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Natasa Vujica Herzog, Andrej Polajnar, S Tonchia

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**DEVELOPMENT AND VALIDATION OF
BUSINESS PROCESS REENGINEERING (BPR)
VARIABLES:
A Survey Research in Slovenian Companies**

**Natasa VUJICA HERZOG*, Andrej POLAJNAR*
and Stefano TONCHIA****

* Laboratory for Production and Operations Management
Faculty of Mechanical Engineering
University of Maribor
Smetanova 17
SI- 2000 Maribor
Phone: +386 2 220 76 35, Fax: +386 2 220 79 90
E-mail: natasa.vujica@uni-mb.si

** Dept. of Electrical, Managerial and Mechanical Engineering (DIEGM)
University of Udine
Via delle Scienze no. 208
33100 Udine - Italy
Phone: + 39 0432 558332 - fax + 39 0432 558251
E-mail: tonchia@uniud.it

Corresponding author: natasa.vujica@uni-mb.si

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DEVELOPMENT AND VALIDATION OF BUSINESS PROCESS REENGINEERING (BPR) VARIABLES:

A Survey Research in Slovenian Companies

Abstract

Business Process Reengineering (BPR) literature is based primarily on case studies and there is a lack of rigorous wide-ranging empirical research covering all its aspects. This paper presents the results of a survey research carried out in 73 medium and large-sized Slovenian manufacturing companies. Seven crucial areas were identified based on a synthesis of BPR literature, which must be practised to achieve effective process reengineering: management commitment, education & training, team work, BPR project characteristics, employee cooperation, information technology support, and levers & results. Variables have been constructed within these areas, using Likert scales, and statistical validity and reliability analyses. These developed variables can be important both for understanding BPR and in terms of the descriptive statistics, also reported in this paper. What emerges is the crucial importance of process orientation, goal setting, and top management commitment. Furthermore, these variables can be helpful for further research aimed at investigating BPR and its linkages with other areas, such as strategy, performance measurement, etc.

Keywords: Business Process Reengineering, Process Management, Survey Research

1. Introduction

Over the past decade there have been considerable discussions in literature about BPR. In 1997 the International Journal of Production Economics issued a special edition on BPR (Vol. 50, Issues 2-3) and the following year, 1998, International Journal of Operations and Production Management produced another special issue on BPR (Vol 18, No. 9-10). In the period from 1998 to 2004 the continuous presence of regular contributions in several journals can be found, displaying a high interest in the mentioned theme. An extensive literature review indicates that the opinions of numerous authors when researching BPR can be divided into two main categories:

- Research area No. 1; researchers who support BPR as a management intervention tool appearing as an answer to continuous market changes, customers' demands and competition (Davenport and Short, 1990; Hammer, 1990; Hammer and Champy, 1993; Grover and Malhotra, 1997; Gunasekaran and Kobu, 2002; Terziovski et al., 2003; MacIntosh, 2003; Hammer, 2004);
- Research area No. 2; researchers of the opposite view, claiming that BPR has failed to meet the expectations that were placed on it, and that the rise of BPR was just a rehashing of old ideas to fit a new context (Mumford, 1994; Gadd and Oakland, 1996; Biazzo, 1998; Case, 1999; Marjanovic, 2000).

Heterogeneous opinions indicate that BPR is a controversial approach. Some authors have tried to clear up the confusion about BPR through systematic literature reviews. For example, in an extensive literature review on BPR (133 references, selected from a list of 900), Motwani et al. (1998) classified BPR research into four sections:

1. definition and overview articles on BPR,

2. normative studies,
3. those mainly done by practitioners,
4. conceptual models for assessing and implementing BPR.

Another example is from O'Neil and Sohal (1999), who, on the basis of reviewing over 100 references, covering a period from the late 1980s to 1998, identified nine major issues that can be researched by the academic community:

1. BPR, corporate objectives and organizational structure;
2. the relationship between the adoption of BPR tools and techniques, and business performance;
3. best practices relating to the adoption of BPR tools and techniques;
4. the extent to which the different elements of **Total Quality Management (TQM)** facilitate the success of BPR projects;
5. best practices in managing BPR projects – lessons learned from successful BPR projects and identifying those factors critical to success;
6. the roles of process owners, customers and suppliers in BPR projects;
7. team work in BPR;
8. the role of top/senior management in successful BPR implementation;
9. managing the risks involved in BPR.

They ascertained that 'empirical research in to BPR has been lagging behind and it presents the academic community with a considerable opportunity. Rigorous, empirically-based research can help in demystifying the confusion that still exists concerning BPR' (O'Neil and Sohal, 1999, p. 579).

If we want to examine this raised question, we must know the basic characteristics of BPR in detail and have statistically-based confirmation, even if restricted to specific

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4 sectors and countries. BPR literature is based primarily on case studies and there is a
5
6 lack of rigorous wide-ranging empirical research covering all the aspects of BPR.
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8 Furthermore, no relevant information about the current state of BPR in Slovenian
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10 companies does exist and in view of this we decided to perform a survey research with
11
12 the purpose of studying the characteristics of BPR. So the aim of this research was
13
14 three-fold:
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- 17 1. to explore the basic characteristics of BPR from literature,
- 18 2. to develop and validate a set of BPR variables, and
- 19 3. to assess the values of these variables among Slovenian companies.

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21 Furthermore, the constructed and validated variables can be helpful for further research
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23 aimed at investigating BPR and its linkages with other areas such as strategy,
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25 performance measurement, etc., according to the overall research framework described
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27 in the following.
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31 This article presents the current state of BPRs, by means of a survey research carried
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33 out in 73 medium and large sized Slovenian manufacturing companies.
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37 This article has been deployed over six sections. In addition to Section 1
38
39 (Introduction), Section 2 presents the main issues of BPR, based on a literature review
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41 and the research framework, with the contribution of previous survey research. Section
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43 3 describes the methodology used, including the sampling procedure. In Section 4, a set
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45 of variables is obtained for identifying the core dimensions of BPR, tested for reliability
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47 and validity, using respectively Cronbach's α and **Principal Components Analysis**
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49 **(PCA)** – 1st part of the results. In Section 5, the new variables are examined and
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51 commented using descriptive statistics (mean value and standard deviation) – 2nd part of
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4 the Results. Finally in Section 6 the conclusions of this study are presented, along with
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6 suggestions for future research.
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10 11 **2. Theoretical background and research framework** 12

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14 As the basis of competition changes from cost and quality to flexibility and
15
16 responsiveness, the value of process management is gradually being recognised. The
17
18 role that process management can play in creating sustainable competitive advantage is
19
20 termed Business Process Reengineering, and was first introduced by Hammer (1990),
21
22 and Davenport and Short (1990). These authors outlined a new approach to the
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24 management of processes, which, it was claimed, was producing radical improvements
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26 in performance.
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31 Different BPR stages can be considered: 'Process management can be applied at
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33 different levels of intensity, from a simple rationalisation of the work processes (Process
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35 Management in a strict sense) to their proper reengineering (Process Reengineering);
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37 business strategies may also be revolutionised (named Business Reengineering): in
38
39 these latter two cases, we witness what is commonly known as Business Process
40
41 Reengineering (BPR), although sometimes people do refer to BPR for *all* the cases
42
43 (Tonchia and Tramontano, 2004). In this paper, we refer to this extended concept of
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45 BPR i.e. ranging from process management in the stricter sense to wider business
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47 reengineering.
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54 *2.1. Definitions of BPR* 55

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57 Several authors have provided their own interpretation about the concept of BPR.
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59 For example, Davenport and Short (1990) have described BPR as the analysis and
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4 design of work flows and processes within, and between, organizations. Hammer and
5
6 Champy (1993) have promoted 'the fundamental rethinking and radical redesign of
7
8 business processes to achieve dramatic improvements in critical, contemporary
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10 measures of performance, such as cost, quality, service, and speed'.
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14 Short and Venkatraman (1992) exposed the customer point of view when defining
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16 BP redesign as the company's action to restructure internal operations by improving
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18 product distribution and delivery performance to the customer. For Johansson et al.
19
20 (1993), BPR is the means by which an organization can achieve radical change in
21
22 performance as measured by cost, cycle time, service, and quality, using the application
23
24 of a variety of tools and techniques that focus on the business, as a set of related
25
26 customer-oriented core businesses rather than a set of organizational functions.
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30 Even if the main BPR characteristic still remains in the radical nature of change,
31
32 some, such as Yung and Chan (2003), have proposed a slightly less radical approach,
33
34 named 'flexible BPR'.
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38 Other authors, such as Vantrappen (1992) or Talwar (1993), focused on the
39
40 rethinking, restructuring and streamlining of business structure, processes, work
41
42 methods, management systems and external relationships, through which value is
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44 created and delivered.
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48 Petrozzo and Stepper (1994), on the other hand, believed that BPR involves the
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50 concurrent redesign of processes, organizations, and their supporting information
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52 systems, to achieve radical improvement in time, cost, quality, and customers' regard
53
54 for the company's products and services. Loewenthal (1994) described the fundamental
55
56 rethinking and redesign of operating processes and organizational structure; the focus is
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4 on the organization's core competence to achieve dramatic improvements in
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6 organizational performance.
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9 Zairi (1997) discussed BPR, including continuous improvement and benchmarking,
10 within Business Process Management, which is a structured approach to analysing and
11 continually improving fundamental activities such as manufacturing, marketing,
12 communications and other major elements of a company's operation.
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18 BPR also has some similarities with TQM, regarding its process orientation,
19 customer-driven inspiration, and wide transversal nature (Schniederjans and Kim,
20 2003). They differ in the approach: evolutionary (continuous, incremental
21 improvement) process change in the case of TQM, and revolutionary (radical, step-
22 change improvement) process change in the case of BPR (Venkatraman, 1994; Slack et
23 al., 2001). Furthermore, Johnston et al. (2001) examined and discussed seven key
24 differences between continuous and radical process improvement, including process
25 changes, expected improvement, benefits attained (long/short term), change initiator,
26 senior management time/effort, business risk, capital expenditure and use of
27 informational technology.
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45 2.2. *Research framework*

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47 In regard to literature review, the concept of BPR should be studied in connection
48 with its logical supplementary areas: on one hand the manufacturing strategy, and on
49 the other hand the performance indicators.
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53 The need for a strategically-driven BPR approach has been perceived by numerous
54 authors (Zairi and Sinclair, 1995; Sarkis et al., 1997). Tinnilä (1995) ascertained that
55 BPR should start from strategies. The desired strategic position should be the starting
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4 point for redesign, rather than improvement in existing operations. Edwards and
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6 Peppard (1994 and 1998) proposed business reengineering as a natural linkage with the
7
8 strategy; they suggested that business reengineering can help bridge the gap between
9
10 strategy formulation and implementation. In this context, business process
11
12 reengineering is seen as an approach, which defines the business architecture, thus
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14 enabling the organization to focus more clearly on customers' requirements.
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19 We focused specifically on manufacturing strategy, as deriving from corporate
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21 strategy, having considered manufacturing companies in our survey; however several
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23 items about the overall strategy have been treated.
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27 Regarding performance measurement, although Hammer (1990) and Davenport and
28
29 Short (1990) in their earlier publications have already emphasized the importance of
30
31 performance measurement in BPR, the focus on measurements has greatly changed over
32
33 the last years, since the seminal work of Kaplan and Norton (1992). Kuwaiti and Kay
34
35 (2000) developed an instrument for measuring performance measurement in BPR, and
36
37 ascertained that a relevant Performance Measurement System (PMS) in the BPR context
38
39 is one taking into account people working in teams, and producing final output for a
40
41 client through internal customer-supplier ties (also see: Kuwaiti, 2004). De Toni and
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43 Tonchia (1996 and 2001) claimed that the pursuit of excellence and the organizational
44
45 change, required by lean production, lead to a management-by-process organization,
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47 and that management-by-process has consequences for the PMS.
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52 Figure 1 presents our overall research framework. Benchmarking has been added to
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54 the framework as a powerful tool for BPR and a trigger for many BPR projects
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56 (Richman and Koontz, 1993; Zairi and Leonard, 1994).
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4 Regarding this overall research framework, in this article only those results and
5 detailed analyses relating to the dimensions of BPR – for the sake of space – are
6 possible to present and justify. In a successive paper, the linkages between BPR (in
7 terms of the dimensions treated in this paper) and the other areas of the framework will
8 be investigated.
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Insert Figure 1 about here

2.3. *Previously performed survey research on BPR*

Deakins and Makgill (1997) conducted a review of BPR literature covering five years: the number of performed surveys researched is extremely low and presents no more than 3.3% of all BPR literature. Not only that, more than a half of the surveys focused on implementation and/or information technology, few survey researches studied human resource issues or strategic aspects of BPR, and even more surprising is the fact that there was not a single survey research performed on either benchmarking or performance measurement.

The lack of empirical study on BPR, covering a wide range of BPR issues, together with rigorous methodology, was confirmed successively by numerous authors (Motwani et al. 1998; O'Neil and Sohal, 1999), and in recent years by Al-Mashari et al. (2001) and Tennant and Wu (2005).

From the available surveys, we can mention the earlier studies of Hall et al. (1994) who defined three critical determinants for successful BPR projects: 1) breadth – whether the project is set up to improve performance across the whole business unit; 2) depth – the change to six fundamental organizational elements (namely: organizational

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4 structure, roles and responsibilities, measurements and incentives, information
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6 technology, shared values, and skills); 3) leadership – the extent of top management’s
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8 commitment.
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11 Maull et al. (1995) resulted from Hall’s idea when performing four in-depth BPR
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13 studies using the action research approach, aimed at identifying key issues underpinning
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15 a BPR programme; they identified six key issues of BPR: 1) scope of changes, 2)
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17 performance measure, 3) information technology, 4) the human factor, 5) business
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19 process architecture, and 6) strategy.
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23 Guimaraes and Bond (1996) identified six ‘major constructs’ in an organizational
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25 view of the BPR implementation process: process changes, goals & objectives planned,
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27 goals & objectives accomplished, implementation problems, derived benefits, and
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29 organization performance. In the same study, they classified the following success
30
31 factors for BPR implementation: external, employee empowerment, operational,
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33 communication, methods & tools, and leadership.
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36
37 Terziovski et al. (2003) presented six predictors for BPR: 1) strategy, 2)
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39 management commitment, 3) information technology, 4) customer focus, 5) continuous
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41 improvement, 6) and performance outcome.
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45 Maull et al. (2003) identified ten dimensions along which a BPR project might be
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47 measured within five themes: 1) taking a strategic approach, 2) integrating performance
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49 measurement, 3) creating a business process architecture, 4) involving human and
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51 organizational factors, and 5) identifying the role of information technology.
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55 As can already be seen, confusion exists about what exactly constitutes BPR and
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57 how it is perceived. So, based on a synthesis of literature and previously performed
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59 surveys, seven critical areas (without strategy, benchmarking and performance
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4 measurement, which are at the moment regarding as the accepted research framework)
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6 that must be practised to achieve effective process reengineering in a business unit were
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8 identified as follows:
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- 10 1. Top management commitment,
- 11 2. Education and training,
- 12 3. Team work,
- 13 4. Project of BPR,
- 14 5. Employee cooperation,
- 15 6. Information technology support,
- 16 7. Levers and results.

17
18 Henceforth, these seven areas will be referred to as critical success factors. While it is
19 certainly true that other sets of critical success factors could be developed or that
20 particular dimensions could be defined differently, this grouping appears to capture
21 most of the important aspects of effective BPR.
22

23 While the proposed factors are literature-based, they can be validated by empirical
24 research. The seven success factors, in terms of their constituent variables, emerging
25 from the survey, will be presented and discussed in Sections 4 and 5 (Results – Types of
26 variables and Descriptive statistics).
27

28 3. Methodology

29 The consequences of the change termed BPR can be perceived in companies all over
30 the world including Slovenian companies. An exploratory survey research methodology
31 was taken up when considering the presented problem. This performed research was the
32 first large-scale study carried out in Slovenia on this theme.
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5 The research was divided into three phases:

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7 i. a wide-ranging analysis was conducted, of the existent literature aimed at
8 determining the major dimensions of BPR;
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11 ii. a questionnaire was designed, in order to investigate the real BPR, pre-tested on
12 experts and pilot-firms (as suggested by Dillman, 1978), and later sent by post to
13 the General and Plant/Production Managers responsible or participating in the
14 BPR project. This questionnaire contained 56 items, designed according to the
15 Likert scales; the names of these items are reported as an Annex;
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27 iii. the resulting data was subjected to reliability and validity analyses, and then
28 analysed using uni- and multi-variate statistical techniques.

28 The research was carried out in 179 Slovenian companies within the mechanical
29 industry, and 90 Slovenian companies within the electro-mechanical and electronic
30 industries. The sample was selected on a geographical basis, in order to have a sufficient
31 and statistically relevant number of firms to analyse, while the choice of mechanical,
32 electro-mechanical and electronic industries was motivated because these are the main
33 industries in Slovenia and many other countries.
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42 Slovenia is small country with two-million inhabitants in the very heart of Central
43 Europe. It is ranked among the successful small European countries, which joined the
44 European Union on 1st May 2004.
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49 **Within** the industry sector, the most important are mechanical and electro-
50 mechanical/electronic with more than 2,500 companies, which employ approximately
51 80,000 people. The bulk of the workforce in the mechanical sector is employed in
52 metalworking, but in terms of value-added per employee, the most successful are the
53 companies specialising in car component manufacture and assembly; these
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manufacturers have been the integral part of international supply chains for quite a while.

Development and production of electronic components, electrical devices, equipment and systems are the most important areas within electrical engineering, with the following key products: electro-motors and machines, household appliances, telecommunication equipment, electronic measuring systems, medical and optical equipment, power distribution facilities and electrical components.

The main criterion for the choice of sample was then the company size (medium and large-sized), because the complexity of the BPR activities, proportional to the size of the business, favour – for the first investigation of the subject – medium to large sized companies, which we may expect to have implemented BPR projects in a more extensive way. According to the Slovenian Companies Act (Ur. L. RS nr. 30/1993), companies are divided into small, medium and large, according to the number of employees, respectively less than 50, from 50 to 249, from 250 onwards; and on revenue, respectively less than 0.83 million, from 0.83 to 3.34 million, from 3.34 million EUR onwards.

Our questionnaires were directed to firms having carried out BPR projects: we did explain in the accompanying letter that, if the company did not reach to identify some activities within the definition of BPR, it was invited to return the questionnaire incomplete.

The response rate was very good for the post-contact methodology (42.38% i.e. 114 firms responded on 269, and 62 firms declared to having adopted BPR or something similar i. e. 64.03% of the respondents and 27.14% of the original sample), all showing

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4 the firms' interest about BPR. The subsequent statistical analysis was, therefore, carried
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6 out on the results of 73 companies which returned the questionnaires correctly filled in.
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9 Of the 73 companies analysed, 53 belong to the mechanical and 20 to the electro-
10 mechanical/electronic industries, with average capital assets of 2.96 million EUR (with
11 a minimum value of 10,000 EUR and a maximum of 50.8 million EUR) and 339
12 employees as an average (with a minimum value of 54 and a maximum of 5,500
13 employees). Capital assets means the amount of permanent capital held by the
14 manufacturing companies as registered at the Court. It is the basic registered capital of
15 the company.
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26 The choices of industry type and firm size were motivated by having a statistically-
27 significant sample and not in order to conduct a discriminatory analysis among different
28 sectors or different company dimensions (which is typically made through the statistical
29 technique known as ANOVA – ANalysis Of Variance).
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35 As mentioned, we chose the mechanical and electro-mechanical/electronic
36 industries because these are the most important ones in Slovenia, and this fact could
37 assure a very random selection of useful sample sizes. Furthermore, the selection of
38 medium and large-sized companies only could lead to a full consideration of all the
39 aspects of BPR, in other words a more consistent sample.
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47 The sample selection criteria we adopted, together with the research items
48 investigated, assured we obtained a generic framework for our research. In other words,
49 the results can be considered generic and not related to a specific country, even if
50 successive research could explore eventual differences in the *application* of BPR among
51 different countries
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5 In the research measurement process, to indicate the degree or extent of each item's
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7 practice by their business unit, a five-point Likert scale (Rossi et al., 1983) was used,
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9 ranging from 'strongly disagree' to 'strongly agree'. If a variable is related to a complex
10
11 concept (Fowler, 1984), it is multi-item and its value corresponds to the mean value of
12
13 the scales. In determining the measurement properties of the constructs used in the
14
15 statistical analysis – that is, the multi-item variables – reliability and validity were
16
17 assessed (Dick and Hagerty, 1971), using respectively Cronbach's α and Principal
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19 Components Analysis (PCA).
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24 *Reliability* has two components (Flynn et al., 1990): stability (in time) and
25
26 equivalence (in terms of means and variances for the different measurements of the
27
28 same construct). The main instruments for reliability assessment are: the “test-retest
29
30 method” (for stability) and Cronbach's α (for equivalence) (Cronbach, 1951). We
31
32 concentrated on the second aspect, because these variables were being developed for the
33
34 first time. All the multi-item variables have a Cronbach's α of at least 0.793, well-
35
36 exceeding the value of 0.60, which is the recognized guideline for the development of
37
38 new variables, established by Nunnally and Bernstein (1994).
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43 *Validity* of a measure refers to the extent to which it measures what is intended to be
44
45 measured. Three different types of validity are generally considered: content validity,
46
47 criterion-related validity, and construct validity. Content validity cannot be determined
48
49 statistically, but only by experts and by referring to literature. Criterion validity regards
50
51 the predictive nature of the research instrument to obtain the objective outcome (e.g. the
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53 existence of a multi-performance PMS should be correlated with the availability of
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55 scores in several different performances). Construct validity measures whether a
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57 variable is an appropriate operational definition of the construct or not.
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5 In order to establish content validity, each item of the questionnaire was critically
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7 reviewed by five academics in operations management at the University of Maribor
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9 (Slovenia) and the University of Udine (Italy) and also by three general managers from
10
11 different manufacturing companies. Following the pre-tests of the items, 56 items
12
13 remained as appropriate for performing research (see Annex).
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15
16 Of the different properties that can be assessed from measurement, construct validity
17
18 is the most complex and yet the most critical to substantive theory testing. A
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20 measurement has construct validity if it measures the theoretical construct that it was
21
22 designed to measure. Construct validity can be established through the use of PCA. The
23
24 purpose of PCA (Pearson, 1901) is to derive, from a larger set of variables, a small
25
26 number of linear combinations (*principal components*) that retain as much of the
27
28 information in the original variables as possible. These linear combinations have
29
30 coefficients equal to the eigenvectors of the correlation (co-variance) matrix and the
31
32 eigenvectors are orthogonal. The principal components are sorted into descending order
33
34 of eigenvalues, which are equal to the variances in the new factors that were
35
36 successively extracted.
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42 PCA was carried out in order to uncover the underlying dimensions, eliminate
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44 problems of multicollinearity (in other words the distorting effects provoked by
45
46 variables inside a group, strongly correlated to each other – Belsley et al., 1980) and,
47
48 ultimately, reduced the number of variables to a limited number of orthogonal factors.
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52 Each multi-item variable was factor-analysed separately: for the items loaded on
53
54 more than one factor, the items responsible for the other factors beyond the first were
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56 eliminated (or considered in another variable) and Cronbach's α was re-calculated. The
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58 presented variables are all in their final version.
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4 A similar procedure was then adopted to group several variables in order to get a
5 more manageable set of variables, without surrendering too much information. Rotation
6 was applied to aid interpretation. Rotation is the application of linear transformation to
7 components: the commonest is *varimax rotation*, which maximises the variation of the
8 squared factor loadings for each component; factor loadings represent correlations
9 between the original variables and each factor (Dillon and Goldstein, 1984). Usually,
10 only the components (or factors) with eigenvalues greater than one are retained (Kaiser,
11 1958), because, together, they account for most of the overall variance.
12
13

14 Interpretation of the factor loadings matrix was carried out following a rule
15 according to which only loadings superior to 0.5 should be considered (except a few
16 cases in which a variable is transverse to several factors): imposing such a limit allows
17 the retaining of only those variables which contribute in a high degree to the formation
18 of a given factor, called according to the name of the variables with higher factor
19 loading.
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40 **4. Results I – Types of Variables**

41 An internal consistency – or reliability – analysis was performed separately, using
42 the SPSS programme package for the items of each critical dimension of BPR (Table I).
43 This table shows that the reliability coefficients – or Cronbach's α – ranged from 0.793
44 to 0.896. According to instructions (Nunnally and Bernstein, 1994), those measurements
45 for all critical factors of BPR are very reliable and there is no need for elimination of
46 the defined items (meant for improving the reliability of the measurement).
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59 Insert Table I about here
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7 In regard to all the initial values of critical dimensions fulfilling reliability
8 conditions, we continued with validity testing, starting with the eleven items relating to
9 top management commitment. A PCA was performed using varimax rotation. Three
10 factors were retained (as shown on Table II) for the following reasons. Firstly, all three
11 factors in the three factor solution generated an eigenvalue greater than 1.0 (Kaiser
12 Normalization). Due to the fact that the eigenvalues are the variances extracted by the
13 factors, this means, for example, that the five items of the 2nd factor ('acceptance of
14 responsibility', 'specificity of BPR goals', 'goals comprehensiveness', 'BPR goals and
15 policy understanding', and 'importance in relation to costs and objectives') have the
16 same behaviour in terms of variance.
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30 The rotated factor pattern for the three-factor solution was evident for the most part.
31 The loading on each core dimension for top management commitment was over 0.50,
32 and all other factor loadings were below 0.50 with the exception of the degree of
33 support to BPR. At the end, all the factors, or new variables, were checked for
34 reliability again, with all re-calculated Cronbach α greater than 0.716, thus improving
35 the reliability criteria.
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44 We termed the first variable 'Identification of top managers with BPR goals', the
45 second variable 'Identification and goal setting for BPR', and the third variable 'BPR
46 understanding'.
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Insert Table II about here

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Table III shows the results of PCA with varimax rotation performed for education and training. The two factor solution was generated with eigenvalue greater than 1.0. It explained almost 69% of the variance (= 56.3% + 12.6%), while subsequent solutions added little marginally to the cumulative variance explained. The rotated factor pattern was very evident for the most part, except training about team building, but it is still obvious that the item training about team building exhibited much higher loading on the second factor than on the first.

The first factor (which is the new variable) consists of training about the importance and role of BPR, about the benefits of BPR, the role of cooperation, the commitment to employee training, and resource availability for training. The second factor consists of similar topics except that the education and training is meant for managers: training about team building, about the importance of BPR, BPR benefits, and the role of cooperation.

Insert Table III about here

A PCA was performed without rotation (because rotation matrix could not be performed in the presence of only one factor) using the performance ratings on the six items related to team work. The one factor solution (shown in Table IV) is very evident, with the eigenvalue greater than 1.0, explaining more than 50% of the variance.

Insert Table IV about here

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4 Table V shows the results of PCA corroborated by varimax rotation, performed on
5 the eleven items relating to the BPR project. The three-factor solution was generated
6 with eigenvalue greater than 1.0, explaining more than 50% of the variance. The rotated
7 factor pattern was very evident for the most part, except the integrity of the present
8 state review, which indicates much higher loading on the second factor than on the first
9 and third. Also, agreement with the organizational redesign (with factor loading
10 0.546) shows a much higher loading on the second factor than on the first and third.
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21 So, the first variable represents the need for organizational changes, the second
22 variable regards the value of BPR implementation, the third variable concerns a strong
23 process orientation.
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31 Insert Table V about here
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35 One factor solution was extracted using PCA for the two successive BPR
36 dimensions, employee cooperation and information technology support. Both solutions
37 are very significant with very high factor loadings explaining more than 70% of the
38 variance (for employee cooperation – Table VI) and almost 70% (for IT support – Table
39 VII).
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51 Insert Table VI about here
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56 Insert Table VII about here
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Based on the performance ratings of the ten items relating to the levers/results, the PCA assisted by varimax rotation, extracted two factors (Table VIII). Both factors in the two-factor solution generated an eigenvalue greater than 1.0. The rotated factor pattern for the two-factor solution is evident for the most part. The items 'use of experiences from the previous BPR', 'analysis of customer demands', and 'use of flow diagrams' have lower factor loadings, but still higher than 0.50. The items 'use of experiences from the previous BPR', and 'use of flow diagrams' exhibit much higher loading on the first factor than on the second one, which is not as evident for the item 'analysis of customer demands'.

We named 'Tools and techniques' the first factor (or new variable), and 'Result orientation' the second one.

Insert Table VIII about here

5. Results II – Descriptive Statistics

Table IX contains all the new variables regarding BPR, explained by:

- the mean value of each variable,
- the standard deviation, and
- the coefficient of variation (CV), defined as the ratio between standard deviation and the mean values of each variable.

As shown in Table IX, in the 'Mean' column, the process orientation and identification of the top managers with the BPR goals were identified as the two most important variables for BPR implementation. This ascertainment also confirms very low CV (16.5% for identification of top managers with BPR goals and 17.3% for process

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4 orientation), explaining that managers responsible or participating in the BPR project
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6 share unique opinions about the importance of the two before mentioned variables.
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12 Insert Table IX about here
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15 16 5.1. *Top management commitment* 17

18 There is a debate in management literature as to whether proactive leadership does
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20 or does not make a difference to the success of a business (Berkley Thomas, 1993). In
21
22 the literature on BPR, however, there appears to be a strong belief that proactive
23
24 leadership and organizational success are correlated. Supporters of BPR contend that
25
26 leadership and organizational success are correlated. Supporters of BPR contend that
27
28 top managers must be fully committed to and involved in BPR for it to succeed. Hall et
29
30 al. (1994) suggest that top managers must act as consensus seekers and role models for
31
32 employees. In contrast, Hammer and Champy (1993) argue that, at least in the initial
33
34 stages of BPR implementation, top management must adopt an autocratic and
35
36 aggressive style of leadership in line with the unpopular decisions that have to be made.
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40 Three variables were designed from a set of items relating to top management
41
42 commitment. Based on the results, presented in Table IX, they can be listed in
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44 descending rank order as follows, but all with high values: identification of top
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46 managers with BPR goals, identification and goal setting for BPR, and BPR
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48 understanding.
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51 52 53 5.2. *Education and training* 54

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56 It is often tempting to think of BPR as merely a rethinking of the way work
57
58 processes are performed by machines, and ignore the fact that work is performed by
59
60 people too. Thus, changing work processes requires an assessment of the impact these

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4 changes will have on people, and the implementation of a training plan to overcome the
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6 impact.
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9 Dutta and Manzoni (1998) have presented an interesting series of pedagogical case
10 studies on the implementation of BPR, revealing – on the one hand – the indispensable
11 need for these interventions, and – on the other – the risk of frustration, mainly resulting
12 from two causes: a limited emphasis and integration of the human factor in the
13 interventions ('the human side of BPR', or the 'the soft side of BPR' – Marjanovic,
14 2000); the need to consider BPR as an effort with a greater strategic outcome than is
15 usually believed. In fact, 'a disciplined, step-by-step approach to implenting process
16 redesign is critical' (Attaran, 2000).
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28 In regard to the survey research results, respondents are very well aware of the
29 importance of education and training, which also includes top managers' education.
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34 5.3. *Team work*

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36 Work within the processes is organized in teams, into which different specialized
37 competences flow, and the sense of belonging to a team is enhanced, since teams are
38 encouraged by the management to make decisions regarding the process itself.
39 Moreover, the objectives of the team act as integrating mechanisms: team working
40 creates a fertile ground for learning and adapting continuously to external stimuli
41 (Youkl, 1981); efficient team work has been shown to be a key element for improving
42 business process performance (Telleria et al., 2002).
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53 Table IX shows that respondents estimated team work as very important, team work
54 defined in the sense of collaboration with the top managers, support given to the team
55 members, autonomy of the team, independence from the department boundaries and
56 team effectiveness (Table IV).
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5.4. *Project of BPR*

We decided to closely examine those factors critical for BPR success because the majority of debate on BPR programmes revolves around their success or failure, thus showing that the success of a BPR project is not completely assured. Holland and Kumar (1995) noted that 60-80% of BPR initiatives have been unsuccessful, similarly Laudon and Laudon (1998) reported a failure rate of 70 percent.

The essence of BPR is an objective overview of the processes to be redesigned. Whereas information needs to be obtained from the people directly involved in these processes, it is never initiated by them. Even at its lowest level, BPR has a top-down approach (Hammer and Champy, 1993). Therefore, most BPR efforts take the form of a project (Earl and Kahn, 1994). There are numerous methodologies being proposed but all share common elements. Typically, the project takes the form of several discrete phases (Carr and Johansson, 1995).

Respondents were asked to indicate the level of importance of the stated statements relating to the BPR project. According to the mean value, shown in Table IX, the characteristic of process orientation (considering concentration on the key business processes, new processes design according to the customer demands, new processes' design with shorter production time and new processes' design for quality improvement – Table V) was selected as the most important value for the BPR project.

Following the results shown in the same Table IX, BPR implementation can be exposed as another important variable. BPR implementation value was presented by the integrity of the present state review, benefits consideration brought about present state processes, coordination of processes performances, and agreement with organizational redesign (Table V).

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4 The third variable (need for organizational changes) was named considering that the
5 introduction of IT is insufficient, that IT should be incorporated only where necessary,
6
7 and efficiency can be pursued not only by automation (1st factor in Table V).
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13 14 5.5. *Employee cooperation*

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16 Supporters of BPR argue that reengineering results in employees being given more
17 responsibilities in their jobs, such as in problem solving and quality checks (Hayes,
18 1994). Hammer and Champy (1993) wrote: 'people who once did as they were
19 instructed, now make choices and decisions on their own'. Empowerment is not seen as
20 a mere residue of reengineering but as an essential condition for its success. Critics,
21 however, challenge these optimistic views on empowerment'.
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30 According to the mean value in our research, shown in Table IX, respondents
31 evaluated employee cooperation as fundamental, but according to the CV this finding
32 cannot be considered as very reliable. High CV (> 20%) means that the opinions of
33 managers from different companies are dissimilar (heterogeneous).
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42 5.6. *Information technology support*

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44 The common theme running through reengineered or breakthrough improvements is
45 technology, in particular Information Technology (IT). IT represents an all-
46 encompassing term for computer workstations linked to computer networks, open
47 systems, client-server architecture, database groupware, electronic commerce, etc.
48 Together they have opened up possibilities for the integrated automation of preceding
49 manual, paper-based business processes (Beates, 1993; Petrozzo and Stepper, 1994;
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4 Wells, 2000), enabling further cost reductions and the rapid growth of new industry
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6 (Venkatraman, 1994).
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9 Process reengineering in a company is a prerequisite for the introduction of
10 advanced information systems (Attaran, 2003). The role of IT as the 'natural partner of
11 processes is linked to the fact that process logics, by concentrating on the transversal
12 interdependencies between activities, focuses on information flows and information
13 elaboration procedures, thus supplying two fundamental elements to create an effective
14 information system' (Davenport and Short, 1990).
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23 Information technology contribution for BPR in terms of IT support to processes
24 performing (Chan, 2000), data availability enabled by IT (Bhatt, 2000), up-to-date data
25 enabled by IT, use of data for achieving goals from strategy (Table VII) was identified
26 as important by respondents (mean value of 3.98 – Table IX).
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34 35 5.7. *Levers and results* 36

37 The various definitions of BPR suggest that the radical improvement of processes is
38 its goal. They do not, however, refer specifically to the tools and techniques used in
39 reengineering business processes. The consequence of this void is that authors and
40 consultants alike have pursued the use of many different tools in search for the best
41 reengineering practices (Belmiro et al., 2000).
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49 In summary, BPR can be seen as a range of tools and techniques (in terms of levers)
50 concerned with the improvement of processes as the result. The most important levers
51 of BPR are: analysis of customer demands, Quality Function Deployment (QFD), flow
52 synchronization, use of flow diagrams, continuous improvement methods (Kallio et al.,
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59 1999).
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5 Representation techniques exist that define both syntax and semantics for process
6 management. The most widely used are (Tonchia and Tramontano, 2004): flowcharts,
7 IDEF-0 (according to the IDEF-0 technique, a process is regarded as a set of activities
8 transforming inputs into outputs, consuming resources and subjected to constraints and
9 controls), Data Flow Diagram (DFD), Role Activity Diagram (RAD), action workflow.
10 A complete list of instruments can be found on: <http://ccs.mit.edu/ph/> – the MIT Process
11 Handbook Project.
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21 Process representation tools are only the first step in BPR implementation: the
22 chance of a successful BPR implementation lies in more advanced instruments, strictly
23 linked to the information system and employees' involvement. For example, the
24 implementation of these techniques is nowadays supported by specific software
25 programmes for process management, such as ARIS (Scheer et al., 2003), Sciforma
26 Process, Process Guide, Workbench, Pro Vision, etc.
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35 Two variables were designed through our survey from a set of items relating to the
36 levers/results effect: result orientation, and tools and techniques. Result orientation was
37 exposed as very important (Table IX) as should be expected because of the strong
38 customer orientation perceived in the companies; tools and techniques, instead, seem to
39 be less important, but with one of the highest CV (Table IX) in our research: probably
40 the variety of instruments can lead to different results and so to different perceptions of
41 their importance.
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53 **6. Conclusions**

54 The starting point of the presented survey research was finding out that the majority
55 of BPR literature is based on case studies and that there is a deficiency of wide-ranging
56 empirical research on BPR. A literature review indicated that there was some survey
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4 research performed in the past, but their results focus on different points of view and
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6 are, as such, hardly comparable.
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9 The contribution of this article is the development and validation of new variables
10 when addressed to BPR, using data collected from companies that have experienced
11 radical changes through BPR efforts. The new variables are shown to be reliable and
12 valid. The presented approach is generic and the survey research results can be
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20 generalized elsewhere.

21 The BPR dimensions discovered through this research are the following (in
22 descending order of importance, measured by the mean value of the relatively
23 constructed variable):
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- 28 1. Strong process orientation,
- 29 2. Identification of top managers with BPR goals,
- 30 3. Identification and goal setting for BPR,
- 31 4. Top managers education,
- 32 5. Value of BPR implementation,
- 33 6. Result orientation,
- 34 7. Team work,
- 35 8. BPR understanding,
- 36 9. IT support,
- 37 10. Need for organizational changes,
- 38 11. Employee education, training and resource availability,
- 39 12. Tools and techniques,
- 40 13. Employee cooperation.
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4 In terms of deviation from one respondent to another, the first five variables have the
5
6 lowest coefficient of variations (CV); the last three variables have, vice versa, the
7
8 highest CV values. This means that at least the first 6-10 dimensions for BPR should
9
10 always be considered, planned and evaluated, both for their importance and their wide
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12 recognition.
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16 Thanks to these discovered dimensions for BPR, the next stage in the research will
17
18 concern the relationships between BPR variables and variables regarding manufacturing
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20 strategy, benchmarking, and performance measurement (with particular emphasis on
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22 employee empowerment and integration), as depicted in the overall framework of
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24 Figure 1.
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Annex**BUSINESS PROCESS REENGINEERING (BPR)**

Please evaluate the importance of the following domains (represented by the statements) when performing BPR in your Company (1 = very low; 2 = low; 3 = medium; 4 = high; 5 = very high).

1. Top management commitment

1. Extent to which the top executive (responsible for company profit or loss) assumes responsibility for changes.
2. Acceptance of responsibility for changes that announce greater profit, lower costs, greater quality etc. by department heads within the company.
3. Degree to which top management (top executives and department heads) support processes improvement.
4. Degree of participation by department heads in the reengineering process.
5. Level to which top management identifies with the reengineering goals.
6. Specificity of reengineering goals within the company.
7. Comprehensiveness of the goal – setting processes within the company.
8. Extent to which reengineering goals and policy are understood within the company.
9. Importance attached to reengineering by the company's top management in relation to cost and schedule objectives.
10. Attention to reengineering results at company top management meetings.
11. Degree of understanding BPR within the company.

2. Education and training

12. Training of all employees in the company about the importance and role of BPR.
13. Training of all employees in the company about the benefits that BPR can bring.
14. Training of all employees in the company about the role of cooperation and preparedness for changes.
15. Team building and group dynamics training for all employees in the company.
16. Top managers training about the importance and role of BPR.
17. Top managers training about the benefits that BPR can bring.
18. Top managers training about the role of cooperation and preparedness for changes.
19. Commitment of the company's top management to employee training.
20. Availability of resources for employee training in the company.

3. Team work

21. Cooperation of team members with the top management.
22. Support to the team for reengineering by the top management.
23. Autonomy of the team, responsible for the performance of reengineering.
24. Incorporation BPR professionals and consultants.
25. Extent of adjustment between several departments, so that business processes can run according to logical performance sequences, independent of the department boundaries.

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26. Team effectiveness by BPR performance.

4. Project of BPR

27. Integrity of the present state process review.

28. Concentration on the key business processes for the operation of the company (making an offer, new product development, etc.).

29. Propositions for new process design, according to customer demands.

30. Propositions for new process design meant for shortening production time.

31. Propositions for new process design meant for quality improvement.

32. Benefit consideration, brought by present state process operations, when designing new processes.

33. Co-ordination of process performance between several departments.

34. Realization that IT enables easier and better performance but the introduction of IT is not the solution as yet.

35. Incorporation of IT support in the workplaces and the extent of demand by the process.

36. Cost reduction and shortening response times using automation.

37. Agreement with organizational redesign if necessary.

5. Employee cooperation

38. Degree of employee incorporation when decision making about BPR.

39. Level to which in-company education, about the need for changes, is built.

40. Level to which employee contribution to better process operating is recognized.

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41. Extent to which the benefits of BPR are exposed within the company.

6. Information technology support

42. Cost availability for advanced information support to the processes.

43. Level of IT support to process performance inside the company.

44. Data availability, enabled by IT, on the single workplace.

45. Up-to-date data enabled by IT.

46. Extent to which data, enabled by IT, are used for the assessment of goals achievement and set up of business strategy (higher quality, shorter delivery times, lower costs, greater flexibility, etc.).

7. Lever and results

47. Efficient use of experience from the previous successfully derived process reengineering.

48. Analysis of customer demands.

49. Quality function deployment.

50. Meetings planning between project manager and all levels of the project structure.

51. Flow synchronization.

52. Use of flow diagrams to represent process activities.

53. Focusing on a few key business processes.

54. Focusing on the whole product, not on a single task.

55. Request for continuous improvement.

56. Integrated computer-aided engineering.

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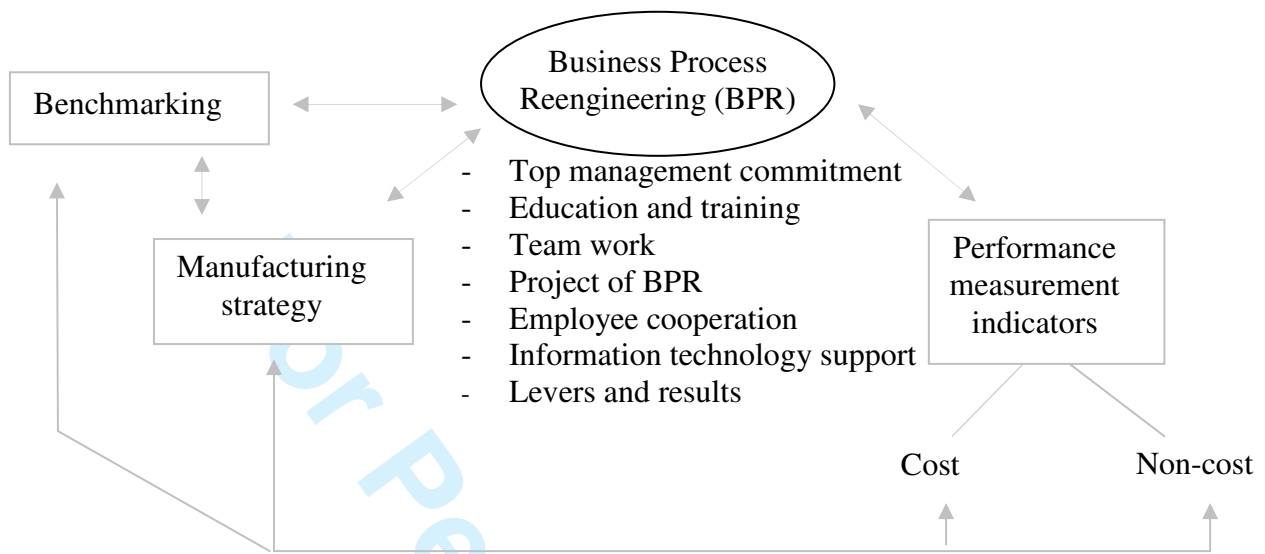
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27 Figure 1: Overall research framework

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<i>Critical dimensions of BPR</i>	<i>Original item numbers</i>	<i>Final number of items</i>	<i>Cronbach α</i>
Top management commitment	1-11	11	0.849
Education and training	12-20	9	0.896
Team work	21-26	6	0.793
Project of BPR	27-37	11	0.830
Employee cooperation	38-41	4	0.863
Information technology support	42-46	5	0.881
Levers and results	47-56	10	0.869

Table I: Internal consistency – or reliability – analysis results for the critical dimensions of Business Process Reengineering (BPR)

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<i>Items on top management commitment</i>	<i>1st factor</i>	<i>2nd factor</i>	<i>3rd factor</i>
Assuming responsibility by the top executives	0.783	0.273	- 0.007
Acceptance of responsibility	0.229	0.596	0.140
Degree of support to BPR	0.436	0.058	0.482
Degree of participation in BPR	0.758	0.028	0.303
Identification with BPR goals	0.656	0.307	0.352
Specificity of BPR goals	0.357	0.677	0.010
Goals comprehensiveness	- 0.144	0.766	0.270
BPR goals and policy understanding	0.441	0.562	0.241
Importance in relation to costs and objectives	0.172	0.517	0.460
Attention to BPR results	0.121	0.204	0.833
Degree of understanding BPR	0.195	0.230	0.790
<i>Eigenvalue</i>	4.493	1.152	1.021
<i>Proportion of variance explained (%)</i>	40.84	10.47	9.28
<i>Cumulative variance explained (%)</i>	40.84	51.32	60.60
<i>Re-calculated Cronbach α</i>	0.754	0.740	0.716
Name given to the new variable:	Identification of top managers with BPR goals	Identification and goal setting for BPR	BPR understanding

Table II: Top management commitment: three-factor solution with varimax rotation

<i>Items on education and training</i>	<i>1st factor</i>	<i>2nd factor</i>
Training about importance and role of BPR	0.779	0.405
Training about benefits of BPR	0.760	0.331
Training about role of cooperation	0.768	0.256
Training about team building	0.425	0.537
Managers training about importance of BPR	0.222	0.879
Managers training about BPR benefits	0.314	0.841
Managers training about role of cooperation	0.251	0.842
Commitment to employee training	0.830	0.182
Resources availability for training	0.674	0.207
<i>Eigenvalue</i>	5.065	1.136
<i>Proportion of variance explained (%)</i>	56.27	12.62
<i>Cumulative variance explained (%)</i>	56.27	68.90
<i>Re-calculated Cronbach α</i>	0.870	0.839
Name given to the new variable	Employee education, training and resource availability	Top managers education

Table III: Education and training: two-factor solution with varimax rotation

<i>Items on team work</i>	<i>1st factor</i>
Collaboration of the team members with top managers	0.765
Support to the BPR team	0.775
Autonomy of the team	0.719
Incorporation of BPR professionals and consultants	0.578
Independance of BPR from the department boundaries	0.674
Team effectiveness by BPR	0.733
<i>Eigenvalue</i>	3.028
<i>Proportion of variance explained (%)</i>	50.47
<i>Cumulative variance explained (%)</i>	50.47
<i>Re-calculated Cronbach α</i>	0.793
Name given to the new variable	Team work

Table IV: Team work: one-factor solution

<i>Items on the BPR project</i>	<i>1st factor</i>	<i>2nd factor</i>	<i>3rd factor</i>
Integrity of the present state review	0.209	0.504	0.136
Concentration on the key business processes	0.396	-0.077	0.596
New processes according to the customers demands	-0.067	0.484	0.617
New processes with shorter production time	0.056	0.417	0.712
New processes for quality improvement	0.143	0.097	0.815
Benefits consideration, brought by present state processes	0.030	0.753	0.174
Coordination of processes performance	0.423	0.738	0.009
Introducing IT is not sufficient	0.766	0.268	0.048
IT incorporation only where necessary	0.836	0.070	0.167
Efficiency not only with automation	0.686	0.290	0.119
Agreement with the organization redesign	0.389	0.546	0.209
<i>Eigenvalue</i>	4.107	1.448	1.053
<i>Proportion of variance explained (%)</i>	37.34	13.16	9.57
<i>Cumulative variance explained (%)</i>	37.34	50.50	60.08
<i>Re-calculated Cronbach α</i>	0.746	0.694	0.720
Name given to the new variable	Need of organizational changes	Value of BPR implementation	Strong process orientation

Table V: Project of BPR: three-factor solution with varimax rotation

<i>Items on the employee cooperation</i>	<i>1st factor</i>
Incorporation at decision making	0.805
Senses about need for changes	0.863
Recognition of the employee contribution	0.844
Exposing of BPR benefits	0.868
<i>Eigenvalue</i>	2.859
<i>Proportion of variance explained (%)</i>	71.46
<i>Cumulative variance explained (%)</i>	71.46
<i>Re-calculated Cronbach α</i>	0.863
Name given to the new variable	Employee cooperation

Table VI: Employee cooperation: one-factor solution

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<i>Items on information technology support</i>	<i>1st factor</i>
Cost availability for IT	0.696
IT support to processes performing	0.863
Data availability enabled by IT	0.859
Up-to-date data enabled by IT	0.881
Use of data for achieving goals from strategy	0.813
<i>Eigenvalue</i>	3.404
<i>Proportion of variance explained (%)</i>	68.08
<i>Cumulative variance explained (%)</i>	68.08
<i>Re-calculated Cronbach α</i>	0.881
Name given to the new variable	IT support

Table VII: Information technology support: one-factor solution

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<i>Items on levers and results</i>	<i>1st factor</i>	<i>2nd factor</i>
Use of experiences from the previous BPR	0.564	0.476
Analysis of customer demands	0.575	0.548
Quality Function Deployment (QFD)	0.767	- 0.030
Project management	0.697	0.209
Flow synchronization	0.606	0.408
Use of flow diagrams	0.561	0.500
Focusing on key processes	0.205	0.714
Focusing on product	- 0.026	0.842
Continuous improvement	0.810	0.138
Integrated Computer-Aided Engineering (CAE)	0.766	0.210
<i>Eigenvalue</i>	4.756	1.200
<i>Proportion of variance explained (%)</i>	47.56	12.00
<i>Cumulative variance explained (%)</i>	47.56	59.56
<i>Re-calculated Cronbach α</i>	0.8750	0.6311
Name given to the new variable	Tools and techniques	Result orientation

Table VIII: Levers and results: two factor solution with varimax rotation

<i>Variables</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>CV [%]</i>
Top management commitment			
Identification of top managers with BPR goals	4.22	0.696	16.5
Identification and goal setting for BPR	4.14	0.805	19.4
BPR understanding	3.99	0.895	22.4
Education and training			
Top managers education	4.12	0.815	19.8
Employee education, training and resource availability	3.86	1.034	26.8
Team work			
Team work	4.04	0.845	20.9
Project of BPR			
Strong process orientation	4.34	0.749	17.3
Value of BPR implementation	4.12	0.821	19.9
Need of organizational changes	3.97	0.891	22.4
Employee cooperation			
Employee cooperation	3.60	1.036	28.8
Information technology support			
IT support	3.98	0.909	22.9
Levers and results			
Result orientation	4.08	0.926	22.7
Tools and techniques	3.82	0.936	24.5

Table IX: Review of the BPR variables with descriptive statistics