TECHNIQUE FOR IMPROVING CARE INTEGRATION MODELS

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Abstract

Recent developments in technologies and improved life style have had a positive impact on prolonging human life contributing to the increasing elderly population. As a consequence, many countries (particularly developed ones) started to experience higher proportions of elderly people (over 65). This has consequently generated the need for care for the elderly that is necessitating the integration of health and social care to accommodate their complex needs. A number of modelling methods have been employed to assist those concerned to cope with health and social care but albeit separately. The literatures so far, identified several techniques that have been employed mostly to model the care integration. However, literatures also suggest that there are some challenges still persist when modelling integrated care. It can be argued that these techniques are not capable of handling the complexities associated with the requirements of integrated systems. This paper attempts to prove the reason why despite the fact that many models of integrated care have been developed, problems are still exist. Based on the literatures, the problems exist due to the unsuitable techniques used to model the IC systems as most of the developed models are using single technique. Therefore, new technique to improve the care integration model is suggested.

Keywords: integrated care models, discrete event simulation (DES), system dynamics (SD), hybrid techniques, Markov Model, lean thinking/technique

1. INTRODUCTION

The world population is increasing rapidly. Data sources from the U.S Census Bureau reported that, in mid-year of 2008, total world population was 6.68 billion with the *mean* of males and females are almost the same. This is widely attributed to developments in science and technology which improved quality of life as well. Thus the life expectancy for human has increased dramatically reaching to 70 or even 80 years in most of the country in the world. Therefore, improvement in the elderly services have increased along with demands for elderly people services, this includes integrated care (IC). The high demand for integrated care along with the complexity of such systems have raised the interests of various researchers in finding the best policies and identifying methods to model the actual interplay of integrated care (Mur-Veeman et al., 2008). Researchers introduced various models to help integrated care decision makers in solving various problems of health and social care from the perspective of process, policies and system. However, despite having models of integrated care being

developed, these models have not been able to represent the re al nature of integrated care. Two main questions remain unanswered:

What are the issues surrounding the existing developed IC decision models?

Why are these issues still in existence?

Hence, this paper aims therefore to address these questions by reviewing the literature on existing IC models through detailed analysis of these models based on criteria of viable IC models that have been deduced from nature and characteristics of real IC systems.

The paper is structured as follows: the following section provides background to health and social care systems based on integrative work. This will include problems in integrated care as well as the elements of integrated care systems will also be discussed in the next section. Section 3 reviews currently developed IC models using covering the different techniques used for modelling and analysis. This will then be followed by discussing and mapping the integration process by investigating the characteristics in each of the developed models and identifying the criteria needed for developing more viable IC models. The last section will discuss the results of the mapping and presents some recommendations on what techniques should be used to improve IC models.

2. INTEGRATED CARE FOR THE ELDERLY

Total number of elderly people in the whole world is approximately 506.9 million, about 6% of the total world population (International Data Base, 2008). The change in is the result of a combination of factors including nutrition, public health, and medicine. Hence, there is a need in improving the health and social care delivery system in term of services especially to the elderly people with complex needs and on how to maintain a good health practice in life. The maintenance of health practice especially to the elderly people focused on two main entities, which are health care and social care. Healthcare is mainly for everybody who needs treatment and medications for their illnesses, injuries and sickness specified under the National Health Services Act 1946 (NHS, 2008; Glendinning et al., 2005). Whilst, social care services look after the health and the welfare services, including children or families who are under stress, people with disabilities, people with emotional or psychological difficulties, people with financial or housing problems and older people who need help with daily living activities (NHS, 2008) provided by the local authorities under the National Assistance Act 1948 (Glendinning et al. 2005). Generally, the function of health care and social care can be concluded as a body that provide services relating to ‘care services’. However, they are separated into two bodies in term of processes, delivery services system, governing, policies, act, as well as the system itself.

2.1 Problems in Integrated Care

The UK government is mainly concerned with the separation of social and health care (Glendinning et al. 2005) since it causes a major problem such as service fragmentation, higher cost of treatment and problem in continuing care after discharge from the hospital especially for the elderly (Mur-Veeman et al. 2008). To address these problems, academicians and policy makers developed models of integrated care that combine both social and healthcare to eliminate the problems. Several techniques have been employed to develop an integrated care model focussing on patient’s pathways. There are direct experimentation (based on lean thinking), Markov Model, Discrete Event Simulation (DES) and System Dynamics (SD). However, issues such as poor quality, medical errors, waiting times and high costs (Grone and Barbero, 2001), as well as weaknesses in transferring patient from one to another care givers (Andersson and Karlberg, 2000) are still being debated until now. Mur-Veeman et

al. (2008) expressed this situation as a 'Berlin Wall' and argues that the government and the policy makers are still finding the best policies or method to reduce these problems. Based on Mur-Veeman et al., (2008)'s argument, the authors argues that problems in integrated care systems are still persistent. The authors argue that the problems of integrated care still exist due to lack of technical ability to cover the whole system from the perspective of integrated care as well as their surrounding environment.

2.2 Characteristics of Integrated Care System/Models

In order to select the correct tool or technique to use for modelling integrated care, the modeller should firstly understand the characteristics of health and social care. These are different from other sectors or application especially when compared to production and manufacturing as its product are services rather than tangible product in other sectors. To date, there is no literature that touches explicitly upon the criteria of integrated care models. Therefore, the authors have developed a set of criteria for integrated care models based on the natures and features in health and social care. These criteria will then be compared with the current developed IC models to provide the answers for questions as in introduction section. These criteria will also be used as benchmarks to select the best technique for modelling integrated care, specifically for evaluating intervention to the systems. The criteria and the basis upon which these are used are given below:

a) Experimentation prior to real implementation

Health and social care environments are very challenging as they deal with mostly dynamic situations. Therefore, output from any initiative done by the policy makers to improve the system should be identified before the actual implementation. It also seeks to avoid the wasted investments as the state of the health and social care system are changing rapidly (Chahal et. al., 2009). This criterion is important in order to select the right technique to use for modelling as argued by Pidd (2004). Indeed, experimentation in a real world situation could be dangerous and impractical (Wolstenholme et. al., 2004). Since there are many intervention that need to be tested, modelling will be the best option as they can be modelled once and be used for simulation and experimentation for many times.

b) Patient flow need to be analysed individually

Patient flow in health and social care is a 'process', from one care service giver to another care service giver. This process of patient flow is stochastic and sequential in nature (Chahal et. al., 2009). In other word, an individual patient's time in the process is not same as the other individual patients. In healthcare nature and system, most of the decisions by the decision makers are based on individual patient attributes (Chahal and Eldabi, 2008). Indeed, Baker (2010) argued that the complexity of healthcare is different as the service needs considerable flexibility as every patient has a unique bundle of needs. Therefore, it is arguable that the selection tools for modelling should have this ability to capture the individual attribute.

c) Feedback loop

Health and social care are a system, which at least can be defined as two different systems, combining into one system that provides care services to the elderly. Since the integrated care is a system, any initiative exercise to any integrated care model should consider the feedback for the whole system. For example, in order to reduce patient's waiting time and reduce the number of patient from withdrawing before receiving the service, the policy makers will need to increase hours of opening clinic. Logically, these objectives will be achieved. However, another unexpected outcome is the pressure on the existing human resource. Human work performance is associated with the amount of work given to them (Arboleda e. al., 2007). Similarly, the doctors' performances will decrease after they have reached into the maximum amount of work (Chahal et al., 2009) assign to them.

d) Cover the whole integrated system

Bryan et al. (2006) highlighted several reasons for causing breaches in care services especially in integrated care for the elderly. These problems have impact on other problems within integrated care such as communication, patient's pathways, imbalanced supply and demand and many more (Moret et al., 2008; Rummery and Coleman, 2003; Grone and Barbero, 2001; Andersson and Karlberg, 2000). Based on this argument and chain-of-problems situation, it is arguable that any tools used to model integrated care should take this criterion into consideration as any initiative will have dynamic impact on other parts of the system. Typically the nature of the problem should be in defined before selecting the modelling tools (Pidd, 2004). Indeed, the interaction between different parts of the systems is crucial (Chahal and Eldabi, 2008). McClean and Millard (2007) suggested that any care model should include the health and social care as part of planning to ensure that such improvement will balance the whole care system. It should be done not only in the hospital, but also the social care should be considered as well. As per the argument above, a good integrated model should consider the whole system to be put into a model regardless of whether it is the healthcare, social, or intermediate care models; or an interface (between health and social care) model. This is to ensure that any implications that affect other parts of the system noticeable.

e) Closely representing the real system

The chosen tools to model the integrated care should have the ability to represent the real system closely including their processes inside the systems (Morecroft and Robinson, 2006). This is to ensure that any 'movement' in the process and any changes to the system and the model will be noticeable. Furthermore, it is also to ensure that all stakeholders understand the whole system that has been modelled. Thus, it will prevent the decision makers from making wrong decision.

f) Easy to use (technique) and simple to understand

Health and social care are complex systems and with their own unique characteristics when compared to other complex systems (Baker, 2010). Therefore, modelling is required to represent these complex systems and to simplify them to gain better insights and understanding about the systems. Such feature will be an advantage to the model (Ward, 1989). Another advantage of having a simple model is amenability to non-specialists (Cooper et al., 2007) and thus improving usability and validation (Barton et. al., 2004). Weinstein et al. (2003) argued that the structure of the model should be as simple as possible whilst considering the fundamental mechanisms of the disease process and interventions. Wolstenhome et al. (2004) argued that model can be used as a tool for understanding the complex system that health and social care planner represent. Indeed, a model can be used as a medium to understand problems inside the system. The selected technique should be easy to learn, understand and used by non-experts. This will help the decision making process faster than waiting for the modelling expert to recreate the models.

g) Assisting decision making clearly

Integrated care model should support the decision making process, especially in clinical practices or healthcare resources (Weinstein et. al. 2003). In other words, for every intervention to the model, the impact of the implementation should be clear. Furthermore, the technique that have been used should have capabilities in providing prediction for the current events (for example, total number of elderly patients that needs the care services in the next 5 years) as this will help the upper management in creating a plan to cater for the situation.

h) Transparent as possible

It will be an added value for model if it has the ability to expose the relation and connection between input and output. This will allow the stakeholders including patients to understand how the care process is conducted. It will also allow decision makers to identify the problems of the system and make correct decisions to solve them. Therefore, it should be transparent as end users can see how the end results appear clearly (Weinstein et. al. 2003). Interactions and interdependencies between parts of the system should also be clear as the care sector is a multifaceted system, in which modelling

techniques can be used to envisage how patients are engaged with in processes simultaneously. This will enhance the understanding of the system.

i) Model should be dynamic and not static

What makes the complexity in healthcare different from other sectors is that healthcare services are human based systems (Baker, 2010). Therefore, every single patient goes through a unique set of processes and has their own pathway. Time is crucial in care services (Chahal et. al. 2009). Therefore, any model it should be to capture this dynamic nature rather developing static pictures (especially in healthcare, intermediate care as well as assessment process). The lead time for each of the processes serves as a benchmark for hospital performance. Furthermore, the time allocated for process completion ensures that the whole system of integrated care will run smoothly. For example, in order to implement an intervention to help reduce late discharge problem, the time in the assessment process (including finding suitable care home and/or creating care packages) should be known, as this will help the healthcare to prevent bed blocking. The dynamics of the model will also ensure that the model building can be used repeatedly for different intervention experiment.

j) Short and long term decision

Baker (2010) argued that one characteristic of any systems is that the system will operate badly before it gets better. Things that work in short term will typically make things worse in the long term period and what works in long term will makes things worse in the short term. Therefore, tools selected for modelling health and social care intervention should consider the effect both, in short as well as long term periods.

k) Ability to simplify complexity

There is no doubt that healthcare systems are very complicated, as it involves so many processes and stakeholders and have to deal with various opinions, interests as well as views (Kuljis, Paul and Stergioulas, 2007). The main purpose of modelling is to simplify the processes. Thus, it will need a good and comprehensive modelling technique as this will ensure that all the stakeholders have a holistic view of the integrated care system and understand the processes of care.

3. INTEGRATED CARE MODELS AND MODELLING TECHNIQUES

3.1 Models of Integrated Care

There are a number of studies related to modelling and simulation of integrated care systems. These considerably less than what is found in other areas and applications such as productions, management and other areas. Table 1 shows summary of examples of the developed integrated care models, and the brief explanation after the table.

Integrated Care Model	**Authors**	**Techniques**
Adult Service in Hampshire	Desai et. al. (2008)	System Dynamics
Best Method for keeping patients	Campbell et. al. (2001)	Discrete Event Simulation
Possible Care Pathways for Elderly People	Katsaliaki et. al., (2005)	Discrete Event Simulation
Investigating Length of Stay of Elderly Patients	Xie et. al. (2005)	Markov Model
Best Place for Keeping Patient	McClen and Millard (2007)	Markov Model
Template of Integrated Care Model	Wolstenhome et. al. (2004)	System Dynamics
Social Health Maintenance Organization (SHMO)	Kodner and Kyriacou, (2000)	Direct Experimentation (Lean Technique)
Program of All-Inclusive Care for	Kodner and Kyriacou,	Direct Experimentation (Lean

Elderly (PACE)	(2000)	Technique)

Table 1: Examples of Integrated Care Model

Desai et al. (2008) developed a model of Adult Service in Hampshire using system dynamics technique to evaluate different interventions to the current system. Their main objective is to predict demand for the older services in the next 5 years. Based on the service demand, several interventions were implemented to the model to cater predicted demand. The model and experimentations showed that the demand rate for the care packages especially for the people with 85 year-old and above are likely to receive more complex and expensive package of care is deemed to be increased, and the number of patients that receive care are likely to decrease. Wolstenhome et al. (2004) used SD technique to develop a template IC model to be used by other local agencies that suit the local circumstances. The model building attempted to integrate primary, secondary and tertiary health care with the social care. The model tend to address the problems of admission prevention and delayed discharge and to show how this can save the resources within the agencies. With the objective to seek an improved performance, as integrated care have relationships between different agencies, the authors used iThink to test and find the best policies that relates to the long patient's pathways from one agency to another agency.

Campbell et al. (2001) have developed a model of integrated care using discrete event simulation (DES) to investigate and compare which is the best method to retain patients, i.e. between retaining patient in hospitals (conventional inpatient care) or hospital-at-home services in terms of their cost. The models predicted that the hospital-at-home proved to be more cost effective compared to the conventional inpatient care. Katsaliaki et al., (2005) used DES to investigate possible care pathways for elderly people in Hampshire Social Services. Their focus was on patients delay by post-acute services due to the limited capacity of beds to cope with the demand or may be due to bed blocking problems. Based on this model, the authors suggested that 500 new places for nursing home that can accommodate and balance the demand for nursing homes for the elderly should be developed.

Xie et al. (2005) have developed a model using Markov modelling approach to address the problem of late transfer of patient to the nursing or residential home and waiting for the assessment of their needs. The model used aggregated Markov processes. The model suggested that the length of stay for the residential home care was 923 days and the length of stay for nursing home care was 59 days and 784 days, for short term and long term stays respectively. In addition, the model also suggested that 64% of all admissions to nursing home care will become long term resident. McClean and Millard (2007) developed a model of health and social care using Markov model to evaluate cost of patient movement within healthcare system, which include the social components such as dependent, rehabilitation, recovery and community care institution. Based on the result of the developed Markov model, the result shows that keeping patient in the community centre was cost effective compared to keeping patient in hospital to improve their fitness.

Social Health Maintenance Organization (SHMO) project was funded by the US government, which combined health and social care comprising acute and for long term care using insurance model with the aims is to improve health of vulnerable older people and minimizing the used of hospital. This model has multi disciplinary areas that collaborate with each other to provide the service called as 'care management'. The members of this care model consist of the nurses, social workers, physician, care managers and other professional. With this model, the patient is provided with the inclusive assessment, care plan, service authorisation, gradually observe the patient condition as well as follow-up. In PACE system, the enrolment is on voluntary-basis. PACE is limited and exclusively for the disabled person age 55 and above. It is a fully integrated care system which provides inclusive acute and long term care, including social and relief services, outpatient clinics, and ongoing clinical oversight. Team care consist of physician and nurses from the primary care, adult day health centre and home care nurses, other professional such as therapist, nutritionist, transportation workers that work together and discuss the care plan for the patients. These two models can be evaluated using the

lean techniques in which the models are implemented in the real world and use direct experimentation for examining flexibility and suitability in the integrated care systems. This can also be seen in several reports from several researchers such as Harrington et al. (1990), Newcomer et al. (1999), Pryor (1994), Polivka and Robinson, (1999) and Zimmerman et al. (1998) about the suitability of these two integrated care systems.

3.2 Analysis of Modelling Techniques of Integrated Care

Markov model is suitable to use should the aim is to show the trend of certain event that enable decision makers can predict in the future. The Markov model can be simple, but in order to build the model, it needs an expertise with background in mathematics, as models are usually built based on mathematical models. It also is not easy to understand and does not provide a clear picture as argued by Venkateshvaren et. al. (2005). Although Markov models can assist decision making by reviewing the results, it lacks some important criteria of good modelling techniques. Markov models do not allow experimentations of any intended intervention to be done before the real implementation. Markov model assume that all patient in any given state have the same attributes, where as, it is known that elderly patient that are transferred to the nursing homes may suffer from several illnesses. Markov models also do not allow for the time patient is transferred from one state to another (Barton et al., 2004). In integrated care, transient time (transfer from one state to another) is crucial as this will affect and reflect on the service performance. The technique does not support the interaction among individual (Barton et al., 2004) which is not realistic since that every individual attribute in health and social care are attached to other individual, as they reflecting to each others. Since the technique used mathematical model, it is not suitable to be used the integrated care as the interdependencies between parts in case system makes the care system complicated (Eldabi, 1999).

Lean technique or lean thinking is a new way of making decision efficiently. It can be categorised as a business process reengineering. Lean technique are used in 5S housekeeping, process mapping, elimination of waste, smoothed flow, just-in-time, pull versus push, schedule bottlenecks, change reduction and kaizen or continuous improvement (Bates, 2010). One of lean quality tools is visual management, wherein the technique visualises processes in health and social care into a paper with flow chart, boxes and arrows. It makes it simple to understand and model by non-experts in modelling. It can also be a representative of the real systems and could cover the whole system of integrated care as long as they can understand the processes involved. As the modelling is likely to draw on a big paper, it will make the process transparent so stakeholders can see through it. This technique will allow stakeholders to see the inside of the whole system to detect any problem related to the pathways or the integrated care system, as they can see thoroughly how the parts of the system are connecting together. However, this technique does not possess all of the important criteria in producing good integrated care models. Although this technique is simple to use in developing integrated care models, it does not assist in the decision making process prior to the real implementation as all experiments (related to assessing intervention to the model) must be done after the real implementation, or direct experimentation. This could be a waste since the intervention might not be the best method to eliminate problems. It also does not provide feedback loop and is a static model, as the technique only allow direct experimentation.

DES can be described as a model of a system that contains a set of individual entities that run through a series of queues and activities in distinct time (Tako and Robinson, 2009). Law and Kelton (1991) argued that simulation techniques are widely used in operational research and management science for analytical purposes as it manages to cope with stochasticity which provides a clearer picture of the complexity compared to other techniques such as mathematical modelling (Venkateshvaren et. al., 2005). DES deals with the models that have what-if scenarios, prediction, and optimization (Chahal and Eldabi, 2008). Miller, Ferrin and Messer (2004) say that simulation is the most effective techniques that can provide prediction in the future if certain decisions are taken. Mahapatra et al.

(2003) argued that most countries in the world have used simulation technique to model and analyze the emergency department. The reason for this is because of the advantage of the simulation is that it can be used to play many policies and scenarios to get the most effective policies before the implementation phase (Miller, Ferrin and Szymanski, 2003). Furthermore, the simulation software are user friendly as the software include graphical and animation interface, which proves to be more convenient to the users as they can imagine how inside of the systems works.

The nature of SD that shows the whole system interactions, makes the SD as learning laboratories rather than optimization tools, as people can learn how the system interact between parts in the system (Forrester, 1961). If we look for interrelationship studies, their cause and their feedback, then SD method is suitable as it will model the whole system based on our boundary and limitation (Chahal and Eldabi, 2008). With the argument that one system cannot stay alone by itself, SD technique will be the best as it will represent a big and complex system that interacts with their environment, and the model does not rely much on huge amount of data, as some healthcare does not have a useful data (Brailsford, 2008). Based on the above arguments, a model that pictures the whole system on how it interact to each other can be run in front of the decision maker and certain decision can be made as soon as possible (Brailsford, 2008). Dangerfield (1999) believed that SD model can be part of the OR technique that can be used to model the complexity of the healthcare system. Table 2 summarize the advantages and limitations of each technique.

Technique	**Advantages**	**Limitations**
Markov Model	- Aim is to show the trend of certain event - Can be simple - Assist decision making by reviewing the results	- Needs an expertise with background in mathematics - Do not allow experimentations prior to the implementation - Assume in any given state have the same attributes - Do not allow for the time patient is transferred from one state to another - Does not support the interaction among individual
Lean technique	- Simple to understand and model by non-experts in modelling - Represent real systems - Cover the whole system of integrated care - Transparent	- Direct experimentation thus, does not assist in the decision making process prior to the real implementation - Does not provide feedback loop - Static model
Discrete event simulation (DES)	- Cope with stochasticity - Detailed individual analysis - What-if scenarios, prediction, and optimization - Can be used to play many policies and scenarios - Graphical and animation interface – more convenient to used	- Lack of feedback loop - Not suitable for long term policies - Not suitable for big systems as it will be more complex
System Dynamics	- Modelling whole system interactions, big and complex system with the environment and behaviours - Provides cause and feedback - Does not rely much on data	- Lack of individual analysis

Table 2: Summary of Advantages and Limitations of the Techniques

4. TECHNIQUE VERSUS CRITERIA OF VIABLE IC

Since there are many types of modelling, Manning et. al. (1996) and Sheldon (1996) stressed the importance of selecting modelling technique that can represent certain situation. Therefore, in order to select the best technique to use for modelling health and social care integration, the authors try to compare all the developed modelling of integrated care with the criteria of a viable integrated care models as in Table 2. The mapping are based on the authors' observation on the current developed models and based on the literature suggestions.

Model of Integrated Care / Criteria of Viable IC	Katsaliaki et. al. (2005)	Campbell et. al. (2001)	Xie et. al. (2005)	McClen and Millard (2007)	Desai et. al. (2008)	Wolstenhome et. al. (2004)	PACE (Kodner and Kyriacou, 2000)	SHMO (Kodner and Kyriacou, 2000)
	DES		**Markov Model**		**SD**		**Lean Thinking**	
Prior experimentation before implementation	√	√			√	√		
Analysed individually	√	√						
Feedback loop					√	√		
Cover the whole integrated system							√	√
Closely represent the real system	√	√			√	√	√	√
Ease of used and simple	√	√			√	√	√	√
Assisting decision making	√	√	√	√	√	√	√	√
Transparent as possible	√	√					√	√
Dynamic Model	√	√			√	√		
Short and long term decision								
Ability to simplify complexity	√	√	√	√	√	√	√	√

Table 3: Mapping criteria with existing developed IC models.

DES and SD techniques have the ability to provide the result from the intervention before the real implementation compared the other techniques (Chahal and Eldabi, 2008). Whilst only DES has the ability to provide individually analyzed result, SD has the ability to provide feedback loop as a result of the intervention. All the applications lack at least one part of the whole system of integrated care, either intermediate care system, or health care subsystem, or lack of social care subsystem with the exception for the PACE and SHMO integrated care system. This is due to the increasing in complexity of the model if the modellers were using DES, or SD or Markov Model. All applications can be seen as closely representing the real system except for Xie et. al. (2005) as well as McClean and Millard (2007), as they used mathematical modelling to represent the situations in the integrated care systems. Because of the limitations, Markov models are hard to use since it needs an expert for model building. All of the techniques support decision making process. The difference between each technique is that each model supports different types of decision with the tools provided. DES applications, SHMO and PACE system integrated care model provide more system transparency as stakeholders of non-modellers can see the system clearly, compared to the other technique applications such as Markov model (Venkateshvaren et. al., 2005). Compared to the other

applications, PACE and SHMO are the one that time cannot include as they were using direct experimentation. As the purpose of modelling is to simplify the complexity, all of the techniques applications have the ability in simplifying the complexity. On the other hand, none of the technique and application provides or assist in decision making in long term and short term simultaneously.

5. DISCUSSION AND RECOMMENDATION

In section 3.1, it has been proved that the developed integrated care models were using only one technique to model the integrated care system. Whilst in Table 3.2, none of the developed model could fully cope with the criteria of a viable integrated care model. Looking at Table 3.2 as well, it is proven that the problems of integrated care still exist due to incapability of the developed models to cover the whole criteria of a viable integrated care models. Therefore, it is arguable that by combining the techniques could be able to address the problem of incapability of covering the whole criteria of a viable integrated care. Based on Table 3.2, criteria of a viable model are covered mostly by System Dynamics and Discrete Event Simulation. However, these two techniques have some limitations.

Using DES alone will ignore the feedback loop and thus, will impact the system model in the future. Although DES can cover the whole system to model, however, it will be too complicated as the complexity will be increase exponentially with it size. Whilst SD ignores individual analysis. Unlike production sector that produces goods using machine with similar mean time, health and social care are human based system, which makes the complexity of healthcare is different from other sectors. Baker (2010) argued that the complexity of healthcare is different as it has multi-dimensional patient transformations. It combines physical, mental and spiritual, extended over time and locations, requiring multiple professional groups, across organizational boundaries and often involving patient's families. Therefore, the process of treatment and time cannot be assumed the same for every patient.

There is no tool that can be used for modelling integrated care to assist decision making both in short term and long term. DES has the capability of providing and assisting short term decision making as it is used to model the problem in operational and tactical. On the other hand, SD has the capability in providing and assisting long term decision making as it is used to model the problem of strategic level (Chahal and Eldabi, 2008). Sweester (1999) has argued that SD is the best tool in strategic planning for organization, which involve in policy analysis as well as cause and feedback analysis whilst Law and Kelton (1991) argued that DES is the best tool for a system since one part of it changed individually as it evolved over time.

Therefore, to improve the integrated care model into a viable model, it is suggested that the two techniques should be combined, namely SD and DES as a hybrid simulation technique**.** By combining these techniques, the limitations in the DES can be covered by the SD technique while limitations in the SD can be covered by the DES. Figure 1 shows how hybrid technique can help in improving the IC model and therefore, improve the decision making process.

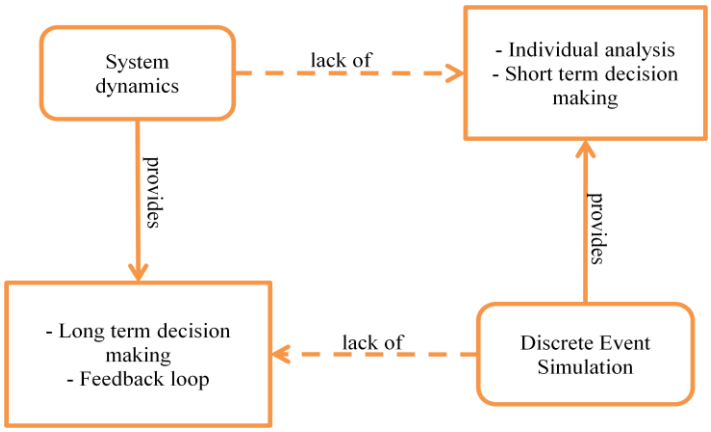

Figure 1: How Hybrid Can Improve Integrated Care Model

6. CONCLUSIONS

Health and social care integration are complex systems as they combine many stakeholders, different processes, procedures and pathways for every patient as well as different agencies involved in handling the same patient. In order to reduce the complexity, modelling is used to depict the system so people from outside can have better understanding. Four techniques that have been used for modelling integrated care have been discussed, which are Markov Model, Discrete Event Simulation, System Dynamics and Direct Experimentation from lean thinking. Most of the developed models were used only as a single technique in modelling. However, it is argued that using a single technique does not have the ability to cover all criteria needed for building a viable IC model (developed from the characteristics of IC systems). Therefore, by combining the techniques, it is argued that it will help to improve the IC model to be more reliable and viable. Future studies will involve developing the framework of how to model the integrated care using hybrid technique. This framework can be a benchmark for the modeller to improve IC model.

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