not only in the industrial sector but also the service sector. Businesses must find innovative ways of ensuring their growth and survival. Hospitals are also looking for ways to improve services to customers as nowadays they are not only for treating patients but also support healthcare provision by offering health-check programs, prediagnosis testing, as well as following up with the customers after treatment. The service innovations of the hospital are complicated by many factors. For example, hospital personnel reflect various skills and specialisms, such as doctors, nurses, technicians, radiologists, pharmacists, marketing officers, IT officers, and service officers. In this context, it can be difficult to provide integration innovation. In addition, there are often many patients for each staff member because of staff shortages. New medical equipment can also raise new problems as the same equipment cannot necessarily be universally used; every patient has different conditions and needs different equipment as part of their treatment. Medium-sized hospitals are not necessarily able to maintain the full range of medical equipment, and to serve a range of patients need to create their own innovations in order to thrive in the business. This research reviews types of health-service innovation in the hospitals, surveying research to develop new service processes, and analyses the relationship between steps in the new service development.
2. Literature reviews

2.1 Innovation in healthcare service

Service innovation in hospitals are new services and new working methods and technologies (Lansisalmi et al., 2006:67) which offer benefits to patients that include healthier lives and less suffering from illness (Faulkner and Kent, 2001:896). From the point of view of hospitals, novel ideas include new products including medicines, medical technology, and IT systems. Novel services are clinical treatment regulations, supporting services such as conference services and new processes such as treatment strategies, patient practice concepts, or new organization structures (Salge and Vera, 2009:55). The organization should always aim to realize internal process effectiveness and ensure treatment quality. Service innovation in hospitals has three important features: freshness, usage of technology, other treatment components, and expected results (Lansisalmi et al., 2006:67). A study of service innovation by Djellal and Gallouj (2007) reviewed related literature on hospital innovation and divided into it into four groups: those which take an economic perspective and study production factors; those which study technology capability and medical biology, including sub-areas dealing with biomedical innovation, biopharmacology, and systematic medical innovation; those which look at IT innovation for management, treatment, and tool and equipment usage; and those examining the innovation of service providers and the healthcare system. Innovation helps people to have greater choices in diagnostics and treatment. At the same time, the use of technology depends on many factors, including the skills of service personnel, service processes, technology, tools, equipment, and safety factors. Therefore, the service design must correspond to the systemic context.

Health-service innovation is more complicated than other service innovation due to the difficulties in changing behaviors of clinical service providers in terms of clinical practice, treatment, hospital regulations, as well as financial, social, clinical, and ethical risks (Lansisalmi et al., 2006:67; Williams et al., 2008:29 and Williams, 2011:214.) Studies of health-service innovation can be divided into two types—echoing the study of service innovation more broadly—incremental innovation (nondisruptive innovation), and radical innovation (disruptive innovation) (Varkey, Horne and Bennet, 2010:383). Radical innovation is a new innovation in the same market while disruptive innovation is related to the emergence of a new market and or group who have never used the product/service before (Hwang and Christensen, 2008:1330). This corresponds to Soleiman’s study (2011:205). Drawing on research by Christensen and Rynor (2003: 45), he studied how health-service innovation was related to disruptive innovation in the market and quality and value in response to customers’ needs.

Schrijvers, Oudendijk, and Vries (2003) categorized types of innovation into two groups. The first is innovation of the care process, meaning the implementation process and activity coordination of the healthcare team, called protocol. It consists of (1) new methods of care delivery which the new medical technology provides, such as laparoscopic surgery and neonatal screening; (2) standardization of existing care to provide better and safer treatment results. Patients are safe and the days they have to stay in the hospital are reduced, resulting in improvements in quality for patients, and effective cost management and pride among service providers; (3) Transmural care programs, involving connections between hospitals, doctors and the community. The second group identified by Schrijvers, Oudendijk, and Vries is structural change, meaning new structures of service, multi-career patient treatment in the hospitals including (1) new structures for the delivery of primary healthcare through the integration of hospital and home-care systems to improve quality, speed of care and reduce costs; (2) multidisciplinary structures within hospitals integrating more than two areas of patient treatment; (3) new public infrastructure to oversee new policy innovations from government such as vaccination.

Fleuren, Wielfering, and Paulussen (2004:111) reviewed literature published between 1990 and 2000 and categorized the work in health-service innovation into four types: guidelines, health promotion programs, quality systems, and other innovations involving doctors, personnel, and medicine. Another study by Parnaby and Towill (2007:141) examines the quality development system in relation to health-service innovation. In a study of health-service innovation using the Train-Do-Train-Do cycle, it was noted that people involved in the process must participate actively in the project, and the process must be adjusted from previous processes to an innovative process termed Management by Project (MBP). Process innovation has four steps: The first is realization, meaning identifying and defining the need for innovation. The second process is investigation, consisting of selection and training for the innovation operation, and method offering. The third step is exploration consisting of testing and method adjustment, and ensuring the best method for the operation and management of the new business. The fourth step is evolution consisting of innovation delivery and continuous improvement with self-learning. This pattern of health-service innovation can be seen in Meyo, Minnesota State, USA, where they set up an innovation team to run an innovation program called SPARC (See–Plan–Act–Refine–Communicate). The team is an in-house service laboratory consisting of various groups including designers, business experts, doctors and other medical personnel, who work together to solve complicated problems in a people-centered way (Duncan and Breslin, 2009). The problem-solving methodology of SPARC.
consisting of topic framing followed by research, design and development, and implementation. The SPARC team also consults and follows up.

Health-service systems are complicated (Fleuren, Wiefferink, and Paulussen, 2004:107). Medical technologies and clinical services (Consoli and Mina, 2009:297; Lechoux and the team, 2008:251) must work effectively together and many related units can cause an innovative gap. This creates a gap in health-service innovation which leads innovations to be unsuccessful at the distribution and operation steps (Adler et al., 2003; Phillips et al., 2006; Parnaby and Towill, 2007; Toner and Tompkins, 2008). A study of the usage of health-service innovation in a respiratory clinic found that only 50% were used in real operations. The principal reason for not using health-service innovations was found to be that the previous methods were easier. The new standards could not be used when there were a large number of patients. Using the methods in research was fine, but it was different during operations (Roberts, Gkasser, and Partridge, 2010). Experts analyzed service changes but found that personnel still used old methods and did not manage costs effectively in an intervention studied by Lehoux et al. (2008:251). They found the innovation process has three perspectives: the perspective comparing patient and provider service needs and technology; the interaction between innovation and uses and patients or medical personnel who use that innovation every day, meaning the design process must be undertaken jointly by designers and users; and the sustainability of the innovation by considering the business model and the design to make the health-service innovation sustainable.

Innovation is a new area for hospitals in terms of the type of innovation, knowledge and management processes and related research. From our review of service and health-service literature, we found that health-service innovation refers to service innovation, as well as innovation process management. However, with the complications of hospital business implementation, innovation is divided in detail in terms of patient care and treatment. Also, the innovation process partly depends on research process outlined in the Mayo hospital case. Therefore, studying service innovation involves studying technology transfer, adoption and diffusion. This study divided health-service innovation as follows:

- Product innovation is an innovation derived from science, technology and IT experiments.
- Service innovation to support medical care consists of service innovation mainly using technology and service innovation without technology, but using technology as a tool in the service.
- Process innovation is an innovation of medical care, guidelines, quality improvement innovation, or new business model.

2.2 New service development Model

Research on the development of new services in hospitals has drawn from research on product development as well as new service development in other business, in particular drawing on the model offered by Varky, Horne and Bennet (2008:384). They offer a process for building health-service innovation by adapting from product development processes, identifying a process consisting of:

Stage1: Idea generation, problem identification, and opportunity recognition. This step is related to hospital strategy, research, cross-functional teams and brainstorming techniques. Moreover, a clinical risk study looking at legal impacts must also be undertaken. Risks should be assessed by engineers, patients or medical personnel (Williams et al., 2008) and a map developed to be used as the basis for finding new ideas.

Stage 2: Idea evaluation. Selecting ideas to support patient needs in a matrix form. The vertical axis consists of the factors of convenience, simplicity, risk/safety, effectiveness, cost, opportunity costs and quality; and the horizontal axis consists of referral or self-referral, clinical visit, consultation, diagnosis, treatment, billing/payment, and follow up.

Stage3: Development and bringing the prototype into use and testing. This step is developed from the quality improvement process. Prototype testing must reflect concern about safety and must be approved by directors and committees dealing with animal and human studies.

Stage 4: First use. The experimenters should be the same group that participated in the service development in order to obtain more precise results.

Stage 5: Commercialization. Health-service innovations can be difficult to protect in intellectual property terms as they are spread by personnel or patients who visit the hospitals every day. Bower (1987) develops a model from Booz, Allen and Hamilton (1982) to develop hospital services in eight steps: (1) develop a long-term business strategy; (2) define a new type of service (3) idea generation is part of the selection process of a new idea; (4) concept development and evaluation to receive a new service idea; (5) business analysis to study potential of the new service and to forecast the profit; (6) service development and testing; (7) market testing; and (8) commercialization. In this study, I have divided new service development into three dimensions, as follows:
Dimension 1, the fuzzy front end, consists of four steps:

Step 1: Service development strategy which has the following activities: selecting topics to build innovation, defining objectives of the study which must correspond to the vision, establishing a cross-functional team to find information, sourcing and defining the budget for the implementation.

Step 2: Idea generation and idea selection, which has the following activities: planning to gather information from primary and secondary patents to cover objectives from both internal and external sources, gathering information and group ideas from different sources, selecting important ideas, defining unique features of the service, and defining important relevant persons.

Step 3: Concept design, which has the following activities: bringing the selected idea to design with involvement from selected persons, bringing the designed idea to test with related persons in the management process in Step 4.

Step 4: Analyzing advantage, disadvantage, opportunities, and obstacles of the services; analyzing financial marketing technology potential; and analyzing medical risk.

The second dimension of service development consists of four steps:

Step 1: Service design, which includes bringing the prototype to into service while considering the safety and risks to patients, and testing in the lab.

Step 2: Process, system design, and testing, which have the following activities: design-related processes to support the services; testing the whole system from prototype, process, and system.

Step 3: Training, which has the following activities: inviting people related to the service to receive training, especially important in the case of high-risk patients who require service-provider skills.

Step 4: Pilot run and market testing, which has the following activities: testing of the service pilot project, testing with a target group which has the same qualifications as people in the design group, as well as other target groups to compare the service and adjust it to correspond with requirements.

The third dimension is commercialization and consists of two steps as follows:

Step 1: Intellectual property, which involves the evaluation of intellectual property by related units to protect benefits for the hospital.

Step 2 Full-scale launch and post-launch review, which includes communicating the innovation to the target group, developing the marketing plan by analyzing marketing components, expectations and satisfaction evaluation.

3. Methodology

This study is based on a questionnaire survey of 1,349 hospitals that have received a quality certification from the Healthcare Accreditation Institute (Healthcare Accreditation Institute, 2010). The hospitals selected were all level 1 accredited hospitals, excluding clinical-type healthcare and specific healthcare. There are 1,093 remaining hospitals. This study collected data from the population group by sending questionnaires with attached return envelopes, as well as two follow up emails. The first was sent to 60 hospitals to test the accuracy and reliability of the questionnaires. In all, 33 hospitals agreed to cooperate and the number of hospitals to be delivery reduced to 33. Therefore, 252 hospitals or 24.9 % returned questionnaires. The researchers selected complete questionnaires to be analyzed for 238 questionnaires.

The researchers sent questionnaires to three experts in universities and in the middle management of the hospitals to review the content validity, content, and construct validity. Following their advice, improvements were made to the questionnaires and they were sent to a sample group of 60 to test reliability using Cronbach’s Alpha Coefficient. The coefficient from the test was 0.892.

4. Result

4.1 General information.

Of those who returned the questionnaires, 79.4% were public hospitals, and 20.6% were private hospitals. The majority of innovation in the hospitals is service innovation combined with process innovation (42.0%). The next most significant is service innovation (13.9%), followed by product innovation (12.6%). The number of innovation projects at the hospitals in a year is mostly less than 10 projects (65.1%), next is 11–20 projects (23.9%), while 5.9% of hospitals had 21–30 projects, and 5.0% of hospitals had more than 30 projects.

4.2 Study process of new service development
The first-dimension fuzzy front end. New service development strategies have the highest average, equal to 3.72. Next most significant is gathering and selecting ideas, which has an average of 3.44, equal to service-provider training. Designing and testing the services has an average of 2.89. Business analysis has an average of 2.86. Designing an idea has an average of 2.70. Design average and process testing is equal to 2.51, and pilot project implementation and marketing testing has an average of 2.42. The hospitals bringing the innovation to use in the hospital have the highest average at 3.60. Next is the social perspective of sharing knowledge use, which has an average of 2.79. The hospitals which develop innovations to sell to customers have an average of only 1.78, which close to the average of the joint ventures at 1.26.

4.3 Results of the study of the relationship between the steps in each dimension of the new service development.

In the study on new service development, the researchers made a relationship assumption between the steps in each dimension of the new service development, as follows:

It is assumed that the steps in each dimension of the new service development have a positive relationship to each other.

Statistical assumption

\[ H_0: \text{Steps in each dimension of new service development are not related to each other.} \]

\[ H_1: \text{Steps in each dimension of new service development are related to each other.} \]

New service development consists of:

The first dimension, fuzzy front end, consisting of four steps: service development strategy, idea generation and idea selection, concept design, and business analysis.

The second dimension, service development, consisting of four steps which are service design, process, system design and testing, training and pilot run, and market testing.

The third dimension, commercialization, consisting of two steps, which are intellectual property protection, and full-scale launch and post-launch review. However, this relationship test does not include intellectual property protection.

The study found that the training of service providers (the third step in the second dimension) is the variation that is not related to steps and dimensions to develop new services for almost all variations except for the first step in the first dimension – service development strategy – but this has a low value relationship of .137. When determine each step, the results were as follows:

The groups with clear relationships are:

Concept design dimension 1 step 3 has a positive relationship with service design dimension 2 step 1, with a statistical significance of .01 and correlation of .757.

Concept design dimension 1 step 3 has a positive relationship with process, system design and testing dimension 2 step 2, with a statistical significance of .01 and correlation of .648.

Service design dimension 2 step 1 has positive relationship with process, system design and testing dimension 2 step 2, with a statistical significance of .01 and correlation of .659.

Concept design dimension 1 step 3 has positive relationship with pilot run and market testing dimension 2 step 4, with a statistical significance of .01 and correlation of .618.

Other steps have a positive relationship with each other of between .233 and .564.

This study refutes the assumption that steps in each dimension of new service development have a positive relationship to each other because dimension 2 step 4, training, is only weakly related to strategy of service development and not related to other dimensions, even though new service development steps in each dimension have a positive relationship with each other.

Implications

This study outlines steps to develop new services for hospitals by using three main dimension steps that build connections and project evaluation in each dimension, and increase clinical risks of service innovation of the process resulted from the guidelines and practice, as well as evaluation in each dimension:

Dimension 1, fuzzy front end, consisting of four steps, as follows: (1) service development strategy including the selection of the innovation, defining the objectives of the study to correspond with the vision, assembling a cross-functional team, investigation of data, sources of data, and defining a budget for implementation; (2) idea
generation and idea selection, including plans to collect data from primary data, secondary data, patent databases, to cover objectives of data sources both internal and external, gathering data and group ideas from different sources, selecting important ideas and defining unique features of the service, and relevant persons; (3) concept design, including involving related persons to be involved in the design and bringing the idea to test with relevant persons in every service process; (4) business analysis, consisting of analysis of advantages, disadvantages, weaknesses, opportunities and obstacles of the service, financial, marketing, and technology analysis.

When the implementation of dimension 1 is complete, the results should be tested by relevant groups and analyzed in terms of financial, marketing, and technological potential and clinical risk before being submitted to decision-making directors at the hospitals to consider. Their considerations should be based on the following criteria which correspond to the vision of the hospitals: time needed to create service innovations and launch to the market, budget, value for money, and clinical risk. If the idea passes the evaluation criteria, it can be implemented in dimension 2. If the idea fails the evaluation at this point, the project should be kept in a database for an appropriate time in the future. Therefore, an important tool for a hospital is an innovation database of ideas which have passed the implementation process. This study identifies this dimension as being part of the top structure of the new service development process.

Dimension 2, service development: After the innovation step 1 has been approved by authorized persons, it can be implemented in dimension 2. Dimension 2 consists of (1) service design consisting of the use of prototypes to design services by thinking of safety and risk to patients, and tests in the laboratory; (2) process, system design and testing by designing the related processes to support the service, and testing the whole system from the prototype, process and the system; (3) training, which includes inviting relevant people in the service to receive training especially in cases where the service is risky for patients and service providers must be skillful; (4) Pilot run and market testing, which involves testing pilot projects with qualified target groups to compare the service and make adjustments to correspond with the requirements. In this dimension 2, all stakeholders should participate in the process to help ensure the innovation corresponds to the needs as much as possible, except in the case of specialty need in which case it demands project specialist consideration.

Dimension 3, Commercialization: This dimension consists of two sub-steps which are (1) intellectual property, meaning people who participated in this step are responsible for appraising the intellectual property and registering protection requests if the service innovation passes all criteria; and (2) full-scale launch and post-launch review. This step brings services to the market. It must pass satisfaction and quality evaluation for future improvement. If it is needed to improve the service, data will be sent back to dimension 2 service development and recorded in the database to connect to the new service development in dimension 1. If the innovation is incremented and must be re-evaluated, dimension 2 service development and dimension 3 commercialization are in the base of service innovation model for the hospitals.

In examining the relationship between steps in each dimension of new service innovation, every step was found to have a positive relationship with the others, and only training was found not to be related to the others and to have only a weak relationship with service development strategy. Hospitals are providers of services that rely on interaction between people, who must be trained continuously. It seems that training is not related to the other steps because personnel are already trained continuously.

Conclusion

In this survey of innovation types in the hospitals, the steps to develop new services, and the relationship between dimensions of new service development, it was found that health-service innovation is divided into product innovation, service innovation, process innovation, and business model innovation; and the new service development dimension is divided three – (1) the fuzzy front end dimension; (2) service development dimension; (3) and commercialization dimension. Committees should review each process in each dimension and consider the implications for project implementation. The next study found that concept design, service design and process, system design and testing had a positive relationship, and the researchers will conduct further research to explore the relationship among these three variables.
References


Annexure

Table 4.1 shows average and standard deviation of implementation dimensions before new service development (Fuzzy front end)

<table>
<thead>
<tr>
<th>Service Development Steps</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service development strategy</td>
<td>3.72</td>
<td>0.778</td>
</tr>
<tr>
<td>Ideas generation and selection</td>
<td>3.44</td>
<td>0.833</td>
</tr>
<tr>
<td>Concept design</td>
<td>2.70</td>
<td>0.917</td>
</tr>
<tr>
<td>Business analysis</td>
<td>2.86</td>
<td>0.760</td>
</tr>
</tbody>
</table>

Table 4.2 shows average and standard deviation of service development dimensions

<table>
<thead>
<tr>
<th>Service Development Process</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service design</td>
<td>2.89</td>
<td>0.924</td>
</tr>
<tr>
<td>Process, system design and testing</td>
<td>2.51</td>
<td>0.845</td>
</tr>
<tr>
<td>Training</td>
<td>3.44</td>
<td>0.828</td>
</tr>
<tr>
<td>Pilot run and market testing</td>
<td>2.42</td>
<td>1.129</td>
</tr>
</tbody>
</table>

Table 4.3 shows average and standard deviation of service development dimensions of the commercial use of innovation

<table>
<thead>
<tr>
<th>Commercial use of innovation</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service launch to the market and evaluation</td>
<td>3.26</td>
<td>0.805</td>
</tr>
<tr>
<td>Joint venture with external company</td>
<td>1.26</td>
<td>0.600</td>
</tr>
<tr>
<td>Sell innovation to hospital customers</td>
<td>1.78</td>
<td>1.223</td>
</tr>
<tr>
<td>Use innovation only in the hospitals</td>
<td>3.60</td>
<td>1.116</td>
</tr>
<tr>
<td>Use innovation from social perspective to share knowledge</td>
<td>2.79</td>
<td>1.231</td>
</tr>
</tbody>
</table>
Table 4.2 shows the correlation matrix of new service development stages:

<table>
<thead>
<tr>
<th>Service strategy</th>
<th>Idea generation and selection</th>
<th>Service concept</th>
<th>Buisiness analysis</th>
<th>Service design</th>
<th>Process, System design and testing</th>
<th>Pilot run and market testing</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea generation and selection</td>
<td>Pearson Correlation</td>
<td>.438**</td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service concept</td>
<td>Pearson Correlation</td>
<td>.387**</td>
<td>.459**</td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Buisiness analysis</td>
<td>Pearson Correlation</td>
<td>.423**</td>
<td>.505**</td>
<td>.508**</td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Service design</td>
<td>Pearson Correlation</td>
<td>.345**</td>
<td>.513**</td>
<td>.757**</td>
<td>.488**</td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td>Process, System design and testing</td>
<td>Pearson Correlation</td>
<td>.372**</td>
<td>.564**</td>
<td>.648**</td>
<td>.538**</td>
<td>.659**</td>
<td>Sig. (2-tailed)</td>
</tr>
<tr>
<td>Pilot run and market testing</td>
<td>Pearson Correlation</td>
<td>.379**</td>
<td>.399**</td>
<td>.618**</td>
<td>.419**</td>
<td>.507**</td>
<td>.494**</td>
</tr>
<tr>
<td>Training</td>
<td>Pearson Correlation</td>
<td>.073</td>
<td>-.017</td>
<td>-.062</td>
<td>-.031</td>
<td>-.080</td>
<td>-.104</td>
</tr>
<tr>
<td>Full scale launch and Post launch review</td>
<td>Pearson Correlation</td>
<td>.304**</td>
<td>.323**</td>
<td>.355**</td>
<td>.304**</td>
<td>.337**</td>
<td>.334**</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).