SHORT NON-REFEREED PAPER

A HEURISTIC TOWARDS DRIVING IMPROVEMENTS IN AN AGRI-INDUSTRIAL SUGARCANE SYSTEM

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Abstract

This short paper reports on a wide range of inter-disciplinary research findings after studying the integrated sugarcane production and processing systems at four mills. A heuristic was developed to detect problems and instigate change in a sugarcane supply chain. The heuristic requires an initial state of mind which draws strongly from complexity. This is followed by an inquiry. Theme networks, an analysis of veto powers and the Viable Systems Model (VSM) displayed promising strengths to surface issues during the inquiry. Thereafter, specific issues, such as stockpiling, harvesting, logistics, cane quality and grower-miller interaction, were identified and further investigated. Although attempts were made to address some of the issues, the researchers could not instigate change and some reasons for this shortcoming are given.

Keywords: supply chain, mill area, diagnostics, heuristic, Soft Systems Methodology

Introduction

The South African sugar industry is well established and most systems are already efficient. However, some inefficiencies still remain, such as vehicle over-fleeting (e.g. Giles *et al*., 2005), unnecessary risk averse behaviour (Bezuidenhout, 2008), limited forecasting and planning (e.g. Everingham *et al*., 2002; Lejars *et al*., 2008), and inability to diversify or add value to baseline products (Wynne, 2009). Most of these inefficiencies are attributed to the fact that different stakeholders sometimes have different and incompatible objectives. The optimisation of sub-components in the supply chain occurs widely and can cause disagreements between stakeholders. In turn, this prohibits the adoption of innovative solutions, even though they are often available.

The aim of this research was to develop an over-arching heuristic aimed at unlocking pertinent system constraints and opportunities in the supply chain. The heuristic considered hard and soft issues. Research was done at Felixton, Umfolozi, Komati and Eston. Seven MSc and PhD students worked on this project. This short paper briefly outlines the heuristic.

Description of heuristic

Wikipedia defines heuristics as '*experience-based techniques for problem solving, learning, and discovery. Where an exhaustive search is impractical, heuristic methods are used to speed up the process of finding a satisfactory solution. Examples of this method include using a rule of thumb, an educated guess, an intuitive judgment, or common sense*.'

This heuristic is comprised of five stages, which do not have discrete boundaries and may not necessarily follow in a linear fashion. The stages are listed below, and are then described in more detail.

- An initial state of mind
- An inquiry
- Analyses
- Report back
- Implementation.

Initial state of mind
Soft Systems Methodology (SSM) (Checkland, 2000) helps the researcher to view the supply chain in a holistic manner. SSM stimulates the researcher to focus on underlying issues, such as diverse stakeholder views, perceptions and expectations. It prompts the researcher to investigate the system holistically, to consider the links between issues, and to be sensitive towards relationships.

Any solution proposed by researchers needs to be carefully conceived to fit a specific problem. The sugarcane supply chain is complex (Higgins *et al*., 2007; Bezuidenhout, 2008) and, because complexity inherits a degree of unpredictability, large changes may prove detrimental over the long term. During interviews, stakeholders often recalled large-scale decisions that have, according to their views, failed. The Panarchy model (Gunderson and Holling, 2002) applies well when changes to the sugarcane supply chain are proposed. This model describes the pathway of change and, instead of large changes, promotes continuous small changes.

Inquiry
The aim of the inquiry phase is to make sense of the messiness (or complexity) in the supply chain, which helps the researcher to narrow down a specific topic for further investigation. The inquiry helps to identify a *real* opportunity in the system by considering the subtle issues that may not initially be obvious. It is essential to view the harvesting, loading, transport, off-loading and milling processes first hand. Information gathering is also done through interviews. A set of interviews with pre-identified stakeholders (see Table 1) provided sufficient information to complete theme and domain maps (Bezuidenhout *et al*., 2013), as well as a Viable Systems Model (VSM) analysis.

Towards the end of the inquiry, a discussion with representatives of the mill area is necessary in order to (a) validate the outcomes, (b) propose a focus area that requires detailed analyses and (c) incorporate any additional comments that may surface.

Analyses
Compared to the inquiry, the analysis phase is more focused and draws on a large number of possible methods to perform a detailed investigation. Analyses could rely on any combination of statistical, modelling, economic and even qualitative methodologies. The analytical tools that were applied in this project are listed in Table 2. Table 2 is not an exhaustive list and researchers should familiarise themselves with the indexes, tools and other knowledge that may be useful when investigating particular issues.

Table 1. Stakeholders interviewed during the inquiry phase.

Stakeholder profile	Number of persons interviewed per mill area
Cane supply manager*	1 to 2
Extension Officer(s)	1 to 2
Local agricultural economist	1
Mill group board chairman	1
Large commercial growers	2
Medium scale grower	1
Small scale subsistence grower	1
Informed growers who disagree with the system	1
Harvesting contractors	1 to 2
Largest haulier in the area	1
Other large hauliers	1
Grower-cum-haulier	1
The cane quality testing manager	1
The mill manager	1

*Cane supply was normally interviewed first and more time was allowed for the interview

Table 2. Analytical approaches that were valuable when exploring supply chain issues at different sugar mills in South Africa.

Analyses type	Mill area*	Reference	Description
Cause and effect mapping	FE, KO, UM, ES	Sanjika *et al*., 2012	Network analyses techniques to detect root causes and key performance indicators.
LOMZI analytical framework	UM	Boote *et al*., 2011	Stochastic simulation of harvesting, cane supply and milling dynamics, accompanied by economic analyses.
Crushing Consistency Analyses (CCA)	ES	Kadwa *et al*., 2012	Physical and economic impacts of cane supply inconsistency.
Shewhart quality control charts	FE	Sibomana and Bezuidenhout, 2013	Detection of cane quality deviations subsequent to weekend logistics.
Soft Systems Methodology (SSM)	UM, FE	Gerwel *et al*., 2011	Participatory methods to facilitate an in-depth understanding of issues.
Viable Systems Model (VSM)	FE	Hildbrand, 2013	A comparison of communication and management structures against a widely accepted model.
Systematic cane deterioration statistics	FE	Sibomana and Bezuidenhout, 2013	Detection of quality deterioration in subsequent consignments due to increasing harvest to crush delays.
Correlation graphs	KO	Samkange and Bezuidenhout, 2013	System structure and key performance indicator. Also, the derivation of different operating modes.

*FE=Felixton, KO=Komato, ES=Eston, UM=Umfolozi

Report back

The method for researchers to report their results to the milling area is fluid and unspecific. Although written reports are essential, verbal reports were appropriate when proposing possible system changes. The mill group board (MGB) is the most suitable platform from which system improvements should be driven. However, the agendas of MGB meetings are generally overloaded, resulting in long and rushed meetings with membership fatigue. It may be necessary to target a group of stakeholders, or even individuals, who relate better to the specific issues under investigation.

Implementation

This project anticipated that several solutions to improve the supply chain were to be implemented as a result of the research. Unfortunately, this did not materialise. The importance of a local champion who has the capacity and authority to drive solutions cannot be over-emphasised. Sugarcane supply chains in South Africa seem to have a structural deficit in creating and supporting the appropriate energy that would drive system improvements on the ground (Hildbrand, 2013).

However, we have also seen evidence that researchers cannot simply "deliver" a solution to a sugarcane milling area. Key champions need to form part of the solution, and SSM approaches strongly promote interaction during the implementation phase. An example is the successful implementation of a vehicle scheduling system at Darnal mill, where stakeholders and a commercial party drove the process (Giles *et al*., 2006). Researchers may need to:

1. find the limits of the solution
2. make assumptions concerning missing information
3. run quick tests and small experiments to check the solution's validity in certain cases
4. continue to gather information and learn the viewpoints of a wide range of people
5. check and re-check all the assumptions
6. use simulation tools to assess different plans.

This participatory research approach becomes a project management activity, and, if successful, holds the potential to create widespread adoption, even beyond the boundaries of the mill area.

An important lesson learnt during this project is that successful researchers in sugar industries worldwide are persons who focus intensely on only a few issues at a time, and who work closely with industry stakeholders while obtaining a deep knowledge of the particular community in which they work. When a certain reputation threshold has been achieved, other industry stakeholders and even sugar industries elsewhere will invite these researchers to their shores and will act more willingly on the advice that they offer. Although unconfirmed, there appeared to be a strong correlation between the receptive attitudes of stakeholders and the frequency with which the researchers interacted with them.

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