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SUPPORTING CRIME DETECTION AND OPERATIONAL PLANNING WITH SOFT SYSTEMS METHODOLOGY AND VIABLE SYSTEMS MODEL

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ABSTRACT

In recent years the introduction and subsequent enhancements of information technology has seen the emergence of major opportunities for developing new approaches to improve information interchange. The provision of information provides opportunities to find resolutions to problem situations, and the power of providing relevant and accurate information through using information systems cannot be underestimated. However, the world of information systems thinking has, so far, experienced difficulty finding a methodology suitable for utilising the full range of available current information technology. This situation in the real world shows itself predominantly as information starvation as current information systems struggle to bring order and structure to information technology developments.

This paper will discuss the issues relating to the development of a new generic framework. The novel aspect of this generic framework for planning information systems is that it integrates Soft Systems Methodology and Viable Systems Model in a coherent whole, whilst embracing the concepts of self-adaptation and autonomy. Further, the generic framework integrates the spatial analysis capabilities of a Geographical Information System.

The generic framework will then be tested in real world problem situations in order to test its effectiveness, efficiency and efficacy with regards to finding suitable solutions to the problem of information starvation. The importance of focusing the framework on GIS functionality is related to the fact that in many organisations GIS is employed as the solution to information starvation because of its ability to display spatial information. This paper will demonstrate the implementation of the generic framework in a UK Police Authority, a large emergency service that suffers from information starvation. In the context of a UK Police Authority the combination of Soft Systems Methodology and Viable Systems Model being supported by GIS functionality is seen as being a significant progression in relation to crime detection and operational planning.

Keywords: Information Systems, Generic Framework, Soft Systems Methodology, Viable Systems Model.

INTRODUCTION

Wide ranges of disciplines, or fields of social science, contribute to our knowledge of organisations and their behaviour. Each discipline has its own approach, or approaches, to description and explanation of organisations. These are set in the paradigms used by communities of researchers. Debate has developed, at an accelerating rate, about the appropriate nature and strength of the paradigms that underlie the research into business and organisations [1].

Skyrme (1997) [2], argues that to try and apply a single methodology however appropriate it may seem to its proponents, does not reflect the richness, diversity and interdependence of most real-life situations. Therefore a multi-methodology approach, which uses techniques from many other methodologies, would seem to have many attractions.

Real-world problem situations are inevitably highly complex and multidimensional. Different paradigms each focus attention on different aspects of the situation and so combining methodologies is necessary to deal effectively with the full richness of the real world. Methodologies tend to be more useful in relation to some phases than others, so the prospect of combining them has immediate appeal. Even where methodologies do perform similar functions, combining a range of approaches may well yield a better result [3].

In order to develop a framework it is first important to understand the process that is required to undertake such a task. There are two main functions of a self-adaptive system, which must be taken into consideration when developing the framework, which are; the capability to determine '*what*' changes are taking place and '*how*' to take the necessary corrective action. An in-depth literature review has been conducted so as to ensure that knowledge of the field is extensive and comprehensive. It is vital to the development of a generic framework that self-adaptive systems concepts are reviewed so as to take into account current and emerging control structures.

Having gained an understanding of the processes involved it is logical that the next steps to take are the design, implementation and experimentation of the generic framework. To begin with, it must be understood and appreciated that there are numerous theoretical approaches for self-adaptive information systems [4, 5].

Peter Checkland's Soft Systems Methodology (SSM) [6, 7, 8] will be utilised to underpin the concepts incorporated into the generic framework. Whilst the soft approach adopted by SSM will allow the framework to determine 'what' changes are happening to the new information system it will not be able to decide 'how' to take corrective action if necessary. Because of this, a hard methodology will be employed to control the decision making process that is fundamental to any information system.

In the world of public sector information system development and implementation Prince2 [9] is the Government standard approach. An investigation has been undertaken to determine which hard approach is most suited to the framework being created. Other approaches such as Effective Technical and Human Implementation of Computer-based Systems (ETHICS) and Stafford Beers' Viable Systems Model [10] have been evaluated. It is essential that the hard approach adopted for the development of the framework must be able to link in with SSM.

Soft Systems Methodology

The Lancaster Model used in SSM consists of seven stages that allow the analyst to produce recommendations that are better suited to the staff within the organisation concerned. SSM aims to look at the problem situation as a whole rather than just the problem itself [6, 7, 8]. For example, SSM would look at an organisation and its staff that cannot gather the information they require, rather than just looking at the IT systems.

Step 1 – *The Problem Situation*. This is where the analyst derives knowledge of the organisation, how it works and what the working procedures are at present. At this stage the analyst tries to find out what people's views of the problem area is. Step 1 is where the analyst performs basic research into the problem area and who the key players are.

Step 2 – *The Problem Situation Expressed*. This is where the analyst writes down the knowledge gained from the previous step. This must be written down in a way that people in the problem domain can understand. Step 2 is done in order to describe the problem domain e.g. conflicts and issues. The best way of expressing the problem situation is through rich pictures. *"A picture is worth 1,000 words."* [1]

Step 3 – *Root Definitions of Relevant Systems*. This step is where the analyst tries to define/create a system at a conceptual level that will address the problem in the problem domain. The analyst must decide what different perspectives can be used when looking at the problem situation. There should be no link between the root definition and the organisation in the real world at this stage.

Step 4 – *Conceptual Model*. Step 4 is where a check is done to validate the root definitions. The basic 'whats' of the process come from the root definitions and describe what the process should be like. Next the analyst must write the activities that need to be done in order for the system to work e.g. the 'hows'. This must not be like a Data Flow Diagram (DFD), however, because the analyst should only be concerned with the human activities.

Step 5 – *Comparison of Step 4 with Step 2*. Here the analyst compares the conceptual models (Step 4) with the real world (Step 2) to see where they differ and are similar. Here the analyst is looking for gaps in the real world situation which are filled by the optimised conceptual model. The analyst may have to go back some steps and redefine certain things.

Step 6 – *Feasible, Desirable Changes*. This step is where the analyst identifies feasible and desirable changes e.g. introduction of a new information system. The analyst must decide to assess whether there are ways of improving the current situation. This could be looking for ways to change the working practices to improve the current problem domain e.g. remove the problem.

Step 7 – *Action to Improve the Problem Situation*. There is where recommendations for taking actions to improve the problem situation are made. The analyst needs to decide how changes from Step 6 could be implemented. The analyst must be aware of the obstacles in the way of implementing the changes.

Because the Lancaster Model can be made into an iterative process Step 7 is close to Step 1 so that the outcome of one cycle can be fed into the start of another one [9, 10].

[1] Soft Systems Methodology: An Interpretation – Michael Francis, 2000.

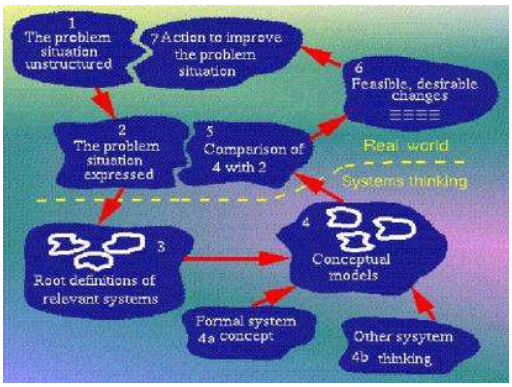


Figure 1. Peter Checkland's Lancaster Model.

The Viable Systems Model

A viable system [12, 13] is composed of five interacting subsystems, which may be mapped onto aspects of organisational structure. In broad terms Systems 1 to 3 are concerned with the 'here and now' of the organisation's operations, System 4 is concerned with the 'there and then' - strategic responses to the effects of external, environmental and future demands on the organisation. System 5 is concerned with balancing the 'here and now' and the 'there and then' to give policy directives which maintain the organisation as a viable entity.

System 1 in a viable system contains several primary activities. Each System 1 primary activity is itself a viable system due to the recursive nature of systems as described above. These are concerned with performing a function that implements at least part of the key transformation of the organisation.

System 2 represents the information channels and bodies that allow the primary activities in System 1 to communicate between each other and which allow System 3 to monitor and co-ordinate the activities within System 1.

System 3 represents the structures and controls that are put into place to establish the rules, resources, rights and responsibilities of System 1 and to provide an interface with Systems 4 and 5.

System 4 - The bodies that make up System 4 are responsible for looking outwards to the environment to monitor how the organisation needs to adapt to remain viable.

System 5 is responsible for policy decisions within the organisation as a whole to balance demands from different parts of the organisation and steer the organisation as a whole.

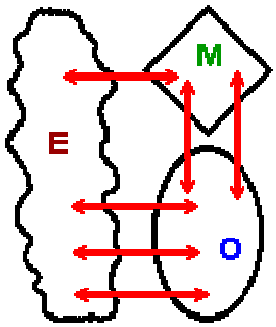


Figure 2. Basic depiction of Stafford Beer's Viable System Model.

In addition to the subsystems that make up the first level of recursion, the environment is represented in the model. The presence of the environment in the model is necessary as the domain of action of the system and without it there is no way in the model to contextualise or ground the internal interactions of the organisation. In Figure 2, E represents the external environment, O represents the operations (or internal environment) and M represents the metasystem, which is the management functionality of VSM. The arrows indicate the various ways that the three parts of the model interact with each other.

Creating a Generic Framework Through Integrating SSM and VSM

As stated earlier in this paper, SSM does not have the capability to deal with 'hard' questions. In any situation there is a 'what' and a 'how'. The 'hard' methodologies deal with the 'how' question, which is missing in SSM. In

effect, SSM can tell the analyst 'what' is happening but not 'how' to take any corrective action [13, 14, 15, 16]. On the other hand, although VSM has monitoring functionality it does give the analyst a clear impression of 'what' is happening but rather 'how' it goes about solving a problem. Keeping a system viable is all about making sure that it has the ability to deal with a constantly changing environment.

It does appear that there is some polarisation between the 'hard' and 'soft' approaches. However, they do have one thing in common with each other. Both approaches have monitoring functions that collect information on the current situation. By tapping into the 'what' functionality of SSM and the 'how' of VSM we can potentially achieve autonomic computing if these two approaches are linked at the monitoring stage. The following diagram shows the very basic elements of SSM.

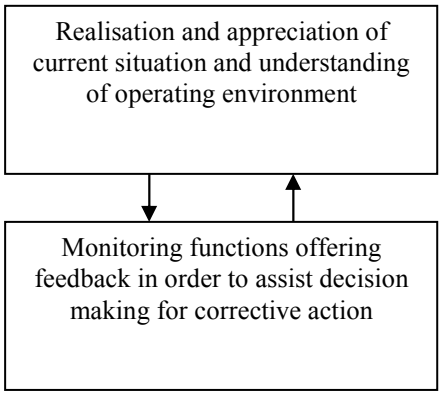


Figure 3. SSM boundary and monitoring function.

It is proposed that the Viable Systems Model, in its entirety, is inserted into the Lancaster Model from SSM in Step 4. This part of the Lancaster Model is specifically designed for other systems thinking and seems the most appropriate place to perform the connection between the two methodologies.

The two methodologies linked in this way can allow them to be monitored efficiently. With VSM residing within SSM the 'whats' and 'hows' of problem situations will be dealt with in one methodology. In addition, the methodology would have the ability to cope with environmental change as it fully embraces the concepts of autonomy and self-adaptation. Based on the overlapping philosophies that exist between SSM and VSM the ability to cope with environmental change in an autonomic and self-adaptive fashion represents a powerful asset to the generic framework.

To ensure the generic framework is capable of self-adaptive and autonomic functionality, it is proposed that Systems 3, 4 and 5 of VSM are utilised in Step 4 of the Lancaster Model. This is the first step in the development of the generic framework whereby there is a transition from establishing the 'whats' to the 'hows' of problem situations. The management functionality of VSM integrates with both the internal and external environments within which the relevant information system exists.

The monitoring functionality of the Conceptual Models, of Step 4 of the Lancaster Model, will provide accurate and up to date information for the management functionality to perform in relation to selecting any necessary control rules or repair strategies. Figure 4 below shows how Conceptual Models and the management functionality of VSM will work together to take the first step towards combining the 'whats' and the 'hows'.

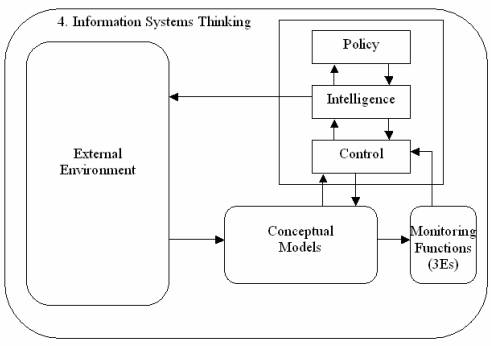


Figure 4. The integration of SSM and VSM through a modified Step 4 of the Lancaster Model.

The new Step 4, as shown above, will assist with the selection of appropriate resolutions to problem situations. To ensure that this process embraces the concepts of autonomy and self-adaptation the R5 model [17] will be introduced to Step 5 of the Lancaster Model.

The R5 model suggests the following set of rules need to be applied in order for information systems thinking to fully understand its operating environment, and therefore develop appropriate solutions:

- Resources;
- Rules;
- Responsibilities;
- Regulations; and
- Recommendations

To ensure the generic framework is fully self-adaptive and autonomic it needs to use R5 in Step 5 of the Lancaster Model so as to conduct appropriate analysis between systems thinking and the real world situation. This will ensure that an appropriate repair strategy is implemented.

In essence, Systems 3, 4 and 5 (of VSM) will perform the duties of R5, however, it should be noted that in any self-adaptive or autonomic information system the ability to override the decision should be present. The intention of the generic framework is for it to develop and improve information systems, and the problem situations that go with it, in such a way so that it is able to lead itself to make decisions based on information it gathers. However, these decisions can always be overridden should it be deemed manually that another resolution is more suitable for the failure or conflict currently being experienced.

Taking cognisance of the requirements and functionality discussed the generic framework will take the form as shown in Figure 5 below.

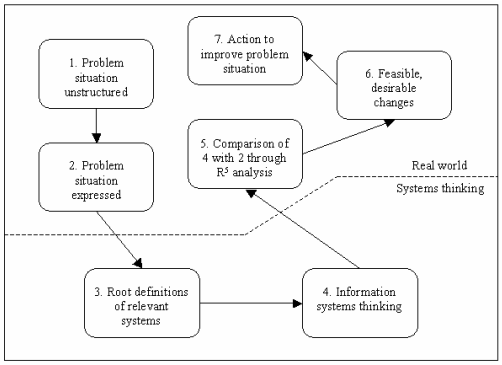


Figure 5. The generic framework.

The intention, when developing the generic framework, was to ensure that the 'look and feel' of the Lancaster Model was kept intact, as it has been a successfully adopted approach to information systems thinking for several decades. Whilst the generic framework may look similar to the Lancaster Model it should be noted that Steps 4 and 5 fully incorporate new functionality whilst still ensuring that the philosophies that underpin SSM and VSM are not compromised [18, 19, 20, 21].

A UK POLICE FORCE: A CASE STUDY

Crime Mapping

In the last few of years the founding of the Crime Mapping Research Centre [22] in Washington has spurred some US Forces into investing in mapping technology to better map, understand and deal with crime, and British and Australian police forces are slowly getting to grips with the technology. Standards of implementation are different across the board, with some areas experiencing great problems in introducing the new technology and theories of crime that accompany it.

As of March 2001, less than a third of the approximately 19,000 US law enforcement agencies have invested in crime mapping systems [23]. The majority of Australia police agencies have crime mapping in some form or another with MapInfo being the most commonly used product. New South Wales are probably the most advanced with MapInfo, boundary files and training available to analysts in each of their 80 Local Area Commands. A survey completed in the UK found that 44% of forces had mapping systems, again with the market share going to MapInfo [24], including the Force included in the case study.

The challenge facing the implementation of GIS to assist front line officers is identifying their needs, with regards to the provision of information and access levels, and ensuring that these are met within the bounds of the Data Protection Act 1998 and the Bichard Inquiry Report 2004.

UK Police Force Case Study

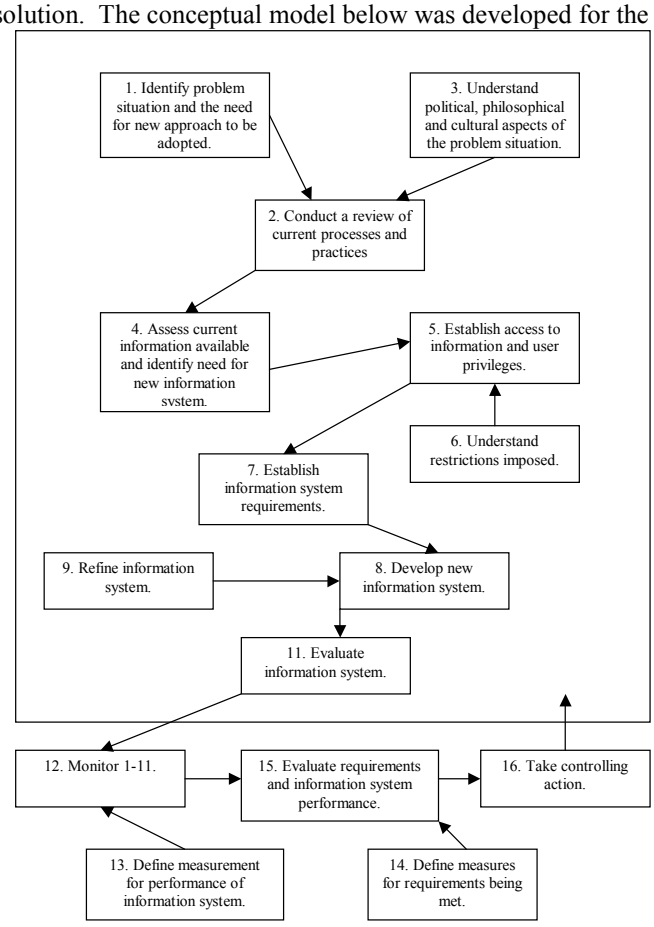
In August 2006 a UK Police Force took the decision that the provision of critical information needed improving. As it turned out, a drastic overhaul was required. The author was drafted in as the lead analyst as part of a project team with the sole objective of developing the provision of information and spent the next twelve months applying the generic framework to the problem situation. Please see the appendix at the end of this paper, which details the problem situation being experienced within the UK Police Force.

The current problem situation in this particular UK Police Force is indicative of most large organisations. That is, the problem of information starvation, which in policing terms demonstrates itself as a blockage that prevents officers receiving the accurate and relevant information they need to carry out the duties associated with their roles. There are some aspects where this Force excels with its provision of information and it is considered to be one of the most advanced UK Forces in this respect. However, it is also true to say that there are instances whereby staff either cannot find they information they require, or can only collect information that is considered irrelevant.

This Force has recently replaced its crime recording system and as a consequence interfaces with other Force systems required updating. This represented a good opportunity to enhance the provision of information within the Force through the implementation of the generic framework [25, 26]. For the purposes of the case study the interface between the Force data warehouse and the new crime recording system was chosen. At this point the generic framework was applied to gain an appreciation of the problem situation and then develop a new model to ensure that the provision of information was improved.

Applying the Generic Framework

The implementation of the generic framework started by trying to establish a structured definition of the problem situation. This involved utilising the SSM functionality of the generic framework. Analysis conducted showed that the approach adopted to introduce new systems itself was causing problems. Staff felt that their views had not been taken into consideration when previous systems had been introduced, which was cited as the main reason why the provision of information was not what it could be. The generic framework encourages the analyst working with the current problem situation to develop a conceptual model to determine the most appropriate way of finding and implementing a suitable resolution. The conceptual model below was developed for the case study being discussed.



To ensure that the new interface between the Force data warehouse and the new crime recording system provided information effectively a process of consultation was established. This process was introduced to engage staff in discussions in relation to the interface but also encouraged the staff to feel that they played an important role in the work that was being carried out. The consultations also produced a very robust set of user requirements and proved to be a very successful research approach.

With staff feeling part of the process it opened up channels of communication by which any assistance or clarification on certain issues could be achieved. This played an important role when the process of testing the interface started. Previous systems had been introduced with the provision of information being dealt with once that system had gone live. Analyses conducted using the generic framework showed that it would be beneficial to test the interface prior to the system go live date by populating a test database with 'dummy' records. This would afford additional time to correct flaws with the interface without affecting operational performance and would ensure that staff involved with the consultation process was happy with the potential provision of information. Should any changes in recording practices emerge at this point they could be taken into consideration without any negative impact to the Force.

The interface that was developed was considered by staff to meet their needs and, once the new crime recording system had gone live, provided information to support operational decisions that had previously been unavailable.

Having utilised the functionality of SSM it was appropriate to VSM's capabilities to ensure that the interface was used and monitored correctly. As discussed earlier in this paper Step 4 of the generic framework links SSM and VSM and enables the switch in viewpoint from defining the problem situation to implementing an appropriate solution.

The outcome of the switch in viewpoint between SSM and VSM ensured that robust and clearly defined interface specifications were developed. However, the interface needed to be constructed by the right people at the right time. At this point in proceedings the R^5 model, from Step 5 in the generic framework, was implemented. Due to the confidential nature of the information contained within the R^5 analysis conducted for this UK Force the results cannot be displayed. However, the analysis ensured that the right resources were provided for the development of the interface, along with establishing which legislative constraints must be adhered to.

The newly developed interface allowed staff to link custody records, victim and offender details, property, court case files and crimes together from one central repository. It had been possible to gather such information before, however, the linkages that connected all this information together had not previously been in existence. This innovation enabled the Force to perform crime analysis much quicker than it had been possible previously. This has led to enhanced decision making at management level, which, in turn has seen a positive effect on Force performance. Within the first few weeks of the implementation of the new crime recording system and its interface crime levels had dropped across the Force. Three months after the implementation of the new interface crime levels across the whole Force had dropped by 10% with detections showing a rise of nearly 6%. Whilst it is still considered premature to announce the success or otherwise of the case study as a whole it is clear to see that the early signs are positive.

In addition to being able to link key information throughout the Criminal Justice process it is now possible for the Force conduct analysis into how many suspects have been named recently, enabling management to deploy officers to carry out the necessary arrests. The information provided also highlights to the management ranks how the suspect was named, including whether they have been named through DNA hits or through fingerprint, footwear and forensic matches. This information has proved invaluable when incorporated into staff deployment plans and crime investigation.

Throughout the investigative process each officer's involvement can now be tracked. The ability to monitor which officer is in charge of particular cases, who carried out various arrests and who have conducted interviews is new to the Force. In fact, this is new to UK Police Forces. Throughout the life of a custody record, crime record or court case file each officer, and their link in the process, can be tracked. This represents an innovation in respect of auditing and staff deployment.

Briefing tools have also been included in the implementation of the new crime recording system and its interface. Management level staff can now produce detailed reports on crime that has happened in their area for any given period, which includes details of victims, suspects, offenders and property involved at the click of a button. These briefings are now produced each morning and are used when determining staff deployments or operational planning. In addition to this, information is highlighted to officers when carrying out their day-to-day duties. For example, if an officer has conducted an arrest they will be informed if the person arrested is wanted on warrant, has missed their bail, or is a named suspect for another crime.

Evaluation

As a result of the newly developed interface the Force is considered to be ahead of most in the UK through its use of GIS, with a vast increase in the provision of information being experienced. GIS now forms the backbone of information used within the Force and is used to support operational planning and key strategic decision making.

GIS has been quickly picked up on by other UK Forces for their use in a variety of different operational situations though their use has not been fully utilised for crime mapping or analysis. There has recently been a flood of publicity as Forces both here and in the United States have invested in GIS. However these systems have been mainly used for mapping incident data, and for providing maps for describing scenes of incidents to a court. Incidents from the emergency system can be displayed on screen so that the operator can allocate the most efficient resource to deal with the particular event.

To complete the consultation process a series of presentations and workshops were carried out to communicate the introduction of the new interface to staff that would be using it to collect information. The presentations and workshops were received well by staff with Bluestar, the company that owns the Force data warehouse, reporting a sharp upturn in the number of crime related searches being carried out.

Accurately guiding responding officers straight to the scene of the incident can save valuable time and these same principles have also been applied to other emergency services.

With incident deployment improving the next progression looks at providing officers with the information they need to carry out their front line duties. The future possible application of GIS for crime pattern analysis as a tool to assist officers seems the next step in solving the information starvation problem. The Force's ability to conduct in depth mapping analysis has now been greatly enhanced due to the additional provision of geocoded information. Staff can now assess details of all linked persons or crimes on dynamic maps that run through the newly developed interface.

Given the approach adopted through utilising SSM's functionality staff are actively seeking new ways to collect the information they require. The culture in the organisation has seen a huge shift whereby staff feel confident in their ability to collect accurate and relevant information, and are willing to conduct their own analysis too. A direct result of this cultural change has seen an increase in performance. In respect of a UK Force this represents a fall in crime levels and an increase in detection rates. This work will continue to develop in the coming months and years as the information provided through mapping has become more powerful and assists the investigative process better than it has done before.

Following on from the implementation of the new interface within the Force requests are being made to further enhance it by incorporating new technology. The introduction of GPRS enabled blackberries for dynamically briefing officers whilst out on patrol is not too for away. This will provide detailed information to officers through tracking their location and determining what needs to be brought to their attention whilst they are on patrol.

The introduction of dynamic resource tracking is in the early stages of being developed. Through dynamically tracking officer movements in real time deployment decisions can be taken in response to situations that may arise. This will be a powerful new development in the world of policing and is only possible due to the implementation of the new interface between the Force data warehouse and the new crime recording system.

The generic framework in this case study highlighted that the problem that existed within the Force had arisen from poor communication when new systems were being introduced. By establishing effective lines of communication and understanding the cultural beliefs of staff within the Force a new interface was developed that would improve the provision of information. The technological capacity to develop the interface was already in existence within the Force. However, changing the processes that led to the development of the new interface ensured that improvements to the provision of information were achieved.

Conclusions

In this paper, the author has introduced the concept of linking SSM and VSM. The concepts underpinning each approach, and the hard and soft dichotomy, described in this paper. Although the methodologies adopt two very different approaches this does not mean that they are mutually exclusive.

There are huge forward strides that can be made in the field of information systems thinking if the full functionality of modern information technology can be fully embraced. This paper has demonstrated how SSM and VSM can be linked and how their approaches, although very different in some respects, can be combined to form a new methodology that is capable of dealing with the 'whats' and 'hows' of changing environments.

The experience gained through the case study at the UK Force has shown that applying an information systems thinking approach has enhanced the provision of information. In particular, the new provision of information has contributed to the investigative processes and performance monitoring mechanisms within the Force. The major impact of introducing an information systems approach to the Force in the case study was taking the organisational culture into account. Many approaches have been tried in the past and failed due to not developing an in depth understanding of the organisational culture and the feelings of the staff within it. By opening the channels of communication effectively the generic framework was able to gather robust developmental specifications and also create user 'buy in' to the new interface. This ensured that staff was confident in voicing their opinions during the developmental phase, which encouraged extensive use of the interface once it had been implemented. Staff felt that they had been part of the developmental process and were responsible for the end product. Previous approaches that had been utilised previously did not recognise the importance of this 'buy in' and subsequently ended up developing a product that staff either could not use, or did not want to use.

Whilst in the context of the case study organisation the application of the generic framework, although very much in its early days of implementation, is showing signs of being a success it is difficult to quantify whether this will be the case in other organisations that it is used in. It is proposed that the generic framework be implemented in other organisations to assess its flexibility and adaptability to cope with different operating environments along with its ability to implement appropriate solutions.

Other Forces within the UK have already started to pay attention to the work conducted within the Force included in the case study as UK policing enters an exciting new era. That said, the intention of the generic framework is to ensure that it can adapt to different problem situations and therefore can be applied in a variety of contexts. Whilst the future is exciting for the Force it is proposed that the generic framework will be implemented in other large organisations with the aim of producing equally positive results.

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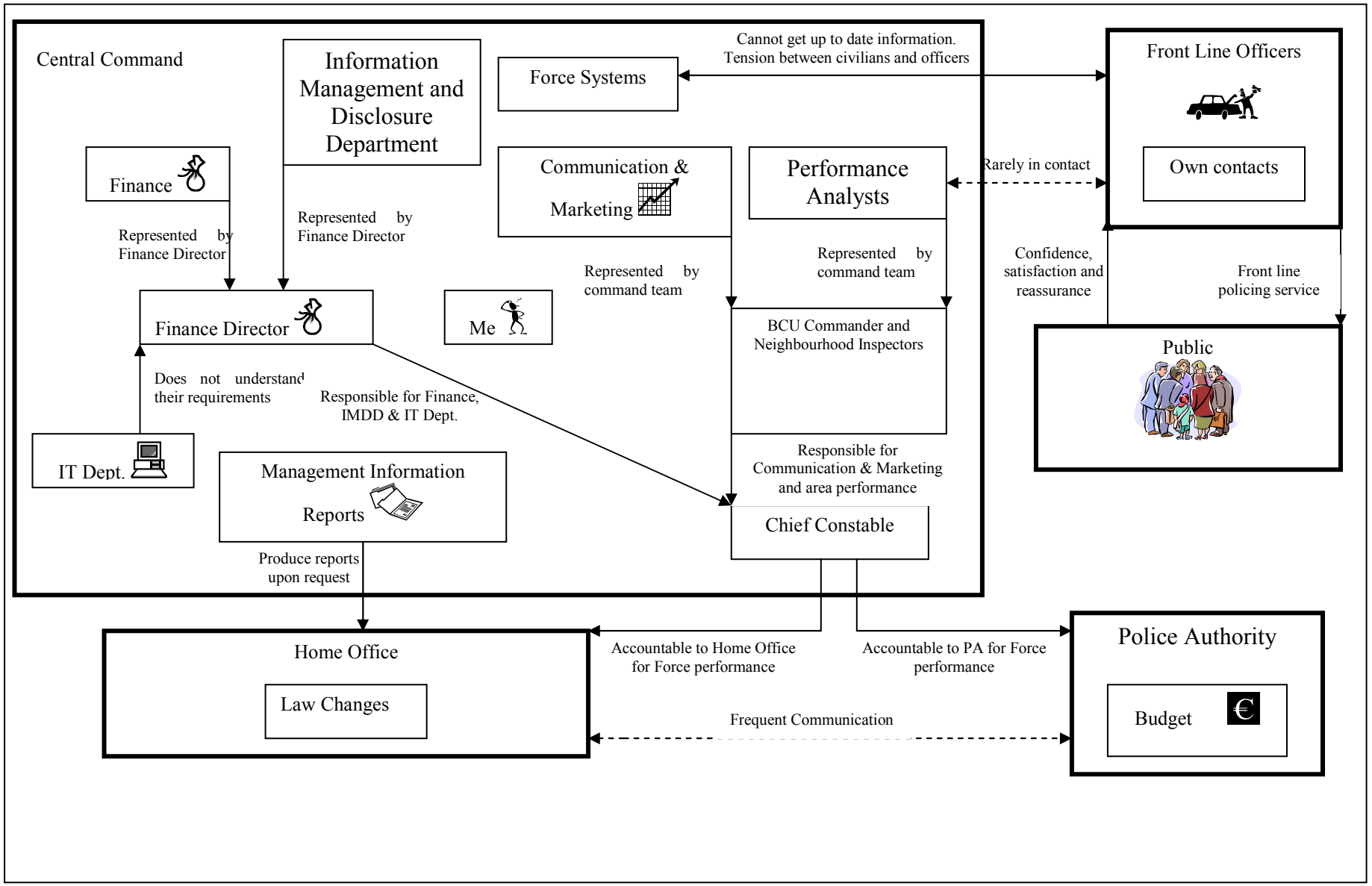
Appendix


Central Command
Information Management and Disclosure Department
Force Systems
Cannot get up to date information.
Tension between civilians and officers
Front Line Officers
Own contacts
Finance
Represented by Finance Director
Represented by Finance Director
Communication & Marketing
Performance Analysts
Rarely in contact
Represented by command team
Represented by command team
Confidence, satisfaction and reassurance
Front line policing service
Finance Director
Me
BCU Commander and Neighbourhood Inspectors
Public
Does not understand their requirements
Responsible for Finance, IMDD & IT Dept.
IT Dept.
Management Information Reports
Responsible for Communication & Marketing and area performance
Chief Constable
Produce reports upon request
Home Office
Law Changes
Accountable to Home Office for Force performance
Accountable to PA for Force performance
Police Authority
Budget
Frequent Communication