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Abstract, Key Words and Abbreviations

Objective: Process innovations can increase efficiency and quality in service organisations [1, 2]. Health services organisations have been criticised for being slow to exploit process-management innovations [3, 4]. To address perceived deficiencies, this article combines knowledge of factors that improve the diffusion of innovation (DoI) in health services organisations [5] with organisational behaviour theory [6] to produce a practical tool to assist health managers and clinicians assess the likelihood of an innovation succeeding in their organisation.

Design: Semi-structured interviews were used to identify and analyse organisational, group and individual factors supporting or impeding the implementation of process changes in a public hospital Sonography Department.

Setting: Emergency and Imaging Departments within a public hospital in New South Wales (NSW).

Results: Using extant research literature and data collected from the hospital, a checklist was developed to identify factors that aid the implementation of innovations within health services settings. The checklist prompts people responsible for innovation implementation to consider key factors that influence the DoI, identify gaps between the current and desired states and develop action plans to address these gaps.

Conclusions: The checklist developed in this article helps health personnel predict the likelihood of innovation adoption, and identify gaps to the ideal state at organisational, group and individual levels. The necessity of conscious change management when implementing innovations is also addressed. Given impending national healthcare reforms, this article is both important and timely.

Key Words:

Diffusion of Innovation, Innovation, Implementation, Public Hospital, Animated computer simulation

Introduction

This article examines and illustrates factors which can influence the diffusion of innovation (DoI) within health services settings. First, current knowledge of DoI in health services [5] is used to develop tables of organisational, group and individual factors that influence DoI. Then, an example of Lean quality improvement methods complemented by computer simulation illustrates the value of a checklist when implementing innovation. The checklist may assist clinicians and managers assess individual, group and organisational factors relevant to innovation adoption before and during implementation efforts.

NSW Public Hospitals

Unmet demands for hospital services constitute a significant and growing problem in many OECD countries [7]. This causes problems for patients and hospital staff charged with meeting increased workloads with limited resources [8]. Nations experiencing similar challenges are increasingly applying proven management methods from other industries, to health services settings [7, 9]. These methods include operations management and computer simulation techniques [10-12]. Although the diffusion of product innovations is well documented [13], the diffusion of process innovations *across* industries is relatively unexplored. Furthermore, hospitals may resist innovation due to the nature of their work (high uncertainty coupled with risk of patient death), workforce characteristics (occupational hierarchies, strong professional and weak organisational identification), leader-workforce relations (transactional exchanges and perceptions of conflicting goals) and weak performance measurement and reward systems [3].

DoI theory may help identify process innovations likely to be acceptable to health services personnel [5] and supply them with tools to improve process quality and efficiency with low risk [3]. Previous studies of innovation in health care delivery show improvements in patient flow, efficiency and quality are possible. [14] For example, Fitzgerald et al. [15] found that by using simulation to make changes to the allocation of staff, the scheduling of patients for appointments, and changing appointment timeslots, innovation could be used to increase patient flow. This article examines a recent case of

innovation diffusion from manufacturing to health service sectors, namely the use of Lean thinking and animated computer simulation to identify and model potential process changes.

Diffusion of Innovation

DoI research tracks the adoption and spread of innovations within and across organisations and markets. Five adopter categories [13] classify individuals and organisations based upon their propensity to innovate as shown in Table 1.

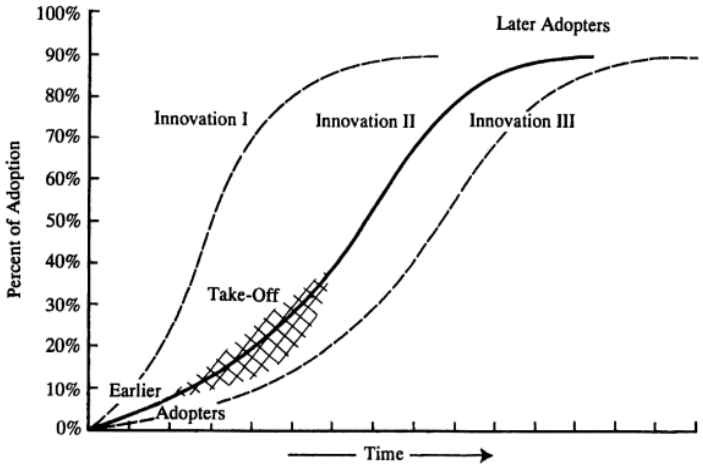
Table 1: Rogers' Categories of Innovation Adopters

Category	Definition
Innovators	The first individuals or organisations to adopt a particular innovation, approximately 2.5 % of the population
Early adopters	The next 13.5% of the population, characterised by opinion leadership and a high degree of respect from peer individuals and organisations.
Early majority	Adopt new ideas just before the average, and comprise about 34% of the population
Late majority	Making up 34% of the population this group will adopt innovations, often as a result of economic necessity and peer pressure
Laggards:	The remaining 16% have lengthy innovation decision processes and adoption occurs a long time after initial awareness of new ideas. The term 'laggard' is not intentionally pejorative. Slow adoption of innovation may be justified by limited resources and exacting performance standards

Source: Rogers, 2003

Four elements, the innovation, communication channels, time and the social system, are identifiable in every instance of DoI [13]. Interactions between the innovation, the social system and the resulting rate of adoption (when plotted on a cumulative basis) produce a distinctive S-curve (see Figure 1).

Figure 1: Innovator Categories and Cumulative Diffusion of Innovation Over Time



Source: Rogers, 2003 [13], p.11

DoI research in health services has tracked the spread of new drugs and new procedures. However, few studies have considered the diffusion of management process innovations in contrast to clinical improvements.

Diffusion of Innovation in Health Settings

In the context of health settings, this work adopts the definition of innovation as 'a novel set of behaviors, routines, and ways of working that are directed at improving health outcomes, administrative efficiency, cost effectiveness, or users' experience and that are implemented by planned and coordinated actions' [5] (p. 582). Every innovation challenges individuals, groups and organisations to adopt new methods or new ways of solving problems, but the probability that the new idea is superior to previous practice is not initially known [13].

The characteristics of health services combine to create organisational environments that are wary of the uncertainty that is inherent in innovation [3]. Innovation implementation in health services necessitates consideration of many factors to address these concerns. A systematic literature review of DoI in health services [5] identified numerous influences which can be categorised into individual, group and organisational factors (see tables 2 to 4). The research team categorised the influences previously identified by an extensive review of health services innovation literature [5] into seven organisational, six group and 11 individual characteristics. This was accomplished by

using Organisational Behaviour theory [6] and the practical experience of the research team.

Table 2: *Individual* Factors Influencing Diffusion of Innovation in Health Settings

Factor	Description and Impact on Innovation
Relative Advantage	Innovations that have a clear, unambiguous advantage over current methods are more easily adopted and implemented
Compatibility	Innovations that are compatible with the intended adopters' values, norms, and perceived needs are more readily adopted
Complexity	Innovations that are perceived as simple to use are more easily adopted
Trialability	Innovations which allow experimentation by intended users are adopted and assimilated more easily
Observability	If the benefits of an innovation are visible to intended adopters, it will be adopted more easily
Reinvention	If potential adopters can adapt, refine, and modify the innovation to suit their own needs, it will be adopted more easily
Fuzzy Boundaries	Complex innovations in service organisations can be conceptualized as "hard core" (irreducible elements of the innovation) and a "soft periphery" (organisational structures and systems required for full implementation); the adaptiveness of the "soft periphery" is a key attribute of the innovation
Risk	If the innovation carries a high degree of uncertainty of outcome that individuals perceive as personally risky, it is less likely to be adopted
Task Issues	Innovations relevant to the performance of the intended user's work and that improve task performance are adopted more easily
Required Knowledge	If the knowledge required for the innovation's use can be codified and transferred from one context to another, it will be adopted more easily
Augmentation/Support	If a technology is supplied as an "augmented product" (e.g., with customization, training, and a help desk), it will be assimilated more easily

Table 3: *Group* Factors Influencing Diffusion of Innovation in Health Settings

Factor	Description and Impact on Innovation
Network Structure	The adoption of innovations by individuals is powerfully influenced by the structure and quality of their social networks
Homophily	The adoption of innovations is more likely if they are homophilous with current users of the innovation —that is, they have similar socioeconomic, educational, professional, and cultural backgrounds.
Opinion Leaders	Expert opinion leaders exert influence through their authority and status, and peer opinion leaders exert influence through their representativeness and credibility
Champions	The adoption of an innovation by individuals in an organisation is more likely if key individuals in their social networks are willing to support the innovation
Boundary Spanners	An organisation is more likely to adopt an innovation if those people who have significant social ties both inside and outside the organisation are able and willing to link the organisation to the outside world in relation to this particular innovation
Formal Dissemination Program	When a planned dissemination program is used for the innovation it will be more effective if it takes potential adopters' needs and perspectives into account, uses strategies to match demographic, structural, and cultural features of subgroups, uses appropriate style, imagery, and communication channels and incorporates rigorous evaluation and monitoring of defined goals and milestones

Table 4: *Organisational* Factors Influencing Diffusion of Innovation in Health Settings

Factor	Description and Impact on Innovation
Absorptive Capacity for New Knowledge	Organisations that are systematically able to identify, capture, interpret, share, reframe, and recodify new knowledge; link it with existing knowledge and to put it to appropriate use will be better able to assimilate innovations.
Culture and Leadership	A "learning organisation" culture, and proactive leadership directed toward sharing knowledge are pre-requisites for absorptive capacity
Receptive Context for Change	A receptive context for change incorporates the ability to embrace new ideas and change, strong leadership, clear strategic vision, good managerial relations, visionary staff in pivotal positions, a climate conducive to experimentation and risk taking, and effective data capture systems
Inter-Organisational Networks and Collaboration	An important influence on an organisation's decision to adopt is whether a threshold proportion of comparable organisations have done so or plan to do so
Structural Determinants	An organisation will assimilate innovations more readily if it is large, mature, divided into semiautonomous, specialized units; if it has slack resources to channel into new projects and if it has decentralized decision-making.
System Readiness for Innovation	Includes tension for change, (If staff perceive that the current situation is intolerable, a potential innovation is more likely to be assimilated successfully) availability of time and resources for innovative activities and intra-organisational communication
External Change Agents	External change agents will be more effective if they are selected for their homophily and credibility with the potential users of the innovation; develop strong interpersonal relationships with potential users and explore and empathize with the user's perspective

The theoretical framework summarised in tables 2 to 4 was applied to the implementation of an innovation (Lean thinking coupled with animated computer simulation) which had diffused from manufacturing to the public hospital setting. Lean thinking was applied to sonography department processes in an attempt to improve patient-flow between emergency and imaging departments (the sonography department was part of the imaging department). The process change suggestions made by hospital staff were simulated using computer software to predict the results if each suggestion was implemented.

Methods

Case research [16, 17] was used to examine an early public hospital adopter of Lean thinking coupled with computer simulation. Qualitative methods were used to collect and analyse data. Data collected included semi-structured interviews with key hospital informants, examination of internal documents and reports in the public domain and over two years of on-site observations. Data were collected from eleven interviewees, ranging

from receptionists responsible for making appointment bookings to the general manager. The semi-structured interviews centred on perceptions of innovations originating outside the health sector and organisational, group and individual factors that influence DoI.

Interviews were recorded and transcribed verbatim. QSR N-Vivo® software was used to aid detailed coding and analysis of the collected research material, facilitating the interpretation process. Thematic analysis [18] was used to identify group factors that influence DoI in health settings.

Results

A detailed description of the computer simulation technique used and full results of the individual, group and organisation levels of analysis are reported elsewhere [15, 19, 20, 21].

Individual Assessments of, and Influences on Innovation Adoption

While evidence of all eleven individual factors was found (see Table 5), three individual factors appeared particularly attractive to clinicians and managers: low-risk, trialability and observability. The combination of low-risk, trialability and observability, facilitated through the use of computer simulation, increased confidence in the change outcomes without the need for physical experiments which could disrupt patient treatments and hospital work practices.

Table 5: Summary of Responses to the Innovation at the Individual Level of Analysis

Factor	Description and Impact on Innovation
Relative Advantage	The innovation focused thinking about the use of hospital resources, demonstrated efficient ways to use those resources and permitted rapid, low-cost testing of improvement ideas.
Compatibility	The ability of the model to accommodate individual and occupational norms helped sonographers accept the model's predictions.
Complexity	After initial set-up, the operation and output of the model were perceived as simple to understand.
Trialability	Sonographers understood the ability to quickly change and experiment with the model, and asked for simulation of more options. Participants commented that being able to trial changes prevented real-world mistakes.
Observability	Changes made to visual representations of current practices and work settings were easily observed and understood when presented in an intuitive way on a computer screen
Reinvention	Respondents agreed the technique could be used in other process

	improvement projects at the hospital.
Fuzzy Boundaries	Interviewees recognised that Lean thinking and animated computer simulation had the flexibility to be applied in different organisational settings.
Risk	Importantly, the innovation was viewed as reducing uncertainty in change efforts, and reducing physical risks to patients.
Task Issues	The model replicated the work environment and case mix of the sonography department as accurately as possible and was recognised as directly relevant to the sonographers' work performance.
Required Knowledge	Experience of Lean thinking and interactive, animated computer simulations provided staff members with skills to comment about perceived problems and test potential changes in a range of settings.
Augmentation/Support	The innovation was supplied as an "augmented product" with university staff customizing the software program used to run the "what-if" scenarios.

As summarised above, informant responses to individual influence factors on DoI were consistently positive.

Group Influences on Innovation Adoption

Although individuals had all responded positively to the innovation when testing options to improve patient flow, they showed varying responses when they discussed the project in their occupational groups. A summary of responses to group factors influencing DoI appears in Table 6.

Table 6: Summary of Responses to the Innovation at the Group Level of Analysis

Factor	Description and Impact on Innovation
Network Structure	The structure and quality of social networks both supported and hindered DoI, depending upon prevalent group norms.
Homophily	The presence of a chief investigator with a nursing background helped build credibility. Although initially difficult to influence, once a group accepted the changes, they became advocates for the new system. However, some sub-groups displayed resistance,
Opinion Leaders	Expert opinion leaders were crucial to generating and maintaining interest in the innovation and securing 'buy in' from various clinical and administrative groups.
Champions	Charismatic members of staff with well-developed networks and alliances within the hospital used their roles to support the evaluation and use of the innovation.
Boundary Spanners	Senior managers and clinicians worked across intra-organisational boundaries to support departmental changes and provide feedback on progress. Connections to Australian researchers and their connections to Dutch researchers provided the innovation for assessment and adoption.
Formal Dissemination Program	Face to face meetings with staff members were held to communicate the changes, even though this required repeating the information for each shift. This was a conscious decision to provide opportunities for discussion and support existing patterns of clinical communication (senior to junior member) present in the hospital.

The resistance took a variety of forms, and the hospital was able to address staff concerns. Space limitations preclude a detailed review of resistance and responses in this article.

Organisational Influences on Innovation Adoption

Pressures for change dominated the organisational factor interviews. These pressures and other organisational factors are summarised in Table 7.

Table 7: Summary of Responses to the Innovation at the Organisation Level of Analysis

Factor	Description and Impact on Innovation
Absorptive Capacity for New Knowledge	Respondents reported that the origin of an innovation, particularly management innovations was not important. There was no evidence of a 'Not Invented Here' syndrome and the ability of an innovation to produce results was the main criterion for acceptance.
Culture and Leadership	Interviewees reported a cultural openness to change and innovation. Leadership behaviours of eliciting support from clinicians, using process improvement as a learning, not blaming experience for the departments and individuals involved, and focusing on measuring and improving hospital performance were reported as significant to the DoI success.
Receptive Context for Change	Dramatic improvements in intra-organisational relations were reported to have occurred during the last four years. The necessity of clinician engagement was reiterated by all informants in relation to power balances in the hospital. Good managerial relations, enabled experimentation and collaboration across functional departments.
Inter-Organisational Networks and Collaboration	Hospital staff members report active links with consultants, universities and Area Health Service groups and all are sources of management innovation. Hospital members were familiar with the use of Lean thinking in quality improvement. The initial users of the innovation (Imaging/Radiology) were already very familiar with a range of Information Technologies.
Structural Determinants	Few comments were made regarding the structure of the hospital. It was clear that inter-organisational networks provided some resources and functional expertise.
System Readiness for Innovation	Reports of pressure for change created by restricted resources dominated the interviews about organisational factors influencing DoI. Respondents reported significant pressures for change from all directions: top down in the form of directives from the NSW Department of Health, bottom up from increasing patient presentations at the Emergency Department with an increased occurrence of co-morbidities and increased demand for imaging diagnostic services by hospital specialists, and even sideways, from comparison with Radiology services in the private sector.
External Change Agents	External change agents came primarily from consultancies, universities and the Area Health Service. These external change agents did not require a medical background to be accepted, but did need to be willing to spend time in and understand the characteristics of hospitals.

The results show that the DoI influences derived from extant research [5] were present to varying extents in the hospital studied. Interestingly, while individual and organisational responses to the innovation were uniformly positive, when some

individuals reassembled into their occupational groups they expressed dissatisfaction with the decisions made and the process by which decisions were implemented.

Discussion

Meaning of the study

Healthcare systems in many nations are experienced escalating demands and constrained capacity [7] creating intense pressure for change. This article examines the use of innovations from manufacturing to improve patient-flow in a public hospital's emergency and imaging Departments. The innovation was adopted partly because clinicians and mangers agreed that the information provided by the simulation was credible and the ideas for improvement were generated by the people performing the service. This is consistent with Lean thinking's focus on measurement and participative decision-making [2].

Differences in evaluations made from individual, organisational and group perspectives demonstrate two key points. The first is the importance of assessing the full range of DoI factors likely to impact innovation implementation, and the second involves making plans to address areas where large gaps exist between the current and ideal states. To enhance the practical value of this study, the findings have been adapted into a checklist (see Table 8). The purpose of the checklist is to prompt clinicians or managers assessing and implementing innovations in health settings to consider a range of factors that can increase, or prevent, the adoption of innovations, regardless of their origin. Although the checklist will benefit from testing with a range of innovations in health service delivery, it offers a practical tool to identify and address potential barriers to innovation adoption and implementation.

Table 8: Innovation Assessment Checklist

Factor	Ideal State	Current State	Actions to Address
Individual Factors			
Relative Advantage	Clear advantage over current method		
Compatibility	Compatible with values, norms and needs		
Complexity	Simple to use		

Factor	Ideal State	Current State	Actions to Address
Trialability	Permits experimentation		
Observability	Visible benefits		
Reinvention	Can be modified		
Fuzzy Boundaries	Can be used in other settings		
Risk	Low risk & high certainty of outcome		
Task Issues	Relevant to users' work		
Required Knowledge	Knowledge needed to use the innovation is transferable		
Augmentation/Support	Support and training are available as required		
Group Factors			
Network Structure	Social networks support the innovation		
Homophily	Similar groups are using it		
Opinion Leaders	Expert and peer opinion leaders support the innovation		
Champions	Key individuals are willing to visibly act as champions		
Boundary Spanners	Key individuals are providing links between the use of the innovation in the organisation and other users		
Formal Dissemination Program	Tailored dissemination strategy ready to be executed		
Organisational Factors			
Absorptive Capacity for New Knowledge	Potentially useful innovations are systematically identified, interpreted and linked with existing organisational knowledge		
Culture and Leadership	Learning culture coupled with proactive leadership		
Receptive Context for Change	Willingness to embrace new ideas, clear strategic vision, climate supportive of experimentation. Effective data capture systems.		
Inter-Organisational Networks and	Peer organisations have adopted the		

Factor	Ideal State	Current State	Actions to Address
Collaboration	innovation		
Structural Determinants	Specialised units exist and decision making is de-centralised		
System Readiness for Innovation	Time and resources exist to support the innovation, staff desire change		
External Change Agents	Credible, have strong inter-personal relationships with potential users and are perceived as similar to potential users.		

Strengths and Weaknesses of Study

Rogers [13] warns of the weaknesses of DoI studies based on data from a single informant, particularly when the informant is an executive and provides an authorised and uniformly positive organisational view of the innovation adoption process. Data were collected from eleven interviewees, in a range of operational, clinical and managerial positions to capture a variety of views regarding the innovation. Also, the explicit use of individual, group and organisational factors provides a nuanced view of attitudes toward the innovation, allowing an improved understanding of, and appropriate and timely responses to barriers to implementation. Methodological limitations associated with this study include the limited lifespan and generalisability of qualitative research findings, coupled with the small and purposive interview sample. Additionally, the sonography project was conducted during a period of comprehensive and rapid change in the emergency department. It is unclear if simultaneous changes increased or reduced organisational acceptance of innovation at the hospital.

Implications for Practice and Future Research

The findings and checklist presented in this article have three important implications for improving and managing health services. First, they suggest that innovative ways to improve health services be sourced from seemingly unrelated industries. Second, the collection of process and case-mix data to simulate change outcomes can encourage innovation through providing low-risk opportunities to experiment with changes and receive credible predictions of their likely impact. Finally, seeking and addressing

organisational, group and individual views of an innovation are likely to assist the process of innovation implementation. As this research shows, it is possible for supportive and resistant responses to exist simultaneously in the same setting. Assessing the value of the checklist in other innovation projects is a priority for future research.

Despite the complexity and exacting characteristics of health service provision, much can be learnt by studying and adapting proven innovations from other settings. Given the current workload, financial and political challenges faced by many health services providers, the ability to identify, adapt and implement useful innovations will become increasingly vital.

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