future planning: to design algorithms to allocate the patients to the most appropriate service for their needs and then to explore service and resource utilisation.

The second question is about whether this health care system has the appropriate mixture of services that cover all the patients' levels of IC need. In order to answer this question the previous one must have been answered because if there is no suitable service for some of the patients IC needs then it is clear that there is a service gap in the system.

The layout of the paper reflects the simulation modelling steps although there are two additional sections for the discussion and conclusion. The first section briefly describes the problem and services of the particular IC health system modelled. The second section describes the use of SSM to understand the IC system and extract a conceptual view for the simulation model. The third section briefly reports the data and information requirements for the computer model, which is followed by sections describing the computer model, and the validation and verification. The section reporting the results from running the computer model focuses on the simulation scenarios that reflect the insights gained from using SSM. The paper also provides a brief discussion, based on this experience, of the difficulties in using SSM, which includes the time required in getting the vast number of stakeholders to cooperate.

2. THE INTERMEDIATE CARE SYSTEM

The study was part of a larger Intermediate Care evaluation project (the ICON project) commissioned for a locality in Kent, England in 2000 by the Elderly Strategic Planning Group and the Joint Planning Board for Care of the Elderly in East Kent [9]. At that time Intermediate Care services were a relatively new concept and their introduction can be attributed to the growing population of older people that in many cases were found to be inappropriately using expensive and scarce secondary care resources. The Department of Health [10] response to the National Bed Enquiry [11] stated that it intended a major expansion of community health and social care services (termed intermediate care – IC) that in contrast to acute hospital services would be focused on rapid assessment, stabilisation and treatment. In addition, the Department of Health pledged to invest £900 million a year by 2003/2004 in IC services. Since that pledge, many IC services have been set up across the UK and as they are becoming more established their evaluation is becoming important. There is only one reported simulation study [12] for an entire IC system (an integrated system of services) and only a couple of studies of IC services using OR [13-14], but only one uses DESM. Furthermore, none have adopted a formal problem structuring method to elicit understanding about the system and its services.

The locality involved in Kent is a discrete area with a population of approximately 20,000 people aged 65 years or over that generally uses a discrete set of IC services. The system encompasses rehabilitation wards in acute and non-acute hospitals, as well as intermediate care services, which makes it a large integrated health care system. More specifically it included three "hard core" intermediate care services (Community Assessment Rehabilitation Team (CART), Day Hospital and Recuperative Care) and seven rehabilitation wards (most of these with a specific rehabilitation patient focus e.g. a stroke ward) that were based in three hospitals that admitted patients from that locality.

3. UNDERSTANDING THE PROBLEM

The actual IC system at the beginning of the study was in its development phase and not particularly understood as a whole by any one person in the system. This created a fuzzy ill-defined situation that needed structure, which was tackled by SSM – a problem structuring method. In the following paragraph a brief overview of the SSM process is presented in order to demonstrate how the conceptual framework simulation model was determined. However, to gain an understanding of the SSM methodology the reader should refer to literature by Checkland [15, 16], the developer of SSM.

Checkland's [17] *four main activities version* of SSM was deployed, which consists of the following stages:

1. Finding out about a problem situation, including cultural/political issues;
2. Formulate some relevant purposeful activity models;
3. Debating the situation, using the models, seeking from that debate both:
   - Changes which could improve the situation and are regarded as both desirable and (culturally) feasible, and
   - The accommodations between conflicting interests which will enable action-to-improve to be taken;

4. Taking action in the situation to bring about improvement.
A primary task SSM approach was adopted which means that we concentrated only on one relevant system rather than many subsystems. Therefore we focused on building one overall purposeful activity model because the main focus at that time was to get an overall understanding of the IC system that was agreeable to all involved in order to build the simulation model.

In this paper we will focus on the second activity – formulating relevant purposeful activity models – and only report on a fraction of the debate that is considered useful to the simulation study. A primary task root definition of the relevant system, the Intermediate care system, was put together from information gained in interviews and group meetings in order to build the SSM purposeful activity model. The mnemonic CATWOE, central to the process of deriving a root definition, was used to define the Customer, Actors, Transformation Process, Weltanschauung (the worldview), Ownership and Environmental Constraints. The definitions in terms of the IC system are as follows:

Customers: *Older People over 65 that require rehabilitation or convalescence*. The IC customers are the older people that are deemed to require convalescence or rehabilitation in order to improve their current state of health. These older people may come from a number of settings or services including acute hospital settings and the community.

Actors = *Intermediate Care employees i.e. nurses, therapists etc*. The number and combination of health care professionals that can be involved in IC services differs from service to service. However, the majority of these resources are nurses, occupational therapists, physiotherapists, doctors and rehabilitation workers.

Transformation Process = the need to support Intermediate Care in our locality is met by designing and operating a system of strategic and operational level activities.

Weltanschauung = a belief that these strategic and operational level activities are important in providing effective care for the older people.

Ownership = the local health and social care authorities.

Environmental Constraints = local IC funding, Department of Health guidelines etc.

The above definitions lead to the following root definition:
Root Definition (RD) = A local health and social care owned system operated by IC staff, that supports IC in our locality *by* designing and operating a system of IC strategic and operational activities *in order to* provide effective care for the older people, *whilst* recognising the constraints of local IC funding and Department of Health guidelines.

Checkland [17] says that it is necessary to "*define the criteria by which the performance of the system as a whole will be judged*" (pgA25). In terms of this research the measures of performance (E1, E2, and E3) are the following:

E1: the criterion for efficacy is to check that the IC function is supported through IC strategic and operational activities.

E2: the criterion for efficiency is to check that the minimum IC resources are used to support the strategic and operational activities.

E3: the criterion for effectiveness is to check that the strategic and operational activities enable older people to be rehabilitated in the most appropriate setting for their needs.

These definitions are incorporated in the purposeful activity model of this IC system (see A-M in figure 1.1) and are used to monitor the actual system. By doing this we are able to determine if these criteria are satisfied and if not to provide standards to achieve them.

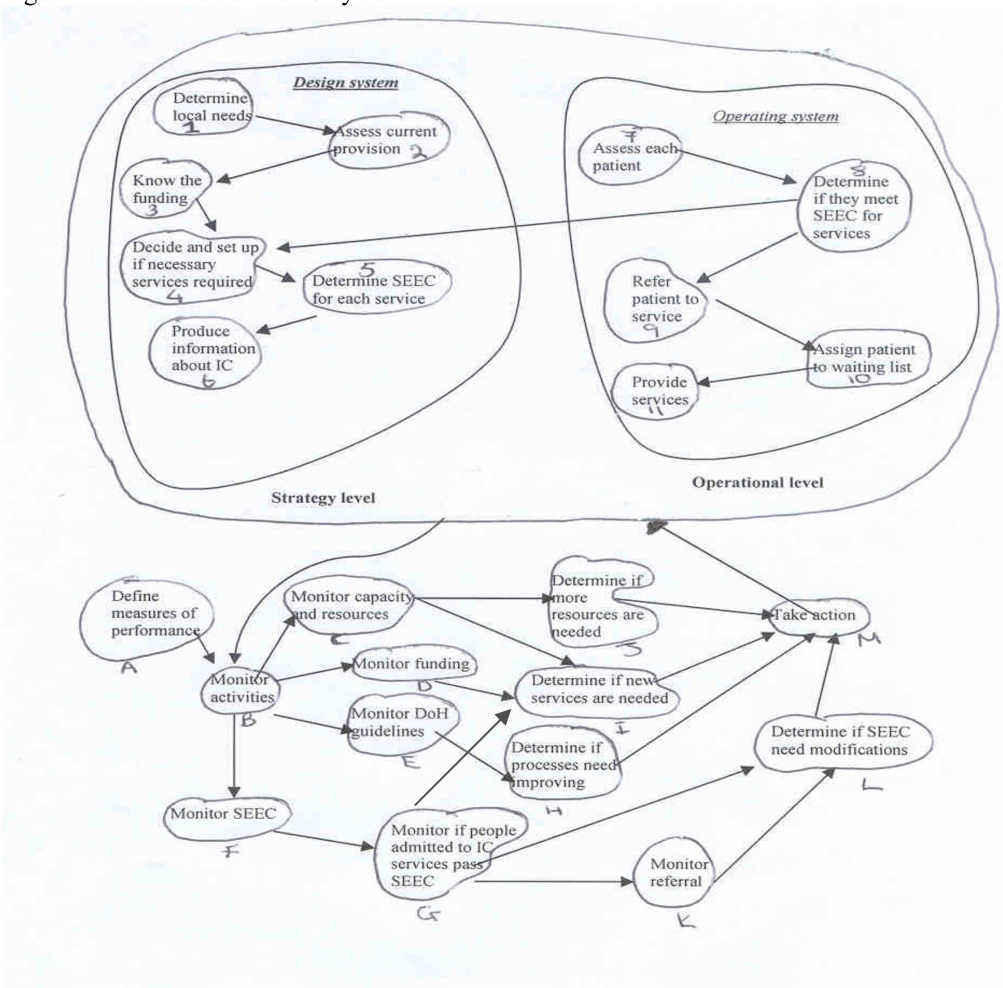
The Root Definition, CATWOE, and the three Es guided the construction of the activity model that aims to show the transformation process T (refer to activities 1-11 in figure 1.1). The activity model building process "consists of assembling the verbs describing the activities which would have to be there in the system named in the RD and structuring them according to logical dependencies" (p.89) [18]. Because this paper omits the enormous amount of information supplied from our stakeholders or observed during the first SSM stage (finding out about the problem situation) it may not be apparent to the reader how the activities were determined and why these are essential to the Transformation Process.

The activities 1-11 and the activities relating to monitoring the system's performance (A-M) in figure 1.1 do not necessarily match reality as they represent the views and the observations of those contributing to SSM that are by nature subjective. Furthermore we told them not just to describe the existing activities in the system but to also talk about any other relevant activities that should/could be there.

The above is necessary as the third activity of SSM is about comparing the "real world" situation with the one constructed in the "systems world"; the SSM purposeful activity model (see figure 1.1) represents the systems world and is considered to be a reasonable model. During this comparison, we determined that there were some activities that were not taking place and some activities that needed improvement. Some examples of the findings from the comparison directly relevant to the simulation study are:

- Older people were not screened against all services in determining the most suitable one for their needs (refer to activities 7,8,9 in figure 1.1). This is important because the Department of Health has instructed IC to ensure that there is fair access to their services using a single assessment process [19, 20], which means that two older people that are alike should be eligible for the same service. The Single Assessment Process (SAP) is about making health and social care professional work together to assess an older person's needs and plan for those needs in an effective and coordinated manner. This also means that the activities relating to monitoring this aspect of the system's performance (refer to monitoring activities F, G, K, in figure 1.1) did not exist or work as they should.
- The Service Entry Eligibility Criteria (SEEC) were not mapped onto the patient assessment instruments for a transparent referral and admission process, ensuring fair access to services (refer to activity 5 and monitoring activity L in figure 1.1).
- Performance measures were mostly limited to recording the numbers of people referred and admitted to a service and average length of stay in the service (refer to monitoring activities C, I, J in figure 1.1).

Figure 1.1 Activities of the IC system



4. THE CONCEPTUAL MODEL

This section will describe the approach undertaken to extract the conceptual model and more specifically determine the modelling objectives. This is because the most important part of deriving the conceptual model is determining the objectives for the simulation study as they will drive the remaining process (inputs, outputs, content, assumptions and simplifications of the model) [1].

The conceptual approach was determined by the findings from the SSM methodology. That means it has been formed through interviews with IC employees and by consulting literature from the Department of Health (DoH) and various other organisations such as the Kings Fund [21-25]. The SSM findings revealed several activities that should or could be taking place but were not at that time. Therefore, we decided that the conceptual model for the simulation study would represent *what should be* going on in an IC system or what some employees and stakeholders would like to be going on rather than *what was actually* happening at that time. To construct a model of the situation at that time, with no structured referral process would not have been of any use in future planning other than to demonstrate that the function was flawed, which was already known to the stakeholders. In fact, measures were being taken as a result of the SSM process to improve the referral decision making process (operating system) so if a simulation model had been built with a weak or no referral system it would have been obsolete prior to the completion of the project as the movement of patients through the system would have drastically changed.

The SSM approach enabled the problematic situation to be defined into the following precise questions and objectives that would be explored in a simulation model:

- Are IC services working to their capacity (refer to monitoring activities C and J)?
- Are the IC patients admitted to the most appropriate IC service (refer to monitoring activities G, K, and L)?
- Are there any service gaps (refer to monitoring activities F, G and I)?

The simulation model was built with all of the monitoring activities in mind, except for D, E and H (refer to figure 1.1) as they could only be explored in the SSM comparison phase. Furthermore it is also true that the above questions relate to the performance measures for efficiency and effectiveness (E2 and E3) as the criterion for efficacy (E1) cannot be explored in a simulation model.

The question regarding capacity is a question that has traditionally been tackled in simulation studies [26-28]. In this study capacity is examined by including all the places/beds available for each IC service in the whole system simulation model. The wards and recuperative care are represented by the actual number of male and female beds but CART and the Day Hospital are represented by an approximate number of places that had been determined by each service manager. Although it is not relevant to this paper, it might interest the reader to know that additional simulation models of the "hard core" IC services were also built to provide each service managers with a more detailed and flexible model of their service [29], rather than the aggregated information produced by the system model, that also confirmed the number of places required for CART and the Day Hospital.

The second question is answered in the model by emulating the decision making process using a rule base that determines the service each patient should be sent to. At the end of a run one can see if a particular patient or group of patients entered the service that they had actually entered in real life.

The model is able to answer the third question by determining whether there is an appropriate service for each level of IC need by examining if there are gaps in the services mix. For example, it can be used to examine the effects of adding a new service or removing an existing service. The question about IC service gaps has been tackled through a soft approach of mapping [24] but does not examine the problem in a dynamic way or allow for a "what if" analysis. However this report describing the soft approach to mapping was important to our study as it confirmed that we had arrived at similar modelling objectives. This mapping report, was published in January 2001 [24], a few months after our conceptual model was determined, and was motivated by HSC 2001/01:LAC (2001) [30]. This requires the NHS and Councils in planning the best balance of Intermediate Care services among other things to including where referrals are generated and what sorts of conditions are triggering these referrals; this is a similar objective to that of our second question. The report explains that this is important for several reasons, which include identifying gaps and "pressure points" in the system (our third question).

The following sentences summarize the guidance provided in this report. In order to map the services and system one should initially get a clear picture of where older people's needs are met or could be met by collecting details and information of all services including those that may not seem suitable at a first glance. In addition, it is also best to involve people and agencies from within the system and ask questions relating to the operational function of the system. This should include checking to see if there are any gaps in the system either in terms of availability of services or resources. Also, it is important to understand the access mechanism into the system. For example, are the referrals appropriate? Are the right numbers of people entering the system? etc. A very important point is about checking the eligibility criteria for services. For example, do they exist? Do they exclude a type of need like dementia? Also finding out about how people move through the system and whether these pathways are based on an assessed need is something else that needs to be considered. All of the above points made in the IC report [24] have been incorporated in the scope of the simulation study.

5. DATA

In order to satisfy the conceptual model the computer model requires the following data and information: a. Service Entry Eligibility Criteria used for the system model rule base, b. Patients' Health and Social characteristics used for observed data distributions, c. Number of services and their beds or patient places and d. Inter-arrival distributions and Length of Stay distributions. The patients' characteristics were collected using a modified (shortened) version of the Minimum Data Set (MDS) by interRAI (www.interrai.org), a comprehensive and validated patient assessment tool that can be used to determine patients needs and can help draw up a care plan. The data collection of the project was undertaken by the IC services and spanned over a period of six months although collecting data concurrently was only for three months to ensure minimum disruption to the staff and patients.

In this study, distributions were generated that best fit the available data because the run time for the models is five months and the concurrent data collection was only three months. The interarrival data in this project are the days between consecutive arrivals and the length of stay is the time in days between the patient's admission and discharge from each service. We focussed on days because it is not necessary to examine the system changes in hours, minutes or seconds. For example, when someone is in intensive care then minutes and hours matter as people move out of beds very quickly but in our case rehabilitation is very unlikely to take less than one day, typically it takes more than a couple of weeks. The interarrival days and length of stay data were fitted to appropriate probability distributions using Stat::Fit [31]. Goodness of fit tests, such as the chi squared and the Kolmogorov-Smirnov confirmed that the negative binomial, the geometric and the Poisson were suitable distributions. The fields in the patient data assessment form were in the form of closed end coded answers, which were correlated in many cases. Generating suitable distributions would have further delayed the project and would not have guaranteed anything better than simply sampling from the observed data stored in an Excel file.

6. THE COMPUTER MODEL

The simulation software used to build the computer model is Simul8 [32]. The actual front end "picture" in Simul8 is too complicated to understand because of the large number of workcenters (see figure 6.1) used. So a simple diagram has been drawn in simul8 to give the reader an idea of the patient movement through the model (see figure 6.2).

Figure 6.1. The actual model for the "whole system"

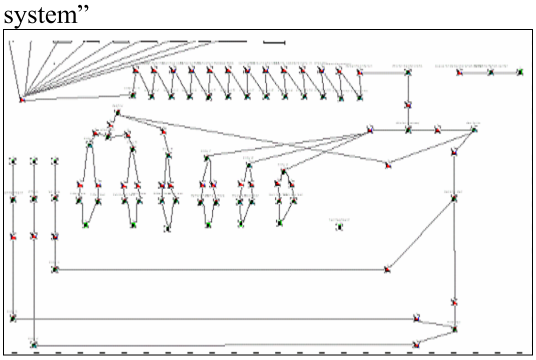
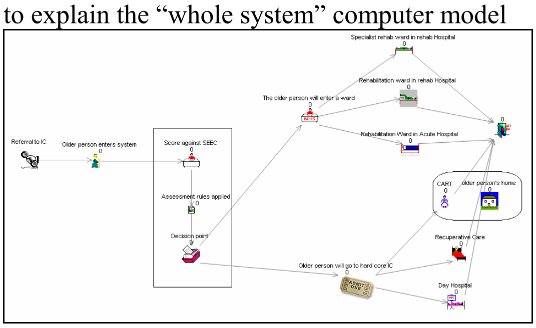


Figure 6.2. Using Simul8's graphical capabilities to explain the "whole system" computer model



The patients arrive into the model with attributes (approximately sixty) that are mostly the fields from the assessment items held as an Excel file. The patient's attributes are used in Visual Logic (VL) algorithms to determine a pass or fail scores for each SEEC, that are represented by a number of workstations. These scores are used in a number of other workstations with more VL emulating the referral mechanism of that IC system by routing the patients to the most appropriate setting/service. The model does not have patients moving from one service to another because the rehabilitation and convalescence requirements of patients will change after leaving a service. If older people were to move between services, they would need to be scored against the criteria again which would increase the models complexity unnecessarily as the patients can re-enter the system as a different entity. There are two further reasons for choosing this approach: firstly, in reality many patients will only go to one service and then go home with no further IC services. Secondly, during the data collection every patient was assessed and was entered in the database as a new entry even if that person was assessed in a previous service. This meant that it was more convenient to treat each new assessment as a new person entering the system.

Furthermore, the model simulates 5 months and the results are of fifteen runs. A warm up time was required as there are always patients in various parts of the system. This was determined by finding a warm up time for each of the services and the highest of these was used for the system model (90 days).

7. VALIDATION AND VERIFICATION

The model's intended purpose was not primarily to make decisions about the resources available at that point in time but to look at the impact of implementing the desirable decision making mechanism. Therefore the validation focused on conceptual model validity, the data validity and the operational validity but only the main issues and findings from this stage will be described in this paper. The validation and verification process has been observed by an operational researcher knowledgeable in simulation modelling (other than myself) and other members of the ICON team as well as service managers. In addition, the "whole system" simulation model has been presented to all localities in East Kent in October 2003 at the request of the East Kent NHS trust (face validity).

Verification mainly concerned testing the visual logic extensions (mixed testing) for the decision making rule base. The Fixed values technique was applied in combination with the Traces technique to examine the Service Entry Eligibility Criteria. Older people were observed moving through the system with particular attributes that would allow them to pass a certain number of criteria and end up in a particular service.

Validation of this conceptual model meant getting agreement that this view of how the system could work is desirable, culturally and politically feasible, which was achieved in the SSM. Therefore we do not need to see the older people entering the same service in the model as in reality to ensure the operational validity of the model. However, we examined the services in the model at the end of a run to observe if the older people went to the same service in the model as in real life (Event Validity). In fact, there were many occurrences of older people being sent to a different service to the one referred to in real life. This actually confirms the model's validity because the SSM phase revealed awareness by the system stakeholders of inappropriate referrals and they had acknowledged that if they implemented a single assessment framework and a structured approach to referral the real situation would change dramatically. In addition, we had discussed this finding with a senior IC manager (system owner) and she explained that she had visited some of the wards to examine the discharge process and discovered that several of the patients were inappropriately placed there at that moment in time. It is also possible that many of those patients were inappropriately placed there in the first place. As the real system develops and operates as its stakeholders want it to operate (like the SSM activity model) the simulation results will become closer to those in the actual system making it possible to validate and verify the whole system model in a more traditional way.

8. SIMULATION SCENARIOS RESULTING FROM SSM

In this paper we will focus on two main scenarios that demonstrate that the model can answer the three questions/objectives derived from the SSM process about patient referral, service capacity and service gaps. More specifically:

- The first scenario is the current configuration of services and capacity but with the Single Assessment Process forming the decision making mechanism. This is the closest to reality as the services that exist are in place and the only major deviation from reality is having a formal and transparent decision making mechanism for referral. In this scenario we will address the patients'

- referral to the services and the services capacity, which is aimed at around 85%.
- The second scenario incorporates a new IC service for the cognitively impaired that will address the issue of service gaps.

8.1 FIRST SCENARIO – CURRENT CONFIGURATION

This scenario explores the efficiency criterion (E2) by monitoring the IC system's capacity and resources (answering the first simulation question/objective). Capacity is mainly monitored by examining the average patients queue size and queuing time for the services, which in terms of the real world is the waiting list to enter an IC service. Resources are monitored by examining the utilization of beds/places of each service. Unlike the real situation at that time, the wards have short queues and the Recuperative Care service has surprisingly large queues (see table 8.1). The Recuperative Care service has an average number of 51.2 (1 d.p.) patients queuing throughout the run with an average queuing time of 103 days. This has affected the length of time the older people are in the IC system (waiting for a service and being treated) and more worryingly the time in the queue exceeds the DoH guideline that IC treatment should be no longer than 6 weeks (45 days). Although the Day Hospital is slightly underutilized in this scenario it is not of great concern as this service does not actually have a set number of places but we determined during the study that it can register between 12 and 24 patients concurrently. The CART results show that it is under-utilized, which is surprising because it has similar SEEC to Recuperative Care. Discussions of this finding with IC stakeholders led to the belief that some of the older people eligible for recuperative care could be eligible for CART and that the existing criteria could be improved upon. Various scenarios have been explored (not described here) that reduce the queuing time for Recuperative Care patients by diverting some of them to CART, which leads to almost doubling the CART capacity to cope with the additional demand. To conclude this scenario shows that implementing a single assessment process through the use of a single assessment tool would increase the amount of patients that qualify to go to the "hard core" IC services. This finding is extremely desirable by all in the system as IC hospitals beds are considered to be much more expensive than "hard core" IC services.

Table 8.1 Results of Scenario 1 for "whole system" model

	Scenario 1			Scenario 2		
Service Type	CART	Recuperative Care	Day Hospital	CART	Recuperative Care	Day Hospital
Ave Time in Queue	0.0	103.0	12.5	0.0	96.2	7.3
Ave Num in Queue	0.0	51.2	9.5	0.0	45.7	5.2
Num of beds/places	45.0	6.0	24	45.0	6.0	24
Ave Num of beds/places Used	17.0	6.0	16.5	16.4	6.0	23
Ave Num of older people completed treatment	73.0	32.1	73	73.1	32.2	100.9
Ave time in system (days)	32.2	113.9	33.23	33.3	107.8	64.8

8.2 SECOND SCENARIO – A NEW IC SERVICE FOR COGNITIVE IMPAIRMENT

This model can be used to explore the criterion for effectiveness (E3) by monitoring if the patients are rehabilitated in the most appropriate service for their needs (answering the second simulation question/objective). As previously mentioned, in the verification and validation section of this paper, at the end of a simulation run we observed that many older people (the simul8 work items) entered a different service in the model to the one they were actually admitted to in real life. This means that many older people were not referred and subsequently admitted to the most suitable service for their needs in real life. Therefore this satisfies the second simulation objective by answering the second question.

In addition, we can answer the third simulation question objective by exploring whether there is an appropriate service in that system for every patient and if not then that indicates at least one service gap. Essentially we are trying to determine if the mix of IC services can cater for all the IC needs in that system. A service gap will exist if there is an exclusion criterion (or a number of exclusion criteria) that apply to all services in a system. Entry to an IC service does not require a patient to pass all Service Entry Eligibility Criteria (SEEC) but the majority. This was a limitation of the SEEC in operation at that time. Using the simulation model we determined that many patients failed the cognitive impairment criterion (e.g. the patient should not be cognitively impaired) adopted by all the services. The idea to explore this resulted from discussions with several IC and other health and social care workers during the SSM phase when reporting problems with mixing cognitively impaired with non impaired patients. However, the National Service Framework (NSF) for older people [33] recommends that people with mental health problems should be included in IC. Therefore patients that have medium to severe (not mild) cognitive impairment could be sent to IC services but the services in our system were not set up to receive them. Essentially, the model is used to examine a change in local policy where patients with medium to severe cognitive impairment would be rehabilitated separately. Therefore, this scenario explores a potential IC avenue and not a specific service or set of services and therefore the size of the service is not important just the number of people that qualify for it, even though a random number of 50 beds/places has been used in the model. The results show a substantial reduction of the older people qualifying for the wards and a minor impact on the 'hard core' IC services (see table 8.2). This also means that the majority of people with cognitive impairment requiring rehabilitation in scenario 1 ended up in the wards.

Table 8.2. Average number of older people in wards

	Scenario 1			Scenario 2		
Service type	Ave Num of older people in Queue	Ave Number of older people in service	Ave Number of older people treated	Ave Number of older people in Queue	Ave Number of older people in service	Ave Number of older people treated
Hospital A (3 wards/57 beds)	5.4	49.78	178.3	0.0	7.8	28.0
Hospital B (2 wards/52 beds)	1.0	46.4	195.3	0.0	25.8	106.2
Hospital C (2 wards/48 beds)	0.4	37.0	148.9	0.0	13.0	53.0
New cognitive impairment service (50 beds)	n/a	n/a	n/a	317.0	50.0	163.8

9. DISCUSSION

At the beginning of this study the stakeholders made it clear that they were keen for us to evaluate the whole IC system and not just the individual services. This meant that they wanted a complex integrated model of their services. However, it soon became apparent that the simulation methodology did not fit this study at this macro level (simulation of a system of services) as it does at the micro level [29] (simulation of an individual IC service). This was because we were not able to understand the system and therefore determine the simulation objectives. Contributing factors were the size of our system, the newness of IC, the difficulties in observing the system as the changes were slow and its services are geographically separate. More importantly, none in the system had an overall understanding of how it worked or could work to provide a starting point to the chaos encountered. We used SSM to understand this large and complicated system of services. It is almost certain that if SSM had not been used we would not have arrived at the same conceptual model and the necessary questions for long term planning would not have been considered. However the use of SSM in determining the simulation objectives meant that a more complicated model was built that required a lot of unavailable data and required undertaking an extensive and costly data collection exercise. In fact, Jun et al. [6] review of the simulation literature for health care clinics suggested that the lack of complex integrated models in health care could be due to extensive data requirements and their associated costs.

This experience of using SSM to enable simulating a complex integrated health care system has uncovered another impeding factor that could affect such studies: the time consumed cooperating with large number of stakeholders. A project that has been commissioned by an overall system owner or a committee in charge of a system does not guarantee easy access or a full disclosure of information or employee insights. Political and cultural issues as well as differences among individuals within an organization can inhibit progress. In our study, the UK NHS fear of blame culture required that the project team spent a great deal of time reassuring the employees that we were not interested in the individual's performance. Gaining the trust of a wide range of employees requires active involvement that is not usually achieved in one meeting. For example, getting employees to talk about the belief that their patients or those of other services within their system were inappropriately placed there, happened only after many discussions.

10. CONCLUSIONS

The study was motivated by the needs of a particular IC system and a simulation model was built for this IC system but it provides insights that are also true for other IC systems. However, the approach can be adapted to fit other IC systems and possible other complex integrated systems. In addition, the study contributes to the wider health care literature by exploring the referral mechanism (decision making) and service gaps in a system that have not previously been explored. This has resulted from using SSM to understand the problem and extract a conceptual model. To conclude, the simulation community would benefit from additional case studies being reported that focus on deriving conceptual models particularly ones of complex integrated systems.

ACKNOWLEDGEMENTS

I would like to thank the other members of the ICON project team and the East Kent Health and Social Care authorities for their invaluable contribution of their time, information and data.

REFERENCES

[1] S. Robinson: Simulation, The practice of Model Development and Use, John Wiley and Sons, Chichester 2004.

[2] K. Kotiadis and J. Mingers: *Combining PSMs with hard OR methods: the philosophical and practical challenges*. Journal of the Operational Research Society. (forthcoming in 2006)

[3] B. Lehaney, S.A. Clarke and R.J. Paul: "A case of an intervention in an outpatients department" Journal of the Operational Research Society, Vol. 50, pp877-891, 1999.

[4] B. Lehaney and H. Vlatka: "Simulation modelling for resource allocation and planning in the health sector" J Roy Soc Health, Vol. 115, pp382-385, 1995.

[5] B. Lehaney and R. J. Paul: "The use of Soft Systems Methodology in the development of a simulation of out-patients services at Watford General Hospital" Journal of the Operational Research Society, Vol. 47, pp864-870, 1996.

[6] J.B. Jun, S.H Jacobson and J.R. Swisher J.R: "Application of discrete-event simulation in health care clinics: A survey" Journal of the Operational Research Society, Vol. 50, pp109-123, 1999.

[7] K. Kotiadis, G. I. Carpenter and M. Mackenzie: "Examining the effectiveness and suitability of referral and assessment in Intermediate Care services" Journal of Integrated Care, Vol. 12, pp42-48, 2004.

[8] S. Robinson, J.S. Edwards and W. Yongfa: "An expert systems approach to simulating the human decision maker" Eds. W. E. F. Medeiros D.J., Carson J.S., Manivannan M.S. Proceedings of the 1998 Winter Simulation Conference, Vol. 1998.

[9] G.I. Carpenter, K. Kotiadis and M. Mackenzie: "An evaluation of Intermediate Care using computer simulation", The summary report. University of Kent: Centre for Health Service Studies, Canterbury, 2003.

[10] Department of Health, "http://www.dh.gov.uk/assetRoot/04/02/04/70/04020470.pdf"

[11] Department of Health, "Shaping the future NHS: long term planning for hospitals and related services: consultation document on the findings of the National Beds Inquiry", Department of Health, London, 2000.

[12] K.Katsaliaki, S. Brailsford, D. Browning and P. Knight : "Mapping care pathways for the elderly" Journal of Health Organization and Management, Vol 19(1), pp57-72, 2005.

[13] H. Campbell, J. Karnon and R. Dowie : "Cost analysis of a hospital at home initiative using discrete event simulation"

Journal of Health Services Research and Policy, Vol. 6, pp14-22, 2001.
[14] M. Utley, S. Gallivan , K. Davis, P. Daniel, P. Reeves and J Worral : "Estimating bed requirements for an intermediate care facility" European Journal of Operational Research, Vol. 150, pp92-100, 2003.
[15] P. Checkland: Systems Thinking, Systems Practice: Includes a 30-Year Retrospective, John Wiley and Sons, Chichester 1999.
[16] P. Checkland and J. Scholes: Soft Systems Methodology in Action: includes a 30 year retrospective, John Wiley and Sons, Chichester 1999.
[17] P. Checkland, P. Checkland, "Soft systems methodology: a 30-year retrospective", Wiley, Chichester, 1999.
[18] J. Rosenhead: Rational Analysis for a Problematic World, John Wiley & Sons, Chichester 1999.
[19] Department of Health, "Single Assessment Process: Key Implications, Guidance for Local Implementation and Annexes to the Guidance", DoH, London, 2002.
[20] Department of Health, "Single Assessment Process: Assessment tools and scales", DoH, London, 2002.
[21] L. Hanford, L. Easterbrook and J. Stevenson: "Rehabilitation for older people", the emerging policy agenda, Kings Fund, London, 1999.
[22] Kings Fund, " Rehabilitation and Intermediate Care", Briefing, 2000.
[23] A. Steiner and B. Vaughan, "Intermediate Care", A discussion paper arising from the King's Fund seminar held on 30th October 1996, Kings Fund, London, 1997.
[24] J. Stevenson, "Mapping Local Rehabilitation and Intermediate Care Services", A whole systems approach to understanding service capacity and planning change, Kings Fund, 2001.
[25] K. Wilson and J. Stevenson, "Intermediate Care Co-ordination", The Function, Kings Fund, 2001.
[26] R. Davies and P. Roderick: "Planning resources for renal services throughout UK using simulation" European Journal of Operational Research, Vol. 105, pp285-295, 1998.
[27] M. B. Dumas: "Hospital bed utilisation: An implemented simulation approach to adjusting and maintaining appropriate levels" Health Services Research, Vol. 20, pp43-61, 1985.
[28] B. Lehaney and V. Hlupic: "Simulation modelling for resource allocation and planning in the health sector" J Roy Soc Health, Vol. pp382-385, 1995.
[29] K. Kotiadis and M. Mackenzie: "Simulation Modelling for Intermediate Care" British Journal of Health Care Management, Vol. 10, pp240-246, 2004.
[30] Department of Health, "Intermediate Care", HSC 2001/01:LAC, London, 2001.
[31] Geer Mountain Software Corporation, "Stat:::Fit", South Kent, 2001.
[32] Simul8 Corporation, "Simul8", http://www.SIMUL8.com/.
[33] Department of Health, "NSF for Older People Supporting Implementation, Intermediate Care: Moving Forward", DoH, London, 2002.

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