

# A Business Intelligence Tool for Studying Value Co-creation and Innovation

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**Key Words:** Value co-creation; open innovation; principal component analysis; linear regression analysis; empirical study; business intelligence tool.

**Abstract.** Value co-creation is an emerging marketing and innovation paradigm describing a broader opening of the firm to its customers by providing them with the opportunity to become active participants in the design and development of personalized products, services and experiences. However, there is not yet a fully satisfactory theoretical vision about its distinctive characteristics as compared to more traditional value creation approaches. One of the challenges in studying value co-creation is the lack of business intelligence (BI) tools that can be used in the conceptualization of value co-creation practices. The present paper provides a preliminary vision for the development of such a BI tool and a first implementation that uses empirical research results in answering two research questions. The first question is: What are the principal components of value co-creation? The second question is: What is the relationship between the degree of firms' involvement in value co-creation activities and their innovativeness?

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## I. Introduction

Value co-creation is an emerging business, marketing and innovation paradigm describing how customers and end users could be involved as active participants in the design and development of personalized products, services and experiences (Prahalad & Ramaswamy, 2004; Etgar, 2008; Payne, Storbacka, & Frow, 2008). It is based on the design and development of customer participation platforms providing firms with the technological and human resources, tools and mechanisms to benefit from the engagement experiences of individuals and communities as a new basis of value creation. The active participation of customers and end users is enabled through multiple interaction channels, very often by means of specifically designed technological platforms through the Internet (Sawhney, Gianmario & Prandelli, 2005; Nambisan & Nambisan, 2008; Nambisan & Baron, 2009). Indeed, it is the advances in Information and Communications Technologies (ICT) that has enabled customers to be much more active, knowledgeable, globally aware and willing to use interactive virtual environments to personalize the existing and shape new products and services. The ability of value co-creation platforms to enable the personalization of new products and services challenges the operational presuppositions of traditional marketing segmentation techniques by promoting a new service-dominant logic (Vargo & Lusch, 2004; von Hippel, 2006a). The new dominant marketing logic enables firms to address broader heterogeneous markets aiming at a better fit between what a customer needs and what the firm does and offers. It entails a new vision of the topology and the dynamics of the entire value creation system including i) a shift from thinking about consumers to thinking about co-creators of value,

ii) a shift from thinking about value chains to thinking about value networks, iii) a shift from thinking about product value to thinking about network value, iv) a shift from thinking about simple co-operation or competition to thinking about complex co-opetition, and v) a shift from thinking about individual firm strategy to thinking about strategy in relation to the entire value ecosystem (Hearn & Pace, 2006). Such vision promotes a new understanding of the customer centricity of the traditional value network concept which is now considered dynamical, as a people-driven web of potential value configurations that could be actualized on the basis of specific customer demands (Norman & Ramirez, 1993; Flint & Mentzer, 2006; Prahalad & Krishnan, 2008).

The adoption of value creation practices leads to the need of „changing the very nature of engagement and relationship between the institution of management and its employees, and between them and co-creators of value - customers, stakeholders, partners or other employees“ (Ramaswamy, 2009). This ongoing change challenges the management of innovations by promoting a new vision of the nature of innovation itself (Prahalad & Krishnan, 2008; Kristensson, Matthing & Johansson, 2008; Tanev, Knudsen & Gerstlberger, 2009). The new co-creative vision of innovation is built on two key distinctive features. The first one is the truly user-driven aspect of the value co-creation activities between firms and customers. In this sense, value co-creation platforms represent a natural extension of some of the key aspects of the user-driven innovation paradigm (von Hippel, 2006) by focusing on the development of participation platforms to, literally, multiply the effect of user-driven innovation methods such as the design of innovation toolkits (von Hippel, 2001; Nambisan & Nambisan, 2008; Nambisan & Baron, 2009) and searching for lead users (von Hippel, 2006b; Bilgram, Brem & Voigt, 2008; Droge, C., Stanko, M. & Pollitte, W., 2009). Another distinctive feature is the focus on the co-opetitive (from co-opetition) nature of the interactions between the different stakeholders, including the customers and end users, participating in the value co-creation process. Before competing and negotiating to capture value, the different players in a value co-creation network need to compete and negotiate in order to be able to participate and to contribute value (Tanev, Knudsen & Gerstlberger, 2009). The co-opetitive dimension of value co-creation platforms leads to a more dynamic type of economic mechanisms as underlying driver of the innovation processes. These mechanisms operate on the basis of multiple transactions between customers, partners and suppliers at multiple access points across the value network. They enable customers and end users to control the relationship between price and user experience (Prahalad & Ramaswamy, 2004; Etgar, 2006) by providing them with the opportunity to actualize (i.e., create) specific value chain configurations that would fit their proper

need, context and preferences. It is in this context that we could talk about customer value *co-creation*. Although focusing on the proactive role of the customer, such understanding is generically holistic in nature; it embraces all the actors involved in the value creation process providing an opportunity for firms to broaden the boundaries of their open innovation processes.

**The objective of this article** is to report the research insights from the development of a business intelligence tool that is based on an empirically-derived quantitative model describing the relationship between the degree of firms' value co-creation activities and their innovativeness. The tool is used to identify the key components of value co-creation based on a methodology using web search generated data and Principal Component Analysis (PCA) techniques and applies a similar, web search-based approach to evaluate firms' innovativeness; finally, it uses linear regression analysis to examine the relationship between the degrees of value co-creation activities and firms' innovativeness which is measured by the frequency of firms' online comments about their new products, processes and services and by the number of new products, processes and services in the last

provided preliminary results demonstrating that this concept could be applied to classify value co-creation practices and articulated the key steps of the data gathering and analysis work flow. These research studies show that factor analysis of the frequencies of a specifically designed set of keywords can be used to extract the key components of value co-creation in a large sample of firms. The research methodology was further enhanced by Tanev et al. (2011) by adding an additional step focusing on: i) examining the perception of firms' innovativeness by measuring the frequency of firms' online comments about their new products processes and services, ii) estimating the innovation capacity of the firms by measuring the number of new products processes and services, iii) applying linear regression analysis to test the two hypotheses about the existence of a positive association between the degree of firms' involvement in value co-creation activities and their innovativeness. The key difference in the approach adopted here can be summarized as follows. First, a new data collection was done by three different web search engines (Google, Yahoo, Bing) to measure the frequency of the keywords on firms' websites. Second, the data

**Table 1.** Breakdown of sample organizations: ECL - firms members of the Eclipse Foundation, OSS - open source software firms, OSS+ECL - open source software firms members of the Eclipse Foundation, GEN - firms that are not open source and non-members of the Eclipse Foundation

Type of firms		Frequency	Percent	Cumulative Percent
1	GEN	65	23.8	23.8
2	ECL	133	48.7	72.5
3	OSS	75	27.5	100.00
	Total	273	100.0	

three years. The underlying hypotheses of this research are as follows:

- *H1: Firms with a higher degree of involvement in co-creation activities are in a better position to articulate the innovative aspects of their new products, processes and services.*
- *H2: Firms with a higher degree of involvement in co-creation activities are in a better position to introduce new products, processes and services.*

The testing of this hypothesis is particularly relevant within the context of an increasingly global competitive environment where firms are struggling with the limits of their innovation capacity through investments in greater product variety and in traditional marketing techniques that do not necessarily lead to a better competitive positioning, innovation and differentiation (Pralhad et al., 2004, 2008).

## II. Methodology

Hicks et al. (2006) and Ferrier (2001) pioneered the concept that an analysis of the frequency of use of specific keywords on public websites and corporate news releases can be an adequate representation of the degree of importance the firms place on the concepts those keywords were chosen to represent. Allen et al. (2009ab) and Tanev et al. (2010ab)

was collected by newly developed multi-functional search tool.

The results are based on a convenience sample of 273 firms that were selected for being representative of the breadth of their value co-creation activities (*table 1*).

## III. Summary of Results

### 1. Development of the 'LuckySearch' Business Intelligence Tool

This section will focus on the details of the development and the functionality of the search tool. The application is developed as a Windows Desktop program. It executes searches on Google, Yahoo! Search and Bing. The search queries are constructed for each keyword and each company's web site. Also one additional search is executed only with the company's web site, to get the count of the pages in the web site. The output of the application is one (287x30) matrix (corresponding to # of firms X # of keywords) saved in Microsoft Excel file with the results of the searches executed against one of the search engines. The results are structured in a table with columns - the selected 29 keywords entered as an input + one column for the pages size of the web site; and rows - the 287 companies' web sites. The data in the table is normalized: the number of pages beneath the site and the keyword counts normalized by the

number of pages beneath the site. The application is able to execute simultaneous searches against one of the three search engines. The number of the simultaneously executed search may be preconfigured by the user of the application. The application is constructed in a way that supposes further development and integration with the SPSS software. The user interface is shown in *figure 1*.



**Figure 1.** LuckySearch tool user interface

To use the software application, the following steps must be executed:

- Import a text file that contains the predesigned keywords. Each keyword should be placed in a new line in the file or in the „Keywords“ text area in the keyword application window.
- Import a text file that contains the web sites. Each web site should be placed in a new line in the file or in the „Websites“ text area in the application window.
- Select a folder in the field „Output directory“, to specify the output directory where the excel file and the text files results should be collected.
- Choose the „Number of threads“, which specifies the parallel web searches executed at a given moment. It is recommended that this value is preset to 2, otherwise the search engine may reject the request to execute the web searches.
- To save the text content from the first found web pages should be parsed and saved in the specified output directory, check the field „Save text results“.
- To specify the number of the first found web pages, from the search engines, which are going to be parsed and their text content saved, choose the number from „Number of links“ field.
- Click the „Search“ button to start web search executions.

As the Bing and the .NET platforms have a common owner - Microsoft, there is plenty of documentation, articles and examples how the Bing API can be used with the .NET development platform. There is an available Bing library written in .NET that can be used for the execution of web search requests. Yahoo! Search has its own .NET Developer Center with HOWTO articles and Community Resources where one can join mailing list and discuss the Yahoo! APIs (as well as OAuth Authorization class source in C# and VB.NET). The OAuth Authorization source saves a significant development tie and is appropriate to be used in this project. For Google there is an available .NET Client Library Developer's Guide, which includes many tutorials and examples in .NET.

From version 14 onwards SPSS can be driven externally by a Python, R and .NET program using supplied „plug-ins“. So for the sake of convenience for the further development and integration with SPSS, one should focus on using development platforms such as: Python, R or .NET. Since the application uses Microsoft Excel file as the output of the application, the development platform should have integration and possibility for output Excel files with filled results in it. Microsoft distributes MS Office libraries that can be used by external sources. They support almost all Windows development platforms including .NET. One advantage of .NET over Python is the possibility to use integrated modules for Windows Forms and the nice compatibility between .NET and Windows' Desktop. Having in mind all of the above, it was found to be most appropriate using the .NET platform and its most popular language C#. As a coding convention for the development we have chosen the one recommended by Microsoft.

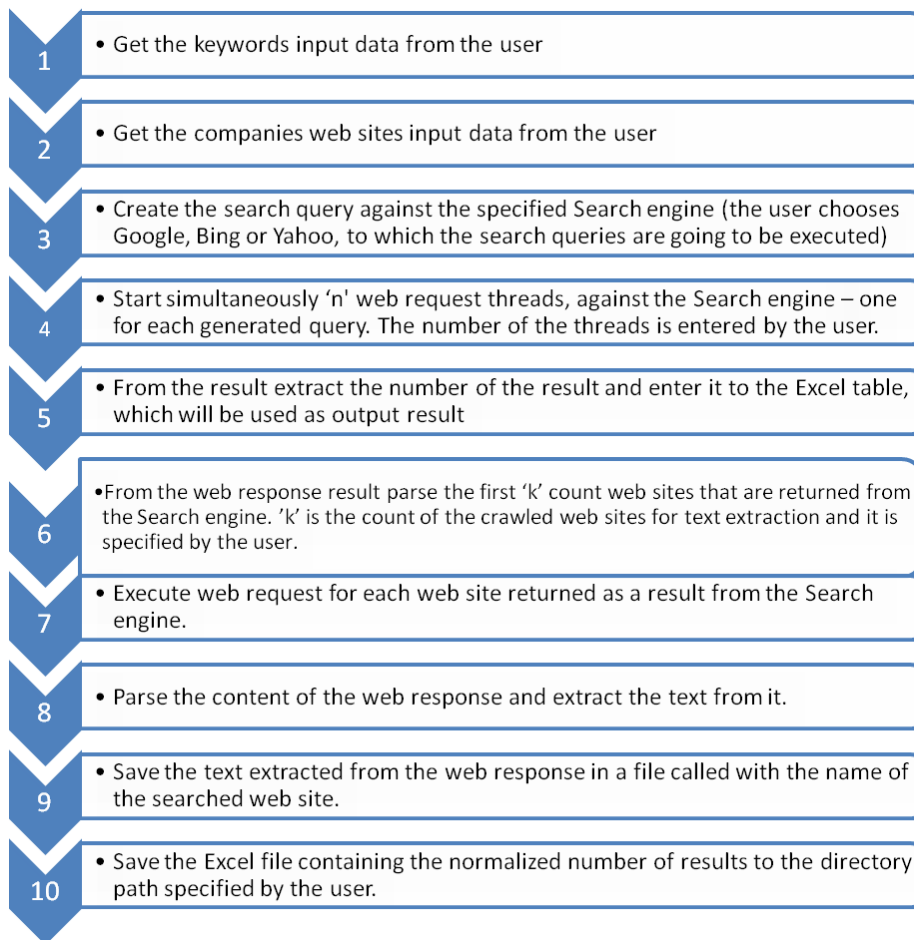
All the search engines' API supports a web response in XML, JSON and SOAP protocols. In this software XML responses are chosen to be used, as this is the most affirmative method today. For the development of the Bing part in the application, Bing API SDK was used. It provides automatic authentication and search query construction. It is recommended to be used by Microsoft MSDN. The application - „LuckySearch“ is developed with three subprojects:

- The user interface is separated in individual sub-project. It contains the user settings, the windows forms interface and the class that outputs the Excel data file with the matrix results. This project manages the executed simultaneous threads.
- Module responsible for extracting the text from the web site content. It parses the web page and removes its HTML, Javascript and Flash code.
- Module responsible for executing web requests to the Google, Yahoo and Bing. It is also responsible for parsing the results from the Search engines. It determines the total number of results for a given requests, and also gathers the returned links in a lists.

The diagram shown in *figure 2* describes the process actions steps that the application LuckySearch must execute to gather the search engines Excel data results and the text data results from the sites linked by the search engines.

## 2. Value Co-creation Components

*Table 2* shows the specific composition of the extracted



**Figure 2.** Process diagram of the LuckySearch application

principal value co-creation components that was used to construct three value co-creation component variables for each of the firms in the sample (Tanev et al, 2010; Tanev et al, 2011). Based on these results, the first co-creation component was interpreted as „Resources, processes, tools and mechanisms enabling customer and user involvement in production, assembly, manufacturing and self-service aiming at design and process flexibility based on product modularity and sharing of internal expertise, resources and IP.“ The second co-creation component was interpreted as „Customer relationships enabled through partnerships and cooperation aiming at cost reduction, design and process flexibility, and leading to better customer and end user experiences based on risk management, transparency and trust.“ The third co-creation component was interpreted as „Mutual learning mechanisms based on the existence of user networking forums enabling customer suggestions, input, demands and requests, and leading to multiple options for users through involvement in test and beta trials.“ *Table 3* shows the descriptive statistics of the three co-creation variables that were constructed by adding up the ratings of each of the keywords weighted by their loadings.

### 3. Innovation-related Metrics

*Table 4* shows the descriptive statistics of the three innovation metrics related to the number of new products, service and processes, together with the perception of innovativeness metric that was used by Tanev et al. (2010). It was measured

by the frequency of firms' online comments about new products, services and processes and collected by means of the composite keyword: *new AND product OR service OR process OR application OR solution OR feature OR release OR version OR launch OR introduction OR introduce OR „new product“ OR „new service“ OR „new process“ OR „new solution“ OR „product launch.“*

### 4. Linear Regression Analysis

The results from the linear regression analysis are presented in *table 5* including two different cases: the general type firms alone and the firms involved in OSS projects alone. The linear regression models for firms' perception of innovativeness suggested by Tanev et al. (2010) are also included as a comparison. The explanatory power is determined by the R square value.

### 5. Analysis of the Relation between Value Co-creation and Innovation

The innovation capacity of the firms was measured by the number of their new products, services and processes. These results were compared to previous results about firms' perception of innovativeness that was measured by the frequency of online comments about firms' new products, processes and services. It should be pointed out that the perception of innovativeness is not a traditional innovation metric since it does not directly count the number of new products, processes and services but the frequency of online comments about them. It could

**Table 2.** Composition of the three principal value co-creation components

<i>Component # 1</i>		<i>Loading</i>
customer+OR+user+produce+OR+assemble+OR+manufacture		.727
product+OR+process+modularity+OR+modular+OR+module		.705
customer+OR+user+IP+OR+”intellectual+property”		.669
design+OR+process+flexibility+OR+flexible+OR+adaptable		.599
internal+expertise+OR+resource		.554
lease+OR+rent+OR+license+OR+“self+serve”+OR+“self+service”		.550
product+OR+process+OR+service+evolution+OR+evolve		.521
<i>Component # 2</i>		<i>Loading</i>
customer+partnerships+OR+interaction+OR+relationship+OR+participate+OR+participation+OR+activity+OR+action		.778
customer+OR+user+risk+manage+OR+management+OR+control+OR+assess+OR+reduce+OR+reduction+OR+potential+OR+ Exposure		.698
customer+OR+user+cooperate+OR+cooperation+OR+collaboration+OR+partnership		.691
cost+reduce+OR+reduction+OR+saving		.685
trust+OR+honesty+OR+integrity+OR+transparency		.647
customer+OR+user+experience		.627
<i>Component # 3</i>		<i>Loading</i>
customer+OR+user+learn+OR+learning		.752
customer+OR+user+suggest+OR+suggestion+OR+input+OR+request+OR+demand		.737
customer+OR+user+OR+forum+OR+connect+OR+network+OR+networking		.716
customer+OR+user+options+OR+choice+OR+choose		.524
customer+OR+user+test+OR+trial+OR+beta		.512

**Table 3.** Descriptive statistics of the three principal component variables

<i>Component</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>Skewness</i>		<i>Kurtosis</i>	
			<i>Statistic</i>	<i>Std. error</i>	<i>Statistic</i>	<i>Std. error</i>
Component_1**(1/3)	2.290	.821	.087	.147	-.105	.294
Component_2**(1/4)	1.857	.556	.028	.147	.251	.294
Component_3**(1/2)	5.984	2.457	.264	.147	-.126	.294
Component_All**(1/3)	3.973	1.105	-.078	.147	-.238	.294

**Table 4.** Descriptive statistics of the innovation-related metrics

<i>Innovation metric</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>Skewness</i>		<i>Kurtosis</i>	
			<i>Statistic</i>	<i>Std. Error</i>	<i>Statistic</i>	<i>Std. error</i>
New products**(1/5)	1.025	0.727	-0.144	0.150	-0.421	0.300
New services**(0.27)	0.748	0.747	0.411	0.150	-0.647	0.300
New processes**(1/3)	0.411	0.617	1.011	0.150	-0.533	0.300
Perception**(1/2)	4.745	1.760	-0.126	0.147	-0.286	0.294

**Table 5.** Linear regression results about value co-creation and innovation-related outcomes. The results for the perception of innovativeness are from Tanev et al. (2010).

Type of firm	Model	Linear regression model	Expl. power
General firms	1	New products = const + 0.599 * C#2	13.8%
	2	New (products + services) = const + 0.554 * C#1	15.2%
	3	New services = const + 0.330 * C#1	14.5%
	4	Perception = const + 0.657 * C#2	43.1%

be expected, however, that this frequency will be proportional to the number of new products, processes and services. In this sense, there is an opportunity by properly „calibrating“ or optimizing the perception metric to construct a modified innovation metric that would be based on information available online and that could be used for an automated quick estimation of firms' overall innovation capacity.

Indeed, the application of correlation analysis indicates that there is a modest statistically significant positive association between the perception of firms' innovativeness and their number of newly introduced products. The Pearson correlation coefficient is 0.155 ( $p < 0.025$ ) suggesting that only 15% of the perception metric corresponds to comments about the introduction of new products, the rest being related to discussing the innovative features of existing produces. The correlation between the perception of innovativeness and the number of new service and processes was found to be statistically insignificant.

A closer examination of the linear regression results leads to a number of findings.

*First*, in the case of the entire research sample, there is no statistically significant relationship between value co-creation and innovation. This situation is different from the one studied by Tanev et al. (2010) where in this case there was a positive association between firms' extent of value co-creation activities and the perception of their innovativeness.

*Second*, in the case of firms involved in OSS projects, there is no statistically significant relationship between value co-creation and innovation. Again, this situation is different from the one studied by Tanev et al. (2010) where for this type of firms there was a positive association between firms' extent of value co-creation activities and the perception of their innovativeness.

*Third*, statistically significant models were found in the case of general type firms alone. The second value co-creation component „Customer relationships enabled through partnerships and cooperation“ appears as the only independent variable in the model describing its relationship to the number of new products (table 5, Model 1). This finding is similar to the one suggested by Tanev et al. (2010) where in the case of general type firms there was a positive association between the perception of innovation and the second co-creation component (table 5, Model 4). The key difference is that in the present case the explanatory power of the model is only 13.8%, as compared to 43.1% in the other case. However, the lower explanatory power corresponds to the modest level of correlation between the innovation and perception metrics. It is important to point out that the second co-creation component has the lowest rate of use as compared to the other two co-creation components (Tanev et al., 2010) but it happens to be the component that provides the statistical evidence in support of our initial hypothesis about the

existence of a positive relationship between the innovative capacity of firms and the extent of their value co-creation activities.

*Fourth*, there is a positive association between the first co-creation component „Resources, processes, tools and mechanisms enabling customer and user involvement in production, assembly, manufacturing and self-service,“ and the total number of firms' new products and services (table 5, Model 2). An additional analysis suggests that in this case the value co-creation activities appear to be more beneficial in terms of firms' potential for new service introduction (table 5, Model 3). Such positive association is similar to one of the findings of Tanev et al. (2010) suggesting a positive association between the total value co-creation component and firms' perception of innovation (Table 5, Model 4). However, again, the explanatory power in the present case is 15.2%, as compared to 43.1% in the other case. Models 2 and 3 (table 5) suggests a higher relevance of the first co-creation component as compared to the previous study. This is a new finding that needs to be further studied.

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