Chain mapping tools for analysis and improvement of inter-organisational information systems and relationships

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Abstract

It is argued there is a gap between existing 'zero level' chain diagrams that only show the organisations involved and detailed process mapping tools that are commonly used when analysing supply chains. To address this, a number of relationship mapping tools are presented. More detailed zero level maps are suggested to identify opportunities for improvement that may have the greatest strategic impact on the chain as well as to highlight likely obstacles to cooperation. Multiple level relationship diagrams are suggested to identify the departments and the organisational hierarchical levels involved in these interactions so a team to work on the problem or opportunity can be established. More detailed work can be facilitated with process diagrams.

Keywords: supply chains, supply networks, chain diagrams, zero level, multiple level, supply chain relationships

1. Introduction

When looking at chains of organisations to improve business processes, maps are used to simplify complex interactions into diagrams that can be analysed visually. Chain maps ensure that those involved in the analysis understand all of the interactions and consequently the implications of changes that may be suggested. Maps can be used to identify problems and opportunities for improvement as well as the greatest obstacles to cooperation. Maps can be used as a tool in chains of organisations to develop strategies to improve the performance of the chain over time.

When mapping interactions between organisations most diagrams found in the literature are drawn simply by depicting the organisations or departments that interact with each other. For example in showing organisations involved in chains being described or analysed in further detail Gifford *et al.* (1998) mapped out 13 Australian food chain diagrams from focal firms to retailers/food service customers (12 in Japan). Peterson *et al.* (2000) produced

14 chain diagrams of Australian agricultural and fishing industries from growers to retailers and restaurants. Other studies used chain diagrams to illustrate the structure of the chain or industry being researched e.g. Kaplinsky and Morris (2002) - forestry, timber and furniture chain, Zylbersztajn and Filho (2003) - Brazilian meat chain. These diagrams have been called "zero level" diagrams in this paper as they indicate which organisation or department is involved. In looking at chains of organisations, zero level chain maps can show upstream customers and downstream suppliers so that the physical flow of products can be mapped from the primary producer to the final consumer (Figure 1). While zero level chain maps are useful to get a general overview of the chain, they do not provide any details of which people are involved nor the nature of the interactions.

When analysing supply chain systems, it is necessary to consider three major aspects of chain interaction (Figure 2). Firstly the physical flow of products, secondly the information flows and thirdly management and control of the chain including the relationships both within and

Figure 1. Zero Level Chain Diagram example: agribusiness food chain (Storer, 2001).

Figure 2. The supply chain management model (Taylor, 1997).

between organisations (Taylor 1997). There are increasing numbers of tools available for mapping physical product (1) and information flows (2). For example flow diagrams, process diagrams and value stream mapping tools (described later in the paper) are increasingly effective at tracking the movement of a physical product or information flow through each major process within an organisation and/or between organisations (e.g. Jones and Womack 2002, Rother and Shook 1998). These tools allow detailed analysis of the flow of goods (1) involved in each process from raw material component suppliers through manufacturers to distribution centres, wholesalers, retailers and the final end consumer. In addition, information flows (2) can be mapped such as systems for: order processing; demand forecasting; efficiency and control. Less work has been done in mapping chains in terms of the relationship characteristics (3) such as trust, commitment, performance, power, responsiveness and degree of integration or fragmentation.

There appears to be a gap in the chain mapping tools found in the literature. The zero level maps do not provide enough detail to make a considered judgement of the opportunities for improvement nor to identify the greatest obstacles to cooperation. While the detailed process diagrams assist in determining root causes of problems and what needs to be changed, they have two problems. Firstly there is an assumption that the grounds for examining a particular process in detail was rationally decided and secondly such diagrams tend to ignore the relationship issues involved within the process. It is argued you need more than an implicit understanding of the detail of who is involved and the nature of relationships when in the early stages of the chain diagnostic analysis.

This paper provides examples of how this relationship detail can be mapped by initially using zero level diagrams, followed by "multiple level" diagrams to identify the departments and the organisational hierarchical levels involved. It is expected the mapping tools presented in this paper will be complementary to existing zero level mapping tools and the more detailed process mapping tools such as value stream mapping, by providing a framework with which to systematically evaluate key aspects of supply chain relationships. Examples are provided of how to bridge the gap between broad brush zero level maps that use a high degree of abstraction and the highly detailed process maps.

These mapping tools may be useful for industry practitioners involved in analysing and improving chains. In addition researchers may find them useful in determining the most appropriate focal firm or product category / process to research.

2. Zero Level Diagrams – mapping organisations and issues

The first stage in analysing chains or networks is to determine the key organisations involved and to map the interactions between each. While this information may be implicitly understood by the people involved in chain improvement, the interactions can be critical and the key to success in process improvement. An adverse response by a key player to suggested improvements may hinder the outcomes expected. Therefore key organisations and interactions need to be explicitly identified early on in the analysis. These maps have been labelled "zero level" maps as they provide the most basic level of analysis. It is suggested that such maps are an early stage chain description and diagnostic tool. The purpose is to identify opportunities for improvement as well as the greatest obstacles to cooperation.

Hines (1998) provides a summary of commonly drawn zero level chain diagrams in developing a supply chain framework model. The framework model depicts how increasingly complex organisational interactions can be studied. The most simple is to look at processes within an organisational functional department such as purchasing or sales (Stage One - Intra Functional Supply Chain). Some complexity is added by looking at processes between organisational functional departments such as between sales and production (Stage Two: Inter Functional Supply Chain). Additional complexity is achieved by looking at a chain of organisations such as a supplier, the focal firm and a customer (Stage Three: Inter Organisational Supply Chain). The network is more complex again as interactions between the focal firm and multiple suppliers and customers are examined (Stage Four: Network Supply Chain). The most complex to study is the regional clusters where interactions between several firms are examined (Stage Five: Regional Clustering Supply Chains). Other authors have termed such diagrams as 'Netchains' (Lazzarini *et al.* 2001).

Zero Level Chain Linkages Diagrams

While Zero Level Chain Diagrams provide details of the interactions between direct customers and suppliers (Figure 1), no details are given of interactions with suppliers further upstream in the chain and customers further downstream in the chain. Zero level chain diagrams can be further expanded to show these interactions. An example of this is provided based on an Australia food processor as the focal firm in a vegetable chain (Figure 3). While the diagram still only shows the interactions between organisations, the linkages between organisations that are several stages upstream or downstream are depicted. Therefore the diagram has been titled a Zero Level Chain Linkages

Diagram. As the diagram shows who in the chain interact with each other, the organisations that may be affected by the flow on consequence of suggested changes can be mapped. For example, Figure 3 looks at the interactions between an Australian food processor (the focal firm) and its customers and suppliers involved in supplying Japanese food service restaurants. A change by a vegetable producer or the vegetable processor may affect not only the food processor but also the Japanese importer & wholesaler and the Japanese food service restaurants. The impact of the change on all in the chain and their response needs to be considered when planning how the change will be made.

Zero Level Chain Linkages Diagrams have been used by Trienekens (1999) to map order information penetration upstream in chains and Lefebvre *et al.* (2003) to show linkages in optical connectivity equipment industry chains.

Zero level netchain linkages diagrams

Zero level chain linkages diagrams can be expanded to show a number of chains or a network of chains called a netchain. Figure 4 shows a netchain of organisations involved with the focal Australian food processor where linkages with

Figure 3. Zero Level Chain Linkages Diagram example: Australian food processor focal firm in a vegetable chain - interaction frequency.

Figure 4. Zero Level Netchain Linkages Diagram example: Australian food processor focal firm netchain - interaction frequency (Storer *et al.*, 2003).

additional meat and vegetable suppliers have been added. Adding additional chains allows issues to be examined that affect multiple chains in the network.

Zero Level Linkage Diagrams of Netchains have been used by a number of researchers. Beverland and Lindgreen (2002) mapped the key actors in a netchain of organisations involved in the New Zealand wine sector from grape growers to final consumers. Cadilhon *et al.* (2003) mapped the netchain vegetable marketing system in Ho Chi Minh City, Vietnam from input manufacturers to consumers. Claro *et al.* (2002) mapped relationship connections in a Dutch flower merchants' business network. Althoff *et al.* (2005) recorded the structure of a Dutch pork netchain.

Others have used more stylised diagrams to illustrate theoretical chain or network structures (Cox 2004, Holmström *et al.* 2006, Kanflo 1998, Lazzarini *et al.* 2001, Omata *et al.* 2001, Trienekens 2004, Van de Vorst 2004) and issues involved such as tracking and tracing systems (Van Dorp 2003), potential alliances, product flows and information flows (e.g. Gifford *et al.* 1998, Neves 2003) and impact of the environment (Fritz and Schiefer 2002).

Diagnostic tool - Zero Level Linkages Diagrams

It is suggested that Zero Level Linkages Diagram (Chain or Netchain) can be used as a diagnostic tool to highlight weaknesses or opportunities to improve the chain's performance. Additional detail on the extent and nature of the interaction can be indicated through the width of the arrow. For example Figure 4 shows the nature of the frequency of interactions between the chain organisations. A wide arrow indicates highly frequent regular interaction while a narrow arrow indicates low frequency interaction only when it is considered necessary such as when there is a problem. There is high frequency regular interaction between the food processor and vegetable processor supplier but less frequent interaction between the food processor and vegetable primary producers who are upstream suppliers. Similarly there is high frequency regular interaction between the food processor and the Japanese trading house customer but less frequent interaction between the food processor and Japanese food service restaurants who are downstream customers. In analysing the patterns in Figure 4, it can be seen that the organisation dealing with end consumers (Japanese food service restaurants) are interacting with all direct and upstream suppliers in the chain with the exception of the meat processor. This may indicate an opportunity to improve information flows between the meat processor and the Japanese food service restaurants to ensure that consumer preferences and responses are understood.

While Figure 4 demonstrates the addition of the frequency of interactions between chain organisations, additional

dimensions can be mapped to identify different types of problem areas and opportunities for improvement. Additions of comments to diagrams have been used by other researchers to highlight key issues in chain diagrams. For example Peterson *et al.* (2000) added balloons of comments about problems and opportunities. Childerhouse *et al.* (2003) mapped a sequence of problems in a UK construction chain. Zylbersztajn and Filho (2003) added text boxes with the institutional environment, important laws and private organizations that were part of the system. Lefebvre *et al.* (2003) added details under the diagram of the characteristics of the organisations researched, the nature of electronic information exchanged (direct bilateral or multi-layer) and the impact of supply chain planning and execution e-collaboration tools. Ireland (2004) added details of organisational characteristics, nature of power/interdependence and supply management approaches. Cox *et al.* (2004) noted the nature of power relationships. Althoff *et al.* (2005) recorded the nature of quality information management systems used. Trienekens (1999) recorded the information flows in the chain including order decoupling points.

In this paper it is suggested that details can beneficially be added to zero level diagrams to show the nature of relationship strength as well as operational systems.

Relationship strength

Relationship strength can be used in analysing a range of chains the focal firm works with to identify which chain to analyse in more detail for improvement. For chains where there are already good strong cooperative relationships, problems may be easier to address and improvements made quickly and easily. On the other hand, relationship strength may be used to analyse chains where the focal firm is having the most difficulty in working and a strategic decision may be to stop operating in that chain or to actively work to improve relationships with chain organisational members to improve overall business performance.

Relationship strength may be measured in a number of ways with details added to zero level diagrams with text box descriptions of the attributes. Attributes may be scored quantitatively (e.g. 1 to 7 scale) or a general qualitative statement may be given about the following:

1. Overall nature of the relationship e.g. adversarial V. cooperative;
2. Negotiation arrangements e.g. transactions on a purely commercial price negotiation basis (hard bargaining) V. open book transparency and sharing of benefits/costs and risks/rewards.

3. Commitment e.g. committed to developing long term relationships V. only interested in short term transaction completion.
4. Trustworthiness e.g. more trustworthy than others in the industry V. less trustworthy than others in the industry
5. Satisfaction with performance e.g. worst performance in the industry V. best performance in the industry
6. Responsiveness e.g. Responsive to requirements and willing to change V. not all responsive to requirements nor willing to change
7. Strategic importance of the relationship in terms of volume of trading, value of trading, critical importance currently (control of key raw material, market, information or technology) or potential strategic importance in the future (profit potential). Volumes and values of the focal firm's products/services could be tracked through the chain.
8. Power and dependency e.g. even power and mutual dependency V. One sided power and dependency on the other organisation (Cox *et al.* 2004, Ireland 2004)
9. Problem solving e.g. constructive problem solving looking at more than superficial solutions and looking at root cause solutions so the problem will not happen again V. recrimination, always giving excuses or demanding financial recompense.
10. Improvement culture e.g. pre-emptive and proactive V. fire fighting reactive

Figure 5a illustrates one method of systematically analysing routes to market on the basis of trading volumes from the point of view of the focal company, in this case a manufacturer of fencing products for agriculture and other uses. It can be seen that the relationship between the fencing manufacturer, the national wholesaler and the main national retailers is clearly the most important in terms of volume of sales for the manufacturer. This chain is hence a logical choice for more detailed process mapping.

Further analysis of the nature of the key relationship in the chain is also beneficial as shown in Figure 5b. An appreciation of such relationship characteristics is important as these set the context for any process improvement initiatives that may arise from processes mapping and may in fact be critical to the successful implementation of any proposals

Humphries and Wilding (2004) adopt a similar approach when mapping supply chain relationships. Using confidential questionnaires they surveyed personnel directly involved in supply chain activity e.g. purchasing, sales, operations, logistics etc., to illicit views on various dimensions of supply chain relationships such as trust, communication, stability, reliability and creativity. A model was then used to develop an overall relationship

effectiveness score ('Supply Chain Collaboration Index'), from the point of view of each company involved in the relationship. Recording the respective views of each company is important as supply chain partners can sometimes have a very different perspective on their mutual relationship.

Claro *et al.* (2002) used a simpler approach in their netchain diagram of connections in flower merchants' business networks. They distinguished connections with organisations based on relationships and transactions to those based only on relationships. The nature or strength of the relationship was not specified.

Storer *et al.* (2003) mapped the netchain with detail added of the extent focal firm employees were aware of downstream customer names (unprompted) as a measure of downstream customer awareness and their strategic importance.

Kaplinsky and Morris (2002) suggest mapping the input-output relationships in value chains to identify change over time (5 years) in terms of:

1. Gross output values
2. Net output values (gross output minus input costs)
3. the physical flow of commodities along the chain
4. the flow of services, consultants and skills along the chain
5. employment e.g. permanency (permanent on payroll V. temporary off payroll), gender, ethnicity
6. destination of sales e.g. wholesalers and retailers, concentration of sales amongst major buyers, numbers of buyers
7. imports and exports, and to which region

Once a chain has been selected for closer analysis based on relationship strength, systems may be analysed to identify opportunities for improvement. A variety of tools are available to map more detailed characteristics such as systems that relate to operations and those that drive operations or strategy.

Operational mapping tools

Individual operational systems may be mapped such as the following with text box details added for problems that have arisen (qualitative statements or scored quantitatively):

1. Physical product flows to downstream customers who take title to the goods
2. Raw material product flows for key ingredients from upstream suppliers
3. Transport and logistics providers
4. Ordering information systems
5. Delivery timeliness monitoring and problem response systems
6. Quality monitoring and exception response systems
7. Inventory monitoring systems

Figure 5a. Zero Level Chain Linkages Diagram example: fencing chain – relationship importance (trading volume).

Figure 5b. Zero Level Chain Linkages Diagram example: fencing chain – relationship importance (relationship strength).

'Current State Maps' are commonly used to analyse these processes within the context of a specific value stream. Initially these were developed to examine internal processes within an organisation (Rother and Shook 1998). Such maps focus on a sample product or product family and visually capture three key aspects of the system: the steps through

which the physical products flow, the steps through which the information flows and a time line to indicate value adding and non-valuing time. Figure 6 shows an example of an internal current state map for a meat processing plant focused on a pork product.

Figure 6. Zero Level Chain Linkages Diagram example: current state map – pork meat processor.

More recently Jones and Womack (2002) have extrapolated the approach to mapping the extended value stream. Figure 7 shows the Current State Map for the whole value stream from farm to consumer for a pork product. Both maps include data boxes which quantify key aspects of operational performance such as process efficiency, quality, inventory levels and delivery, as well as providing a set of quantified Key Performance Indicators for overall process effectiveness. However current state maps of either an individual plant or a whole chain do not include any attempt at relationship mapping, other than as a first pointer to the potential interactions between individuals, departments and companies involved in the order processing and product delivery systems.

A similar problem exists with other operational mapping approaches. For example, netchain diagrams based on the supply chain operations reference (SCOR) model developed by the Supply-Chain Council show the nature of the process undertaken i.e. source, make and deliver as well as the planning of each of these processes, the infrastructure and the supply chain. When these models have been used by Sinha, Whitman and Malzahn (2004) and Huang, Skeoran and Wang (2004) the organisations involved were not specifically identified but may have been implicitly understood by researchers. Sinha *et al.* (2004) used the netchain diagram of the upstream supply chain (tier 1 & 2 suppliers upstream from the original equipment

manufacturer) to understand the structure of the supply side of the chain prior to assessing the risks of competing objectives between suppliers.

It is suggested that an additional dimension could be mapped to show the nature of relationships, with effectiveness ratings given for the degree of cooperation (singular V. joint cooperation) in:

1. Product and service development
2. Process improvement
3. Planning of strategy – opportunities and threats
4. Department/organisational/chain management e.g. measurement and reporting of department/organisation/chain performance at monthly/bimonthly meetings

In conclusion zero level chain diagrams and zero level chain/netchain linkage diagrams have been presented as a first stage diagnostic tool to highlight weaknesses about relationships, information flows or any other aspect pertinent to the situation. It is suggested that these diagrams be used initially to identify where work is required for the greatest strategic impact on the chain. It is envisioned that each system would be mapped individually, but key issues from each map could be extracted and overlayed onto a master map in identifying which chain or issue will be the focus of further effort. Details about issues can be based on executive and area managers' knowledge as well as on

more rigorous data collection and analysis by a consultant or researcher.

However, while zero level diagrams are good to indicate which organisations interact with each other and value stream maps show the characteristics of physical processes and information systems, neither of these approaches adequately show which organisational departments or people are involved in these interactions. More detail is needed to narrow down which departments and people should be involved in addressing the problems and opportunities. It is suggested that multiple level chain relationship diagrams can be used for this purpose as a further diagnostic tool.

3. Multiple Level Diagrams - mapping relationships between departments and people

Having used a Zero Level diagram as a first step, a Departmental Chain Linkages Diagram can be used as a second stage diagnostic tool to show which organisational functional departments are involved (Figure 8). The width of the arrow again can be used to indicate the nature and extent of the interaction (relationship strength, operational systems, operational information drivers, strategic information systems etc.). For example Figure 8 shows the frequency of interactions between different organisational departments of two organisations in an Australian food chain. Arrow 'A' indicates that there is highly frequent interaction between the vegetable supplier's sales/marketing department and the food processor customer's purchasing department. By comparison, arrow 'B' indicates there is less frequent interaction between the other departments. This

would indicate that for the improvement project it would be crucial to involve sales/marketing and purchasing staff and it may be useful to have representatives from the other departments.

Note, while Figure 8 has shown only the interactions between two organisation's departments (vegetable processor and food processor), a third or fourth organisation can be added (e.g. vegetable primary producer, Japanese importer etc) although, the diagrams can look very complex. Therefore in using Departmental Chain Linkage Diagrams it may be better to draw two or three organisational diagrams rather than depicting multiple organisations.

Having identified the organisational departments that need to be involved, the next step is to identify the people from those departments who are mostly involved with the problem. If operational staff are predominantly involved in regular problem solving then it would be warranted to ensure operational staff are represented in the improvement team along with the department managers. GRAI grids (Groupe de Recherche et Automatisation Integre of the University of Bordeaux in France) have been used to model coordination between decision levels in manufacturing chains and show decisions made and information flows (Trienekens 1999 p100). The GRAI grid has been adapted to develop a Level 2 Hierarchical Chain Linkage Map that can be used when more details are required of the hierarchical level of people involved in systems (Figure 9). For example Figure 9 shows that strategic planning decisions developed by executives in the retailer flow down to subordinates in management control and operational control roles. In addition, details are shown of how information about the strategic plan is passed on to the Food Processor and Ingredient Supplier (e.g. vegetables). This information is then discussed within

Figure 8. Level 1 Departmental Chain Linkage Diagram example: Australian vegetable and food processors (Storer, 2000).

the food processor and ingredient supplier organisations. As with other chain mapping tools presented, additional information can be added to the diagrams to indicate how the information flows within each organisation as well as between each organisation by the use of arrows with the width indicating the frequency of the information flows. The communication media used can be denoted through the use of symbols (📄 for written communication and 👄 for face-to-face oral communication) or letters (F for face-to-face, P for phone, E for email, R for report). In analysing Figure 9 it may be concluded that there is a lot of downward flow of information from executives in written form and that more upward or two way discussions may be warranted. In addition, the only discussion between the ingredient supplier and food processor was at the executive level and some discussion by managers may be warranted. Issues of this type can be added to the map in text boxes or as symbols.

In summary zero level diagrams are useful to depict the organisations involved in interactions in order to identify chains of interest to work on and systems where improvements will create value. Further details of the interactions can be provided using multiple level diagrams such as Level 1 Departmental Chain Linkages Diagrams and Level 2 Hierarchical Chain Linkage Maps so that the departments and people involved with the problem can be identified so a team to work on the problem can be established. However, to solve problems additional

relationship mapping tools may be needed that show processes involved in the system in more detail.

4. Process diagrams – examining the detail

The most basic process diagram is to identify individuals (by position title) involved in the process and show it as a Level 3 Chain Process Map (Figure 10). For example Figure 10 shows a complaint resolution process at a food service outlet. Most of the discussion about the complaint is between the floor staff and the customer. The Floor manager is involved in discussing the issue with the floor staff and when necessary with the customer and supplier sales manager. Further detail may be added on information communication media and issues in text boxes as relevant. The process may track details further downstream in the chain if appropriate e.g. if contamination or quality problems needed to be tracked to root causes in supplier departments (e.g. food processor) or downstream suppliers (e.g. vegetable supplier).

If the number of people involved or the time taken to complete a process are major issues, then an Event Process Chain Map can be useful. An Event Process Chain Map details the people involved in each step of a process and the time taken from start to finish (Figure 11). Added details can be included about the distance travelled for physical goods (steps, metres, kilometres), performance metrics or other issues. The example in Figure 11 shows what happens

Figure 9. Level 2 Hierarchical Chain Linkage Map example of strategic planning (Storer, 2005).

Figure 10. Level 3 Chain Process Map example: food service complaint resolution process.

Figure 11. Level 3 Event Process Chain Map example: food service complaint resolution process (Storer, 2005, adapted from Trienekens, 1999).

when a complaint is made at a food service outlet or retailer and who gets involved to resolve it. The time taken in the process can be detailed in the horizontal line with W symbols indicating that there is some waiting before the next step in the process takes place. The title of the people involved in each activity or event may also be added to the descriptors for further clarity. When time is not such an issue the process can be mapped sequentially for each step without measuring the time scale involved and without indicating any waiting or delays.

5. Summary and discussion

A number of relationship mapping tools have been presented in this paper to address the gap between existing zero level diagrams and detailed process mapping tools that are commonly used when analysing supply chains. It was argued that existing zero level maps do not provide enough detail to make a considered judgement of the opportunities for improvement and to identify the greatest obstacles to cooperation. In addition while conventional process mapping tools such as Current State Maps focus

on physical process and information systems they tend to ignore relationship issues. It was argued you need more than an implicit understanding of the detail of who is involved and the relationship issues when in the early stages of the chain diagnostic analysis to ensure the selection of systems for improvement is based on a considered decision making process. Examples of how this relationship detail can be mapped was presented using detailed zero level diagrams to show the key organisations involved and to map the relationships between each. It was argued an understanding of the organisations and relationships can be critical and the key to success in process improvement as an adverse response by a key player to suggested improvements may hinder the outcomes expected.

It was suggested that zero level diagrams be used as an early stage chain description and diagnostic tool to identify opportunities for improvement that may have the greatest strategic impact on the chain as well as to highlight likely obstacles to cooperation. The Zero Level Chain Linkage Diagram was shown as a way to show interactions with suppliers further upstream in the chain and customers further downstream in the chain. To identify different

types of problem areas and opportunities for improvement, details can be added to diagrams to show the frequency of interactions between chain organisations and the nature of relationship strength as well as operational issues.

As a second stage diagnostic tool, multiple level relationship diagrams were suggested to identify the departments and the organisational hierarchical levels involved in these interactions so a team to work on the problem or opportunity can be established. Level 1 Departmental Chain Linkage Diagrams can be used to show which organisational functional departments are involved. Level 2 Hierarchical Chain Linkage Maps depict the people from the departments who are mostly involved with the issue.

Having decided on the chain and issue to address, and having identified the departments and people to get involved, the final stage is to look in more detail at the problem or opportunity. Conventional process mapping tools (e.g. flow diagrams and value stream mapping tools) tend to focus on the systems for physical product flow and information flow but frequently ignore inter-departmental or inter-organisational relationship issues. Level 3 Chain Process Maps can compliment these maps by identifying the individuals (by position title) involved in the process together with relevant details on the nature of their interactions. Level 3 Event Process Chain Maps detail the people involved in each step of a process as well as the time taken from start to finish and any issues.

The chain mapping tools have been presented in this paper in a sequential format, drilling down from the broad chain issues (zero level) to more detailed organisational department and hierarchical structure issues (levels 1 and 2) and finally to fine detailed process diagrams (level 3). In reality they may not necessarily be used in a sequential way. Some of the details may be understood implicitly based on discussions by those initiating the improvement as well as the improvement team members. In this case the chain mapping tools can be used to crystallise issues and summarise discussions. In the authors experience the chain mapping tools are used in an iterative manner as earlier diagrams are revisited later in the process when working with chain members and the improvement team. In particular they are useful in demonstrating outcomes back to participants and senior executives in a summarised format. When using the chain mapping tools to demonstrate outcomes, key issues may be extracted to reduce the level of detail and highlight where action needs to be taken.

In terms of other practical issues, qualitative assessments may be made when deciding which chain and system to focus efforts on as well as identifying the nature of problems and opportunities in those systems. Thought may need to be given on how subjective opinions are collected. Confidentiality may be needed so that there is less pressure

to show the positives and downplay the problems that may reflect poorly on some participants. To ensure a balanced view is obtained it is suggested that details be collected from multiple key informants for all relevant major departments who are involved (department managers and executives as well as operational staff). It is also necessary to be aware that organisations along the chain may have quite different perspectives on the importance and nature of the relationships. This should be understood at an early stage in the diagnostic as it may fundamentally affect the willingness and commitment to participate in cross-company process improvement initiatives.

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