Understanding data supply chains by using the Supply-Chain Operations Reference (SCOR) model

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Abstract

Spatial data such as roads and land parcels is increasingly becoming a commodity that is being created with the aim to sell or to provide spatial information to other institutions for further processing or to decision makers to aid in their decision processes. This paper looks into the spatial data supply chain of ESI-GIS unit of Eskom and the use of an adapted SCOR model (GISDataSCOR) to model and analyse the supply chain. Spatial data needs to be sourced from various sources (SOURCE), which is then stored in a data warehouse. The spatial data is then sourced from the data warehouse and transformed into a new spatial data set using Geographic Information Systems [GIS] (MAKE) and the new spatial data set is delivered to a customer (DELIVER). RETURN in this environment deals only with defective data sets. It is of the opinion from the researchers that data as a commodity will play an important part of the future economies and that data supply chains are one of the supply chains of the future and that supply chain management is going to play prominent role in ensuring that data is sourced, created and delivered efficiently and effectively.

Keywords: Geographic Information Systems, supply chains, supply chain management, spatial data, SCOR

Introduction

This paper discusses the application of supply chains and supply chain management in a GIS unit to manage large or data intensive GIS projects, which is based on a PhD study done at the University of Johannesburg, Johannesburg, South Africa. The term GIS-product is used to describe to the spatial data set that is created using a GIS. Current literature looks at the management of GIS in organizations such as the management of the implementation of the GIS into the organization. Other literature looks at the use of Workflows to manage GIS projects. Workflow is used to automate certain functions of GIS procedures necessary for a certain GIS project. The aim is to propose a management model that lies between these two approaches namely Supply Chain Management to plan and manage GIS products. Supply Chain Management looks at the flow of materials and information from different suppliers to a manufacturing unit to the delivery of the final product to the client.

The methodology is based on GISDataSCOR (GDS), an adaptation of the Supply-Chain Operations Reference-model (SCOR) from the Supply-Chain Council to enable the modelling and analysis of a GIS unit's supply chain (Schmitz, 2006). GDS has five entities to describe the supply chain from the supplier's supplier through to the customer's customer, namely PLAN, SOURCE, MAKE, DELIVER and RETURN.

Supply chain management and Geographic Information System

For the purpose of the PhD research supply chains for electronic spatial data were defined as 'the supply chains encompass all activities associated with the flow and transformation of spatial and attribute data from the raw data stage (capturing), through to the end user, as well as the associated information and money flows. Data, information and money flow up and down the supply chain'

(Schmitz, 2007). The management of this supply chain can be defined as follows: ‘Supply chain management (SCM) is the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage’ (Handfield and Nichols, 1999:2).

Geographic Information Systems (GIS) are defined as ‘a computer-assisted system, combined with appropriate infrastructures, resources and management, that **acquires, stores, retrieves, transforms, manipulates and displays** geographical and related non-geographical data’ (Schmitz, 2007). Acquisition is the sourcing of spatial and non-spatial data from suppliers. Storing of the data is the placing of the spatial and non-spatial into a data warehouse or other forms of storage media. Retrieval, transformation and manipulation of spatial and non-spatial data are the production process of a GIS unit to create a GIS-product. Displaying the GIS-product is first done at the GIS unit to review the result of the production and to do final quality control and secondly by the customer using either GIS software or on a hard copy such as a map. The definition of a GIS system clearly suggests a supply chain, namely suppliers, storage, production and customers and thus the research to investigate whether supply chains and supply chain management can be used to improve the efficiency and effectiveness of a GIS unit when producing and delivering GIS-products.

There are three types of GIS-products that can be produced by a GIS unit. The first GIS-product type is a stocked GIS-product. An example of a stocked GIS-product is 1:50 000 topographic map data that is created by the Chief Directorate: Surveys and Mapping (CDSM) in South Africa. CDSM creates and updates these datasets and makes them available for purchase by publishing a catalogue. A GIS unit orders the data from CDSM, CDSM downloads the data from their data warehouse on to a DVD or CD-ROM or makes it available for downloading and supplies the data to the GIS unit. The second GIS-product type is a Make-to-Order GIS-product, where a GIS unit creates a GIS-product when it receives an order using standing operating procedures. An example would be a GIS unit that supplies georectified satellite images. The georectification of the ordered image will only be done once an order was received. The last type of GIS-product is an Engineer-to-Order GIS-product, which is a once off product for a GIS unit such as determining a cost surface for electrification taking the distance from the road network, slope, land use and hydrology into account (Schmitz, 2007).

GISDataSCOR

The GISDataSCOR (GDS) is an adapted Supply-Chain Operations Reference (SCOR) model. The SCOR model was developed by the Supply-Chain Council as an easy to use model that described a supply chain of an organisation from its supplier’s suppliers to its customer’s customer using five management processes, namely PLAN, SOURCE, MAKE, DELIVER and RETURN (Supply-Chain Council, 2001). The GDS model used the SCOR terminology and content as far as possible, to enable the GDS model to be incorporated in future versions of the SCOR model if so desired by the Supply-Chain Council. The GDS model as with the SCOR model is divided into three levels, namely GDS Level 1 are the five management process as listed above, GDS Level 2 are the process categories such as P1 (Plane the supply chain), S3 (Source Engineer-to-Order product), M2 (Make-to-Order), D1 (Deliver stocked product) and DR1 (Deliver Return defect product) (Schmitz, 2006).

The GDS model made the following changes with regards to the SCOR model at Level 2 process categories. GIS-products are datasets that need to be maintained at regular intervals to keep them current. A land parcel dataset needs to be updated regularly to include changes in ownership as well as new developments. This necessitated the addition of a fourth MAKE process category M4 (Maintain-to-Stock). With M4 (Maintain-to-Stock), the stocked GIS-product is taken from the data warehouse, updated and placed back onto the data warehouse as a new version of the stocked GIS-product, which is then made available as a stocked product to customers. DR2 and SR2 (return of maintenance, repair or overhaul product) and DR3 and SR3 (return of excess product) were excluded from the GDS model since it not applicable to a GIS unit (Schmitz, 2006 and Schmitz, 2007).

Methodology

The methodology is based on the methodology described by Bolstorff and Rosenbaum (2003) and consists of the following phases:

- The business context of a GIS unit, which gives the reason for the GIS unit’s existence as well as the types of GIS-products produced by the GIS unit;

- Performance and benchmarking using the SCORcard that is done using GDS Level 1 supply chain management processes, namely PLAN (P), SOURCE (S), MAKE (M), DELIVER (D) and RETURN (R);
- Mapping the AS IS material flow, which is done at GDS Level 2 process category level. On this level the supply chain of the GIS unit gets defined for further analysis. The following numerals are added to the above management processes, namely 1 (Stocked product), 2 (Make-to-Order), 3 (Engineer-to-Order) and 4 (Maintain-to-Stock), examples are given in the previous section;
- Doing the disconnect and opportunity analysis for each identified unique problem statement based on the disconnect analysis;
- Identifying areas of improvement by mapping and analysing the GIS unit's AS IS supply chain processes at GDS Level 3 using the supply chain as defined at GDS Level 2 as well as mapping the TO BE processes at GDS Level 3;
- Recommendations and implementations, which included the prioritisation of disconnects starting with those that have the biggest impact with regards to reducing the cost of the supply chain and improving the efficiency and effectiveness of the supply chain.

<u>Modelling and analysing a GIS unit's supply chain</u>

In this section only the important results based on the abovementioned methodology will be discussed. The GIS unit that was used to model and analyse its supply chain was ESI-GIS, a GIS unit in Eskom (a state owned electricity provider) that provides the core datasets for electrification planning in South Africa. The study was done between October 2006 and May 2007. Its GDS Level 2 supply chain showing the different disconnects, which have an impact on the supply chain that are turned into opportunities is shown in Figure 1. These disconnects have causes and sub-causes that cause the disconnects such as project execution problems (cause); inadequate quality control measures (sub-cause) and unnecessary pre-processing of data due to correcting faulty sourced data (sub-cause) of the 'production problems' disconnect.

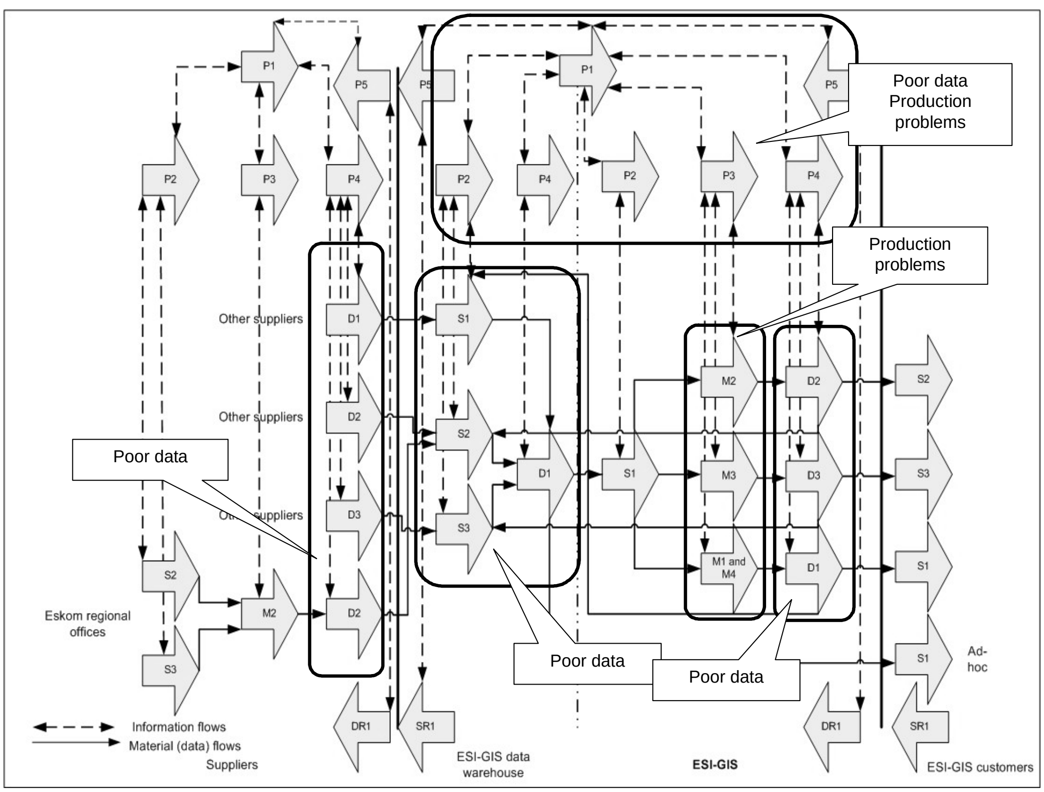

Figure 1: ESI-GIS's GDS Level 2 supply chain with disconnects (From Figure 8.6, Schmitz, 2007).

The financial impact of turning the identified disconnects into opportunities is presented in Table 1.

Table 1: Opportunities identified for the disconnects shown in Figure 1 (From Table 8.10, Schmitz, 2007)

Problem statement	**Opportunity**	**Cost savings**
Poor data	Reduction of 10% in labour costs based on improving the quality of data	R 149 764.54
Production problems	Reduction of 5% in labour costs by improvement of resources, planning and adherence to standards	R 74 882.27
	Total savings	R 224 646.81

Total savings of R 224 644.81 were based on the total manpower costs during the 2006/7 financial year of R 1 497 645.41. Other important supply chain metrics are the Cost of Goods Sold (COGS), which excludes the above manpower costs are R 13 067 769.07; customer service costs were R 359 577.59; data warehouse and information technology costs are R 79 220.00; purchasing and acquisition costs are R 1 004 745.53; planning costs of R 299 529.08 and sales, general and administration costs are R 350 019.78, which gives a total of R 16 658 506.46. Unfortunately owing to non-payment of some of ESI-GIS's customers, ESI-GIS's income was only R 12 358 406.89, which resulted in a R 4 300 099.57 shortfall. ESI-GIS's delivery performance was 73 percent of the total number of orders, with 68 percent of the orders as perfect orders, i.e. no comebacks on these orders.

Figure 2 is the result of analysing the GDS Level 2 process category level supply chain as well as the abovementioned opportunities at GDS Level 3 process element level using workbooks for each management process, based on the GDS model, which looks at each process element capturing performance metrics, current practices and process steps followed to execute the process element. Other data captured are the business rules that needs to be adhered to such as following corporate procurement processes, future improvements of current practices as well as any disconnects (problems) experienced during the execution process. These disconnects are linked back the disconnects with their causes and sub-causes as identified in the GDS Level 2 process category level supply chain. These disconnects are given a unique number as to indicate where in the GDS Level 3 process element level future (TO BE) supply chain of ESI-GIS they have an influence. These unique numbers are linked to process elements such as disconnects 10, 12 and 19 are linked to process element M3.2 (Schedule production activities). The TO BE supply is designed, together with solving the identified disconnects, to improve ESI-GIS's supply chain. The Level 3 supply chain is mapped using a SWIM diagram in which each function of the GIS unit is depicted as a swimming lane like in a competition swimming pool.

During the GDS Level 3 process element analysis it was discovered that the original disconnects with their causes and sub-causes cannot all be linked to those identified at the various process elements. It was thus decided to divide the different disconnects into two groups namely Priority 1 disconnects, which are those disconnects identified at both sessions and Priority 2 disconnects that were identified at the first session as indicated in the methodology section. In total there were 62 disconnects identified of which 32 were Priority 1 disconnects ranging from customers that do not know what their needs are, the metadata is not centralised that leads to not being sure what data is currently available at ESI-GIS through to regulatory non-adherence, which leads to faulty or incomplete data. The second decision was to solve the Priority 1 disconnects first by ranking the Priority 1 disconnects thus indicating which of the identified disconnects should be solved first by having the biggest impact on improving the supply chain. The method used was based on the ABC analysis that is used to place stock in a warehouse, namely the 20 percent of the stock that bring in 80 percent of the sales should be placed within easy reach in a warehouse. Using this method, the disconnects were linked to a monetary value using the costs identified from the GDS Level 3 process element level supply chain analysis and ranking them in descending order starting with biggest cost impact first. The percentage impact for each disconnect is then calculated using the total cost involved. By summing the percentages, those connects that make up 80 percent are then classed as A class disconnects, the next group of disconnects that total up to 15 percent are classed as B class disconnects and the remaining five percent are classed as C class disconnects.

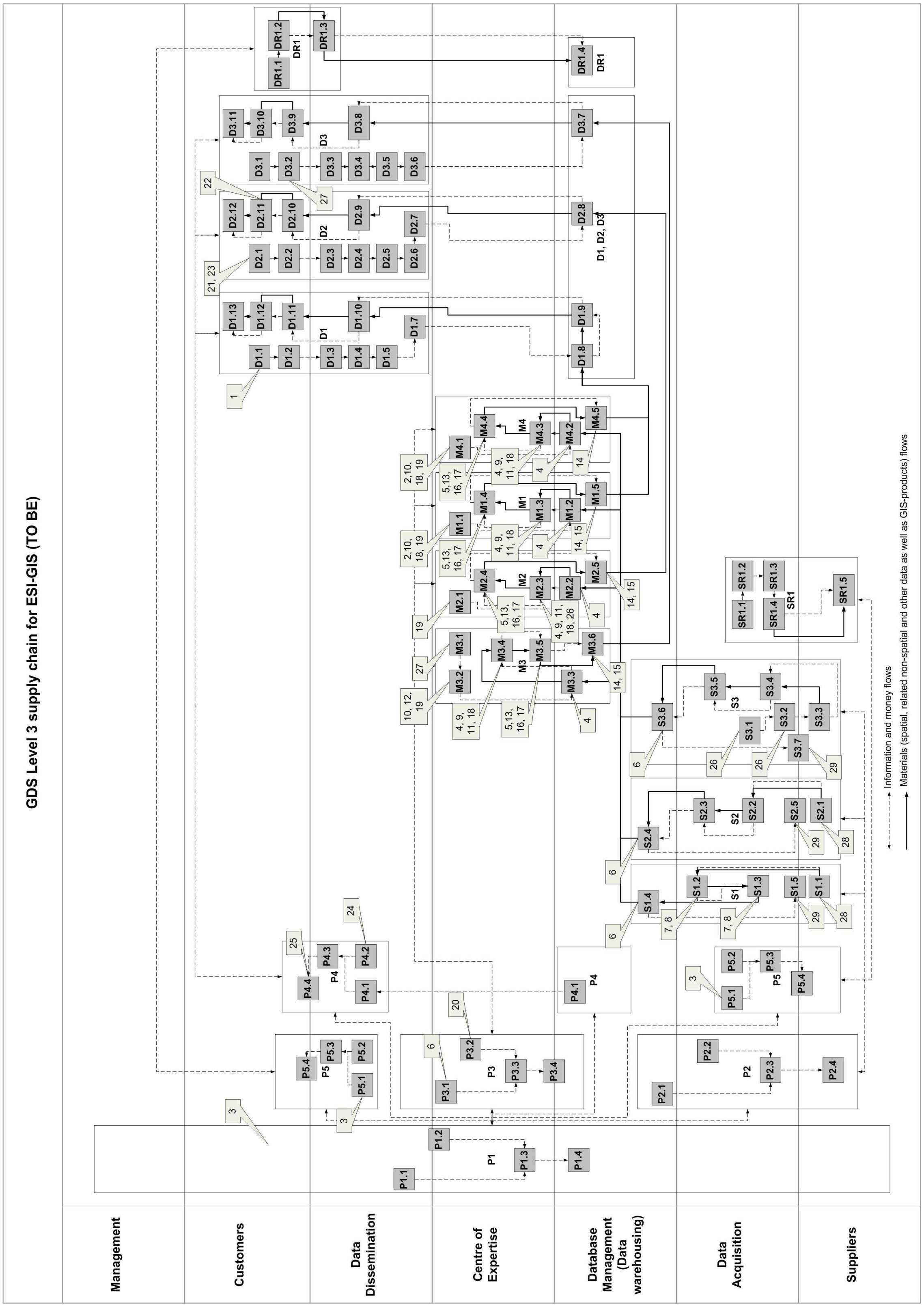

Figure 2: ESI-GIS TO BE GDS Level 3 supply chain with disconnects (From Figure 8.8, Schmitz, 2007)

Table 2 give those disconnects that have an 80 percent impact on improving the supply chain. The biggest impact on the supply chain as indicated in Table 2 is to improve the production (M: MAKE) of the GIS-products by ESI-GIS. The second biggest impacts on the supply chain are the suppliers of spatial, related non-spatial and other data (S: SOURCE). The reference numbers are given in brackets, as to link them back to the supply chain as mapped in Figure 2.

Table 2: The identified disconnects that have an 80 percent impact

Disconnect	**Process element that is affected by the disconnect**
Non-compliance to data standards (11)	M1.3, M2.3, M3.4, M4.3
Faulty data from suppliers (7)	S1.2, S1.3
Regulatory requirements non-adherence (8)	S1.2, S1.3
Poor data quality (10)	M1.1, M3.2, M4.1
Lack of advanced GIS skills (18)	M1.3, M2.3, M3.2, M3.4, M4.3
Do not know what data is available (4)	M1.2, M1.3, M2.2, M3.3, M3.4, M4.2, M4.3
ISO processes not updated (9)	M1.3, M2.3, M3.4, M4.3

Conclusions

Although the GDS model, methodology and the workbooks that are based on the GDS model to model and analyse a GIS unit's supply chain is not perfect, it provided sufficient insight into an electronic data creation supply chain to identify shortcomings in the supply chain, especially with the production of GIS-products, that needs to be solved in order to improve the efficiency and effectiveness of the supply chain by using supply chain management. It also highlighted the need to have proper supply chain relationships in place, especially with the suppliers of spatial, related non-spatial and other data to ESI-GIS, since they cause delays within supply chain by not delivering on time as well as delivering faulty data. The latter is indicated in Table 2 as one of the biggest impacts on ESI-GIS's supply chain. Using supply chains and supply chain management it provides a GIS unit a comprehensive overview on its performance with regards to the production of GIS-products; guiding the unit to improve its production activities by having the complete supply chain visible and where in the supply chain it needs to improve it; and in particular it provided an insight on how ESI-GIS functions from a totally new perspective than the normal management of the unit (de la Rey, 2007). Thus it is concluded that by using supply chains and supply chain management, a GIS unit can improve its efficiency and effectiveness when producing and delivering a GIS-product.

References

- Bolstorff, P. and Rosenbaum, R. 2003: *Supply Chain Excellence: A Handbook for Dramatic Improvement Using the SCOR Model*. AMACOM, American Management Association, 1601 Broadway, New York, NY 10019, USA.
- de la Rey, A., 2007: Personal communication. Manager of ESI-GIS, Eskom Convention Centre, Midrand, South Africa
- Handfield, R.B. and Nichols, E.L. (1999), *Introduction to Supply Chain Management*. Prentice Hall, Upper Saddle River, New Jersey, USA pp 183.
- Schmitz, P.M.U., (2006), *GISDataSCOR Version 1.0*. CSIR Parliamentary Grant Report CSIR/BE/CL/IR/2006/0024/B, CSIR Built Environment, Meiring Naude Rd, Scientia, City of Tshwane, South Africa.
- Schmitz, P.M.U., (2007), *The use of supply chains and supply chain management to improve the efficiency and effectiveness of GIS units*. Draft (unexamined) PhD thesis, University of Johannesburg, Johannesburg, South Africa.
- Supply-Chain Council, (2001), *Supply-Chain Operations Reference-model Version 5.0*. Supply-Chain Council, Inc. 1150 Freeport Road, Pittsburgh, PA 15238, USA. www.supply-chain.org