Management,
Knowledge and Learning
International Conference 2011

CAN WE USE THE STATISTICAL CAUSALITY WITH SUFFICIENT RELIABILITY?

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Abstract:
Purpose of this applicative project research (ARRS L5-2329) is the identification and analysis of the key process indicators which significantly contribute to the benefits of the business processes exploitation in the company of Luka Koper, d.d. Beside that is our intention to display the importance of the systematic process approach. With this case study we attempted to get deeper understanding, and to clarify and evaluate the causalities between enablers and results. Long-term framed qualitative and quantitative analyses indicate the benefit of the identificated key processes indicators or Balanced Scorecard (BSC) and their influence on the fulfilment of the strategic directions.

Keywords: business processes, balanced scorecard, causality, learning, sustainability.

1. INTRODUCTION

The Luka Koper, d. d. is recognized as a significant port and logistic system in the Adriatic maritime market. The company introduced their first balanced scorecard (BSC) system in 2006. Beside that the company entered the competition for the most prestigious European Business Excellence Award, and becomes an Excellence Award Finalist in 2006.

System of performance measures or BSC, when used in practice, shows that is difficult to determine transparent relations between perspectives. However, the implemented model doesn't enable the identification of all information on the relations (i.e. correlations, causalities) between process Key Performance Indicators (KPI's). In this manner company doesn't have transparent evaluation of resource inputs in efficiency of the implemented model in the management system (Janeš & Dolinšek, 2010). Diagnostic activities, in this context, are usually "too expensive" to the company and it's usually overworked employees. Because of the latter's outlook, diagnostic is regarded as being time-consuming activity. With the development and application of a model for identification of the influential KPIs' which gives important contribution to the business results, company can perform its own diagnostic activities and focus on improvements of the key processes in a short and long-time period.

Many authors, such as Kaplan and Norton (1992), Bititci (1994), Bititci et al. (2006), Olve et al., (1999) and Robson (2004), argue that the establishment of a system of performance measurement must begin with the review of the strategy and not the actual outcome of business processes. Therefore, measures must be directly related to the strategies of the organization and should be selected on the basis of the strategic objectives of the organization. Knowledge about the relations and causality between the KPI in the selection and composition of balanced scorecard is essential for efficient and effective management of the organizations. Studies of many authors in the field of performance measurement systems show the actuality of this scientific field and the selected methodology provides support to decision-making process in organizations.

2. LITERATURE REVIEW

The historical roots of the performance measuring system began in 1925 with management accounting practices (Bititci et al., 2006), when the management of organizations was generally relying on short-term perspective and taking into account historical data, which represented mainly financial perspective and associated indicators. Attention of managers has been focused only on perspective which was measured i.e. financial perspective to supervise income and expenditure. The financial perspective with its appurtenant performance indicators gives managers review of the economic consequences. But this happens only after a time, when the latter have already occurred and demonstrate the result of the (un)successful introduction and implementation of strategies of the organization (Bose & Thomas, 2007; Schmidt, 2006). One of the first systems of performance indicators has been the supervision table (French. tableau de bord) which was set up more than fifty years ago in France. And some years later was set up the Parker's balanced view of the activities of the organization (Parker, 1979; Thakkar et al., 2007; Urrutia & Eriksen, 2005). Gradually was formed the need of taking into consideration various perspectives, such as customer perspective, internal processes perspective and learning (innovation) and growth perspective. Taking into consideration various business perspectives and associated financial and non-financial indicators has become an important topic of the practitioners, experts and researchers in the nineties of the last century. Cross and Lynch (1989) have suggested a pyramid or cascade of

measures, which combines the activities through hierarchy of the organization. Fitzgerald et al. (1991) are distinguishing between performance outcomes and related factors (Parida & Chattopadhyay, 2007; Thakkar et al., 2007). At that time Kaplan and Norton (1992), have perceived the lack of business supervising in accounting and developed a system of balanced measures or "Balanced Scorecard" as we know it today. Nanni and Dixon (1992) have developed an integrated system of measurement operations at the same period (Gosselin, 2005; Laitinen, 2005; Modell, 2009). Somewhat later, approach which the authors called the prism of the operations next to six sigma approach, lean production and theory of constraints woke up the attention of the professionals (Neely et al., 2002). Many authors, such as Kaplan and Norton (1992), Bititci (1994), Bititci et al. (2006), Olve et al., (1999) and Robson (2004), argue that the establishment of a system of measurement must begin with the review of the strategy and not the actual outcome of business processes. Therefore, measures must be directly related to the strategies of the organization and should be selected on the basis of the strategic objectives of the organization. Neely et al. (2000) presented a process approach to the measurement system. In addition to these, there are various attempts to the development of integrated, multidimensional and balanced measurements of organizations performance (Burgman et al., 2005; Parida & Chattopadhyay, 2007). Researchers have stressed the importance of different dimensions in the development of measurement system of organizations. For example Bititci, Carrie and McDevitt (1997) took advantage of two dimensions of measurement - the integrity and distribution. Drucker (1990) and Russell (1992) gave the emphasis on the harmonization of financial and non-financial criteria. As a result of the findings of various authors, notably Kaplan and Norton (1992), who claim to avoid the lack of information for management decision-making or reaction management, if an organization introduce a system of balanced scorecard (Bititci et al., 1997; Thakkar et al., 2007). Link to the strategy is subtle but powerful. Kaplan and Norton ranked four perspectives in the system of BSC: a financial perspective, customer perspective, internal processes perspective and learning and growth perspective. On the basis of cause - effect relations between these four perspectives can be completed long-term strategic goals of the organization. This can be achieved by the decomposition of vision and strategic objectives of the organization on a set of causally related measurements and associated indicators. This set of indicators is further decomposed across all levels of management so as to promote understanding of the objectives of the organization from the perspective of managers and all employees (Agostino & Arnaboldi, 2011; Biloslavo, 2008; Kaplan & Norton, 2000, 2004, 2006; Modell, 2009; Poister, 1982; Wisniewski & Dickson, 2001). The research is focused on the study of relations between performance indicators which we will develop in a series of economic data known as time series (Granger, 2004). Knowledge about the relations and causality between the KPI in the selection and composition of BSC is essential for efficient and effective management of the organizations. Studies of many authors in the field of performance measurement show the actuality of this scientific field and the selected methodology provides support to decision-making process in organizations.

3. METHODOLOGY

Main purpose of our research is to explore and clarify the cause - effect relations between KPI. This will give us a basis for understanding these relations and understanding about the relations between business strategy and operations at all levels. In this quantitative oriented research the influence of the measured process KPIs' on the company's strategy fulfilment is discussed. As a research method was chosen case study (Yin, 1994) of the Luka Koper, d.d. company which is based on the following criteria:

- First BSC system has been introduced in 2006,

- Luka Koper, d.d. entered the competition for the most prestigious European Business Excellence Award, and has become an Excellence Award Finalist in 2006, and
- The project of identification of the KPI in collaboration with the UP Faculty of Management Koper has formally started in 2009.

Data for the model testing, application and analyses were gathered in period between September and November 2010. From the collected data we constructed time series of KPIs' for one of the terminals for maritime throughput in the period from January 2003 to September 2010. In previous years of the project we already ascertained correlations between KPI (Janeš & Dolinšek, 2010). But the research question about causality still remains: For which relations between the key performance indicators can we statistically (quantitative) and practically (qualitative) ascertain causal relations?

4. EMPIRICAL FINDINGS AND DISCUSSION

For the first set of indicators, we reviewed the records of KPIs' from four perspectives of the BSC and obtained 14 indicators from the company's information system (IS). Some of those KPIs' were even calculated. All gathered KPI are regularly monitored by the company in quarterly periods. Data from the quarterly periods (from 2003 to 2007) were converted into monthly data by linear interpolation (Hair et al., 2006). From the IS we also obtained monthly data of the period from January 2007 to September 2010. Of all the collected KPIs' we developed six time series, which were found suitable in the sense of data quality. Appropriate performance indicators in our case were those from which we could developed longitudinal time series.

We have chosen KPI by which the company executes monitoring of the performance in four perspectives. Among the indicators that were available, we were opting for those who are monitored in general cargo terminal (GT). This was agreed in the meeting with the management representatives. The indicators which are monitored or calculated only at the level of the company were omitted (eg. earnings per share, return on equity, etc.). Due to limited space only a selection of the KPIs' is presented in Table 1.

Some of the variables used to represent the indicators of business processes of the GT terminal were with missing values. These indicators were operating efficiency OE1, return on sales ROS1, revenue per unit for all throughput RU1, land throughput LT2, container throughput CT2, total costs per unit TCU3, variable operating costs per unit VOC3 and water consumption WACN3, which we have excluded from further analysis.

Results of analysis of the eight terminals for maritime throughput made in 2009 showed, that during the observation period from 2006 to 2008, revenues were weakly correlated with consumption of energy. Revenue per unit of maritime throughput and maritime throughput were correlated from weak to moderate level. Maritime throughput was most related with the consumption of fuel, with medium to strong correlation, while the other two, i.e. electricity and water consumption had a weak correlation with the maritime throughput. Revenue and maritime throughput also do not have significant correlation in the same period (Janeš & Dolinšek, 2010).

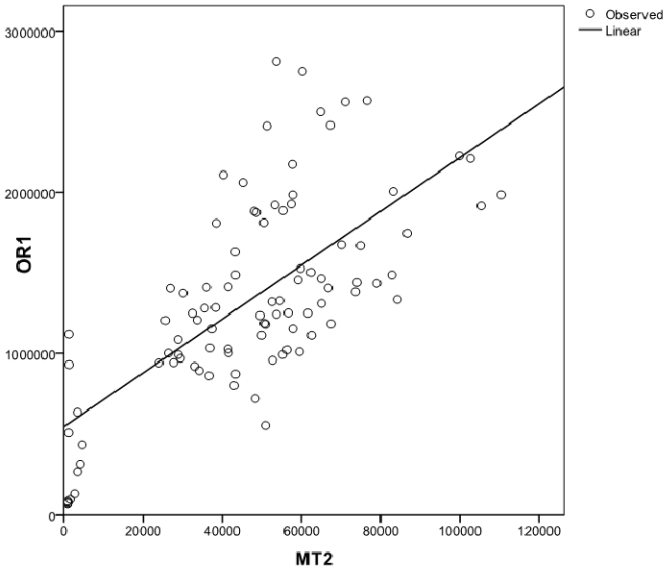
4.1. Analysis of the linear relations between the KPI

Below we present examples of calculated linear regression to the selected KPI. To calculate the model parameters were collected indicators of the GT terminal. All variables represent indicators which are monitored in the company's' BSC system. We used six indicators which are: operating revenue OR1, revenue per unit of maritime throughput RUMT1, maritime throughput MT2, fuel consumption FC3, electricity consumption EC3 and water consumption WACN3. The analysis was carried out in the manner that:

- The relations between the KPI are linear,
- We considered scatter diagrams and,
- Linear regression was calculated between pairs of selected KPI.

Due to limited space, we present only some of the findings. In general, the degree of linear relationship between performance indicators is abnormally low (e.g. from FC3 = 0,236 MT2 + 4778,542; R^2 = 0,270 to OR1 = 16,691 MT2 + 546030,457 ; R^2 = 0,460, see Picture 1), due to numerous factors. One of the most important is the quality of data used.

Picture 1: Scatter diagram of variables OR1 and MT2



The primary time series are based on quarterly data, but since these are, according to the results, too few for reliable analysis we have used different methods of interpolations, for the transformation of quarterly data into monthly data. Moreover, the data is subject to instability, such as a sharp drop in maritime throughput in the period from 2007 to 2009. All these factors undermine the quality of the identified linear relationship between performance indicators. For this purpose, we continued analysis of the empirical testing of the resulting causal relationship between KPIs'.

4.2. Causal relations between key performance indicators

The concept, which is interesting for our research, is the time causality, which means that the cause occurs before the result and contains unique information about the latter. From this idea follows that knowing the cause supports predictions of several aspects of the consequences. In this example we set variable X as a cause of variable Y if we get better predictions about Y, using historical information about X, than without this information (Granger, 2004).

We first performed a stationarity test. Stationarity means that the time series have average value and variance are constant during the observation period (Gujarati, 1995). We ascertain stationarity for the reason of excluding the possibility of false regression.

Table 1: Causal relations

	Causality/lags	1	2	4	6
1	FC3 –> EC3	0.03703*	0.07884*	0.01572*	0.00356*
1	EC3 –> FC3	0.74454	0.92075	0.88684	0.29984
2	RUMT1 –> MT2	0.03831*	0.17488	0.18980	0.33967
2	MT2 –> RUMT1	0.54068	0.60548	0.35883	0.58421
3	FC3 –> MT2	0.94163	0.69060	0.18958	0.12132
3	MT2 –> FC3	0.36816	0.45128	0.21591	0.33813
4	OR1 –> MT2	0.05368*	0.27578	0.16598	0.31841
4	MT2 –> OR1	0.47701	0.84626	0.61457	0.86282

Note: Values marked with an asterisk * represents causality relation ascertained with Granger test

Our results show that there is statistically significant causal relation between fuel consumption FC3 and Electricity consumption EC3, where the fuel is cause and electricity is the effect. Under certain conditions, there is a statistically proved causal relation between the resulting Revenue per unit of maritime throughput RUMT1 and Maritime throughput MT2 and the Operating Revenue OR1 and Maritime throughput MT2. For the remaining cases can not be identified statistically significant causal consequent relations, which is primarily related to restricted availability of data, which we have already highlighted in the analysis of linear relations.

5. CONCLUSIONS

Discussed organization can be a model in terms of demonstrating the achieved level of business performance excellence. Using the model to identify KPI is suitable for classification and assessment of the integration and causality between the performance indicators under the four perspectives of the BSC. Thus, a quantitative approach is useful in combination with a qualitative approach, which is common practice in determining the causal relations resulting in the strategic map of BSC. Whatever the management levels, the simulations of the model are possible by combining the KPI and consecutively acquire new knowledge about their relations, causality, improving the monitoring of strategic guidelines and objectives. Some of the influences of specific factors that affect the unexplained part of the variables analyzed in the study are certainly random, but some may arise from current circumstances in the company and are not included in the model or we did not have available data. A case study of the port and logistic system Luka Koper, d.d. have also some limitations. The first relates to sample size and quality of the data which were available. A second limitation is a quantitative analysis in the four perspectives of the BSC. Since this is the case study which investigates the impact of the KPIs' on the results and causalities between them, we also encountered the data, which are treated as a business secret. We must also consider the impact of external factors, such as changing government regulations, access to public infrastructure such the second rail track to Divača and investment in the railway business, logistic centers, development of maritime passenger terminal and alcohol terminal and competing ports in the Mediterranean (in particular, Rijeka and Trieste). The company has faced sharp decline in maritime throughput in 2007 as a result of the global financial crisis which is reflected through the KPI in the years 2008, 2009 and 2010. Further research into the impact of

introducing the four perspectives of the BSC to monitor the implementation of strategies, organizational culture and business results is definitely recommended. With research of the case studies, as well as benchmarking between them, we contribute to clarify the position of Slovenian organizations among other organizations in the EU and beyond.

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