Business Continuity Data Analysis for Key Business Functions in Dairy Farms and Cattle Feed Yard Industries

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Abstract. The present contribution seeks to infer new business continuity management knowledge based on multidimensional data analysis in the field of agriculture. The research relies on real business continuity data regarding the Dairy Farms and the Cattle Feed Yards industries. The utilized data sets enable the formulation of domain business continuity management data hierarchy schemas including dimensions and facts for efficient aggregate data analysis based on online analytical processing operations. The multidimensional models are proposed for the efficient business continuity management policies in the selected industries. Specific business continuity reports are also presented as examples of the possible multidimensional data analysis outputs in the investigated agricultural industries.

Keywords: agriculture; business continuity management; key business functions; data set; dairy farms; cattle feed yard; online analytical processing.

1 Introduction

In the modern industry, business decisions and key business functions are fully supported by information and communication technologies (ICT's). The process automation, the digital services provision, the information sharing through multiple systems, channels and platforms are just some selected examples through which the importance of ICT has been proven.

One of the advantages of digitization, is the possibility to extract data from multiple sources and process it in such a way that efficient decisions can be made in terms of the company's competitive advantage. Especially in agriculture, the assistance of computerized systems and the various data collection and processing tools can significantly boost agricultural productivity (Lytos et al, 2020).

However, the computerized processes are highly exposed to various threats which can cause their unplanned interruptions. Business Continuity Management (Watters, 2014) aims to the rapid restoration of all the critical systems and key business functions in the enterprises, the public organizations and the industry. Business Impact Analysis

Proceedings of the 9th International Conference on Information and Communication Technologies in Agriculture, Food & Environment (HAICTA 2020), Thessaloniki, Greece, September 24-27, 2020.

(Tamminedi, 2010), which is a crucial part of the BCM, deals with the efficient settlement of recovery priorities based on the criticality of each key business function.

"*Data collection is an important activity throughout the BCM development process*" (Engemann, 2012). A limitation regarding the research around the agricultural business continuity strategies is the lack of available data sets. Despite this limitation, research outputs regarding the business continuity discipline in the agricultural domain, can be based on small data sets following the statement of (Coble et al, 2018) that for understanding the concept of big data in agriculture one should first explore small data.

In the current work, an effort to explore a small data set regarding business continuity management in dairy farms and cattle feed yard industries is attempted. The data has been gathered from the Panhandle Regional Planning Commission in Texas (PRPC (a), n.y; PRPC (b), n.y). The contribution includes conducted reports regarding two key business functions, namely information technologies (IT) and business administration (BA).

The collected data has been imported to and processed in MS Excel 2013. Online Analytical Processing (OLAP) operations have been utilized in order conduct interesting primary results with respect to the business continuity policies in these two agricultural industries.

2 Research Motivation

The primary concern which has triggered the current investigation stems from a research conducted with respect to the application of business continuity management in the Czech agricultural enterprises, where it has been concluded that "agrarian organizations are not interested in applying BCM according to standards" (Hajek and Urbancova, 2013).

Additionally, the recent developments regarding the COVID-19 outbreak has triggered the necessity for rethinking the importance of business continuity management in the agricultural industry. According to a recent statement of the Food and Agriculture Organization of the United Nations (FAO, 2020), "*the pandemic is impacting global food systems, disrupting regional agricultural value chains, and posing risks to household food security*".

Due to the fact that a special BCM concern is dealing with epidemics, agricultural BCM data can be a valuable tool for improving related policies regarding the restoration of unexpectedly interrupted key business functions, even those which are related to information and communication technologies. However, the "*amount of information risk at the dairy farms is small, but not zero*" (Dynes, 2009). Such research outputs cannot be ignored bearing in mind that multiple hazards can influence ICT's in the dairy as well as the cattle feed yard industry.

Based on the above, it has been considered necessary to collect real business continuity data regarding ICT - related key business functions from the agricultural domain in order to examine the recovery policies, including the consideration of various hazards which mainly threaten the uninterrupted operation of the agricultural companies. Data from two industries, namely the dairy farms and the cattle feed yard,

has been currently spotted and analyzed with the help of online analytical processing (OLAP) operations.

2 Tools and Methods

2.1 Data Collection

As above stated, the current research has been based on two BCM guides regarding, a) the Dairy Farms Industry and b) the Cattle Feed Yard Industry in Texas, Panhandle region. Both guides have been downloaded from on the web site of the Panhandle Regional Planning Commission (PRPC (a), n.y, PRPC (b), n.y). Both BCM templates include two different tables namely, the Key Business Functions (Fig.1) and b) the Hazards, Impacts and Risk Mitigation Measures (Fig.2).

Industry	KBF	Sub Function	Department	Criticality Ranking
Cattle Feedyard	Business Administration / Personnel	Payroll	Business Manager/Feedyard	Moderately Critical
Cattle Feedyard	Business Administration / Personnel	IT Systems and database support	IT Manager	Moderately Critical
Cattle Feedyard	Business Administration / Personnel	Feedyard management and supervision	Feedyard Manager	Moderately Critical
Cattle Feedyard	Business Administration / Personnel	Hourly employee management	Feedyard Manager	Moderately Critical
Cattle Feedyard	Information Technology	Off-site network data services administration	IT Manager	Least Critical
Cattle Feedyard	Information Technology	On-site network operations	IT Manager	Least Critical
Cattle Feedyard	Information Technology	On-site network and data service administration	IT Manager	Least Critical
Cattle Feedyard	Information Technology	Maintenance of physical hardware	IT Manager	Least Critical
Cattle Feedyard	Information Technology	Maintenance of software	IT Manager	Least Critical
Dairy Farms	Information Technology	Off-site network and data systems management	IT Manager	Least Critical
Dairy Farms	Information Technology	On-site network and data systems management	IT Manager	Least Critical
Dairy Farms	Information Technology	Software and hardware maintenance	IT Manager	Least Critical
Dairy Farms	Business Administration / Personnel	Accounts Payable	Human Resources/Employee Relations Manager	Least Critical
Dairy Farms	Business Administration / Personnel	IT Systems and databases to support dairy personnel	Human Resources/Employee Relations Manager	Least Critical
Dairy Farms	Business Administration / Personnel	Overall dairy farm management and supervision	Human Resources/Employee Relations Manager	Least Critical
Dairy Farms	Business Administration / Personnel	Hourly employee management	Human Resources/Employee Relations Manager	Least Critical
Dairy Farms	Business Administration / Personnel	Accounts Receivable	Human Resources/Employee Relations Manager	Least Critical
Dairy Farms	Business Administration / Personnel	Payroll	Human Resources/Employee Relations Manager	Least Critical

Fig. 1. The Key Business Functions Data Set for the Dairy Farm and the Cattle Feed Yard Industries. (Source: Authors' work in MS Excel based on BCM Data from the Panhandle Regional Planning Commission).

Industry	KBF	Hazard	Cause	Risk Exposure	KBFs Impacted
Cattle Feedyard	BA	Computer / automation network failure	Cyber attack	Medium	2
Cattle Feedyard	BA	Computer / automation network failure	Aging equipment	Medium	2
Cattle Feedyard	BA	Computer / automation network failure	Inadequate PM (preventive maintenance	Medium	2
Cattle Feedyard	BA	Loss of management	Weather	Low	8
Cattle Feedyard	BA	Loss of management	Flu pandemic	Low	8
Cattle Feedyard	BA	Loss of management	Job departure	Low	8
Cattle Feedyard	IT	Loss of management	Weather	Low	8
Cattle Feedyard	IT	Loss of management	Flu pandemic	Low	8
Cattle Feedyard	IT	Loss of management	Job departure	Low	8
Cattle Feedyard	BA	Loss of utilities	Weather	medium	8
Cattle Feedyard	BA	Loss of utilities	Utility Malfunction	medium	8
Cattle Feedyard	IT	Loss of utilities	Weather	medium	8
Cattle Feedyard	IT	Loss of utilities	Utility Malfunction	medium	8
Cattle Feedyard	IT	Loss of supplier	Commodity shortage	medium	3
Cattle Feedyard	IT	Loss of supplier	Supplier failure	medium	3
Cattle Feedyard	IT	Loss of supplier	Business product failure	medium	3
Dairy Farms	BA	Onsite FEAD/FMD outbreak	Natural/Intentional	high	10
Dairy Farms	IT	Onsite FEAD/FMD outbreak	Natural/Intentional	high	10
Dairy Farms	BA	Total/partial loss of dairy	Severe weather	Medium	10
Dairy Farms	IT	Total/partial loss of dairy	Severe weather	Medium	10
Dairy Farms	BA	Loss of Management	Pandemic	Low	3
Dairy Farms	IT	Loss of Management	Personnel loss	Low	3

Fig. 2. The Hazards, Causes, Risk Exposure and KFs Impacted Data Set (Source: Authors' work in MS Excel based on BCM Data from the Panhandle Regional Planning Commission)

The present work seeks to discover information regarding IT and business administration business functions which are both based on the continuous operation of information systems, networks and databases. In order to achieve this goal, the dimensions and hierarchies of the involved data had to be considered. They are utilized as input to the formulation of online analytical processing reports. The software tool used for OLAP analysis is MS excel 2013.

2.2 Data Hierarchies

One of the most important tasks related to the effective data analysis is the observation of possible hierarchies. The specific task is crucial when databases entities and business intelligence data warehouses are designed. The main source for defining data hierarchies is either the users' aspect and requirements or the existence of a data set from which hierarchies can be discovered. After spotting the hierarchies, the corresponding schemas can be generated.

Strict Hierarchies: According to Vaisman and Zimanyi (2014), hierarchy types can be strict and non-strict. In the former type and the relationship type between parent and child levels is one to many.

Non-Strict Hierarchies: in the occasion when a many-to-many relationship exists between a higher and a lower level then the hierarchy type is non-strict.

2.2 Online Analytical Processing (OLAP)

In business intelligence systems, multidimensional schemas are used in order to analyze data based on multiple dimensions, different granularity levels (hierarchy levels or levels of detail for each dimension), measurements and facts (else called numeric measurements) (Grossman and Rinderle-Ma, 2015). The authors describe the *data cube* as a "*common metaphor*" which successfully delineates such schemas, while (Kimball and Ross, 2010) support that multidimensional schemas enable "diving the world in measurements and context". The most representative OLAP operations which are accompanied by aggregate measurements (mean, count, max, avg) are:

- Drill-down and Rollup: navigate through different granularity levels
- Slicing and Dicing: maintaining granularity levels but modifying the cube size, and
- Pivoting: rotating between rows and columns and measure facts from different perspective.

For the current research, MS Excel Pivot Tables have been incorporated in order to generate useful OLAP reports.

3 Results and Discussion

3.1 Hierarchies and Multidimensional Schema based on the Key Business Functions Data Set

The following multidimensional hierarchy schema (Fig.3) has been determined with respect to the Key Business Functions data set (Fig.1):
Non-Strict Hierarchy (n:m relationship): Industry ⟶ Key Business Function ⟶ Sub-Function ⟶ Department ⟶ Criticality Ranking.

In this case, the dimensions which are defined are: Industry which includes the granularity levels *Key Business Function, Sub Function and Departments* and, the dimension *Criticality Ranking*. Determined Facts are the Number of Functions, Sub-Functions, Departments and Criticality Ranking.

Respectively, the following multidimensional hierarchy schema (Fig.4) has been determined with regard to the Hazards, data set (Fig.2):

Non-Strict Hierarchy (n:m relationship): Industry ⟶ Hazards ⟶ Cause Risk Exposure.

The core dimensions which have been observed are the Industry, Hazards and Risk Exposure, while the core fact is the number of impacted KBFs.

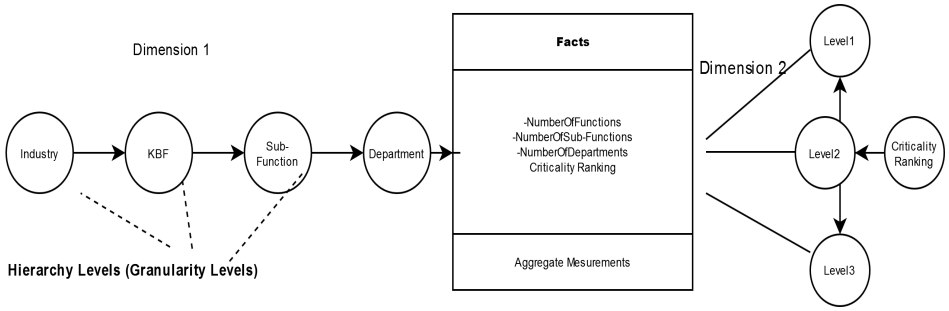

Fig. 3. The Key Business Functions Hierarchy Schemas

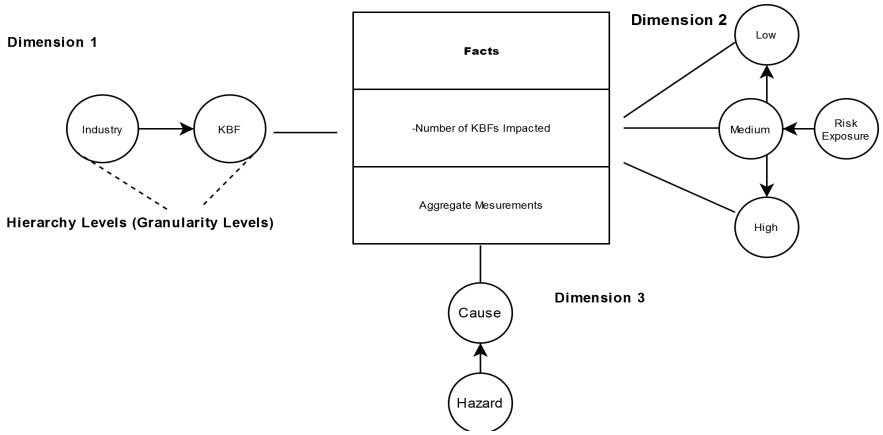

Fig. 4. The Hazards, Risk Exposure and Impact Multidimensional Schema

3.2 OLAP Operations

The following OLAP operations have been selected:

Data set 1: A selected report includes a pivot analysis of the number of Departments and their Criticality Ranking for both industries. The following illustrations depict

different perspectives of the analyzed data due to the rotation of rows and columns (Pivoting Operation) (Fig. 5, Fig. 6)

Count of Department	Column Labels		
Row Labels	Least Critical	Moderately Critical	Grand Total
Cattle Feedyard	5	4	9
Dairy Farms	9		9
Grand Total	**14**	**4**	**18**

Fig. 5. Total Number of Critical Departments in Each Industry.

Count of Department	Column Labels		
Row Labels	Cattle Feedyard	Dairy Farms	Grand Total
Least Critical	5	9	14
Moderately Critical	4		4
Grand Total	**9**	**9**	**18**

Fig. 6. Total Number of Industry Departments which are Critical.

Moreover, with the help of the Slicer Excel functionality, data can be further filtered according to the desired granularity level, namely Industry or KBF. The following example includes results for the percentage of critical departments for each industry when filtered according to the Industry level. In our example, 43% of the Least Critical Departments belong to the Business Administration KBF while 57% of the Least Critical Departments belong to the Information Technology KBF. By filtering the data according to the Industry level Dairy Farms, the ratio is modified, since 67% of the Least Critical Departments belong to the BA and 33% belong to the IT KBF. (Fig.7)

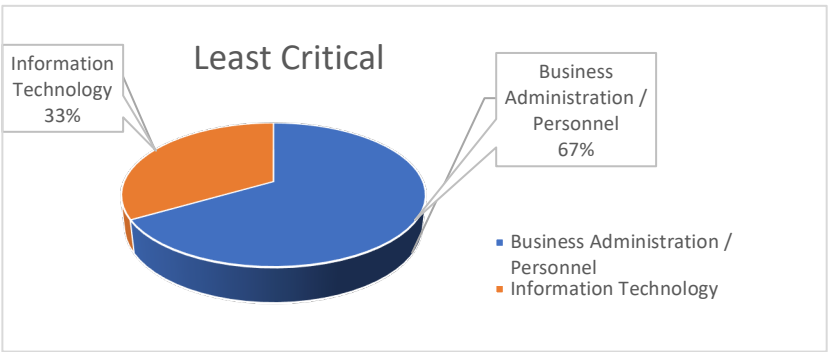

Fig. 7. The Ratio of the Least Critical Departments which belong to IT and BA KBFs filtered by the Industry (Dairy Farms).

Another selected OLAP operation concerns the Hazards, Impacts and Risk Exposure Data set. The data has been analyzed according to the Hazard that affects the two selected Key Business Functions, its Cause, and the Number of all the KBFs impacted[1] Moreover, the data is filtered according to KBF (IT, BA) and Industry (Fig. 8). The illustrated example includes the Pivot Analysis of the Hazard (Columns), Cause (Rows), Number of affected KBFs for the Cattle Feed Yard Industry and the Business Administration KBF.

	A	B	C	D	E
1	Industry	Cattle Feedyard			
2	KBF	(Multiple Items)			
3					
4	Sum of KBFs Impacted	Column Labels			
5	Row Labels	Computer / automation network failure	Loss of management	Loss of utilities	Grand Total
6	Job departure		8		8
7	Aging equipment	2			2
8	Cyber attack	2			2
9	Flu pandemic		8		8
10	Inadequate PM (preventive maintenance	2			2
11	Utility Malfunction			8	8
12	Weather			8	8
13	Weather		8		8
14	**Grand Total**	**6**	**24**	**16**	**46**
15					

Fig. 8. Pivot Analysis of the Hazard (Columns), Cause (Rows), Number of affected KBFs for the Cattle Feed Yard Industry and the Business Administration KBF.

The inferred results indicate that OLAP operations are tools that can be utilized as drivers towards crisis situations and can support effectively crucial decisions related to the formulation of effective agricultural business continuity policies. The selected data can be further utilized as input for data mining predictions too.

[1] All the involved business functions are of the selected industries/.

4 Conclusions

The current research has been conducted in order to highlight the importance of efficient data utilization towards the formulation of efficient business continuity management (BCM) strategies in the agriculture field. The data which has been utilized concerns the business continuity policy in two selected agricultural industries in Texas, namely the Dairy Farms and the Cattle Feed Yards. From the collected data, multidimensional schemas, hierarchies and selected OLAP operations have been incorporated in order to generate useful BCM reports for two key business functions, namely Information Technologies and Business Administration. An interesting OLAP analysis of the criticality ranking as well as the hazards and the vulnerability of the selected ICT-related functions has been conducted in MS Excel. Future research steps aim to analyze the total of the KBFs and infer significant predictive BCM results in the selected industries with the help of data mining tools.

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