The development of measures of process harmonization

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Published: 01/01/2013

Document Version
Publisher’s PDF, also known as Version of Record (includes final page, issue and volume numbers)

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Download date: 27. Oct. 2017
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Heidi L. Romero, Remco M. Dijkman, Paul W.P.J. Grefen, Arjan van Weele

Beta Working Paper series 415

<table>
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<th>BETA publicatie</th>
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<td>NUR</td>
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<td>Eindhoven</td>
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The development of measures of process harmonization

Heidi L. Romero, Remco M. Dijkman, Paul W.P.J. Grefen , Arjan van Weele
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Abstract
Recent years have witnessed a marked increase in interest by researchers and practitioners in the concept of process harmonization. However, they fail to present performance measures to evaluate the extent of process harmonization achieved after implementing harmonization initiatives. At a process level, measures provide information to control and manage processes in order to improve them. Given the importance of process harmonization in process improvement as has been attributed in the literature, there is a need of measures to evaluate to what extent processes are harmonized (i.e. to what extent differences and inconsistencies are eliminated). The aim of this study is to develop and validate a set of operational measures to evaluate the level of harmonization of business processes in an organization.

The research approach was composed of two phases: First, an exploratory phase to derive a measurement model composed by a set of measures of process harmonization; and second, a confirmatory phase to empirically assess the measurement model derived. As a result, a valid and reliable hierarchical measurement model was developed composed by a second order formative construct “process harmonization” and three first order reflective constructs: representing data, resources and IT-related measures.

Keywords: harmonization, business process, hierarchical measurement model, partial least squares
1. Introduction
Interest in process harmonization by researchers and practitioners has increased in the last years (Ricken and Steinhorst, 2005; Fernandez and Bhat, 2009). Process harmonization is the process of designing and implementing business process standards across different regions or units, so as to facilitate achieving the targeted business benefits arising out of standardization, whilst ensuring a harmonious acceptance of the new processes by the different stakeholders (Fernandez and Bhat 2010, p.368). This interest has been expressed in theoretical efforts: (1) by researchers explaining the concept, and (2) by practitioners describing methodologies to harmonize business processes. However, they fail to identify performance measures to evaluate the extent of the of process harmonization achieved after implementing harmonization initiatives, and its further link with the improvements achieved as results of harmonization efforts.

Performance measurement is of critical importance for organizational management (Dess and Robinson, 2006). At a process level, measurements provide information to control and manage processes in order to improve them. “Unmeasured and unchallenged performance does not improve” Ebert (2005). Given the importance of process harmonization in process improvement as has been attributed in the literature (Foster and Herndon 1997, Hammer 1990, Stein 1999), there is a need for measures to evaluate to what extent processes are harmonized (i.e. to what extent differences and inconsistencies are eliminated).

Therefore, the aim of this study is to develop and validate a set of operational measures to evaluate the level of harmonization of business processes in an organization. This set of operational measures can be useful for two main reasons: First, researchers can use them to develop normative theory based upon empirical investigation on process harmonization; and second, practitioners can have a mechanism for relating process performance in terms of the level of harmonization, to specific actions at an organization. For instance, if a company that produces electronic devices offers support after sale for the products. Imagine that the general management decides to change from having one centralized personnel in customer service, to outsource this process to call centers distributed in different locations around the world. If the after sales support is critical for this type of products and the company has experience a significant drop in sales, it is possible to evaluate the level of harmonization of this process within the different locations and link these measures with specific actions to be taken. Measures provide direction of which aspects of the process harmonization can be improved.

The main research question to be addressed by this study is: What measures can be used to evaluate the level of harmonization of business processes in an organization? An integral approach for construct measures and validation procedures has been followed to achieve the goal of this study. It is based on the approaches proposed by Churchill’s (1979) and MacKenzie et al. (2011). It is divided in two phases: an exploratory phase and a confirmatory phase. This approach uses different methods for data collection, including literature review, interviews with experts, workshops and an online survey, to gather different views of the concept.

The remainder of this document is organized as follows: First, the paper presents an overview of the methodology followed to conduct this study, including a detailed description of each step. This is followed by an explanation of the exploratory phase and the confirmatory phase. For both phases, the description of each step is divided in three parts: the unit of analysis, procedure, and results. Conclusions, limitations and future directions are then discussed in the last section.
Research method
A number of rationales have been brought forward to explain different decisions involved in the operationalization of constructs in strategic management research. The current study adopts an integral approach, based on the procedures proposed by Churchill’s (1979) and Mackenzie et al (2011). The process is depicted in Figure 1 and is divided in two phases, an exploratory phase and a confirmatory phase.

The goal of the exploratory phase is to build a model for measuring the level of harmonization of a business process. In this phase three steps were defined. In Step 1, concepts which are used to describe “process harmonization” in the literature are identified. The domain of the construct under study “process harmonization” is specified in step 2, by defining aspects of the construct that must be considered for further measurement. Based on this delineation, measures of the concepts selected in the previous step are identified and classified. The classification is based on the type of aspects of the business process that they measure, such as resources involved in the process or data. This second step provides two main outcomes: first, a list of the main aspects of the construct under study; and second, a measurement model of process standardization which is used to further validate the measurement model developed with our approach. The third step of the exploratory phase consists of deriving measures for each aspect of process harmonization. A measurement model is built using the measures derived, to be assessed in the confirmatory phase.

In the confirmatory phase, a sample of measures of process harmonization is empirically assessed. In Step 4, a set of data is collected using an online survey. In step 5, factor analysis is used to evaluate the number of dimensions that represent the measures previously derived. A revised measurement model is built, modifying the number of dimensions and indicators included in the original model. The validity and reliability of the measurement model are evaluated in step 6.

![Figure 1 - Procedure for developing measures of process harmonization](image-url)
Exploratory Phase
An understanding of the concept of process harmonization is required to derive measures. In the exploratory phase, the meaning of this construct is analyzed. The main goal is to derive a measurement model, including different aspects and a list of measures of process harmonization.

**Step 1: Identifying related concepts**
This step consists of searching in the literature to identify concepts related to process harmonization, to better understand the construct under study and define its domain. “It is imperative, though that, researchers consult the literature when conceptualizing constructs and specifying domains” (Churchill, 1979, p.67).

**Unit of analysis**
The unit of analysis in the first step was a selection of conference papers, journal papers, managerial papers, thesis reports and company reports, which analyze the concept of “process harmonization”. The search engines used include Google Scholar, ABI/INFORM, EMERALD and SPRINGER. A literature review was conducted following a research protocol based on the protocol proposed by Vanwersch et al (2011), to illustrate the decisions made during the process. It helped to identify how the construct has been used in prior research and how it differs from other related constructs.

**Procedure for step 1**
A literature review was conducted to broaden the knowledge base in the research area of process harmonization, which is very fragmented and previous contributions have not been contextualized (Kumar 2010, p.30). An iterative process was followed, which includes four steps: search, select, classify and analyze. An iterative process was chosen because this is an exploratory research in which we do not know in advance how extensive the available literature is. The search step involves: (1) a pre-search, using Google Scholar as a search engine, to identify how extensive the literature on this topic is and to determine the keywords to be used for the search; (2) a systematic search, using the keywords that were identified in the pre-search step and three search engines: ABI/INFORMS, EMERALD and SPRINGER; and (3) a cross-reference search, using a backward tracing technique, looking at the references of articles collected during the systematic search. The type of documents chosen in this phase include: conference papers, journal papers, managerial papers, thesis reports and company reports.

A next step was the selection process which consisted of the evaluation of all the articles selected, using two different criteria: relevance and quality. The relevance criterion helps us to evaluate if the article contributes to achieve the goals of this study, while with the quality criterion helps to assess the quality of the sources. Documents collected were analyzed looking at phrases or words in the text to capture the contextual meaning of the concept as suggested in Strauss and Corbin (1998). Concepts used to describe process harmonization were highlighted and linked to each document. Table 1 shows a concept matrix suggested in Webster and Watson (2002), which was used to summarize the findings and to identify which are the concepts mostly associated with process harmonization.

**Results of step 1**
The analysis of the literature found ten different concepts related to process harmonization in the 33 articles selected. Table 1 shows a summary of the findings. It includes the list of articles selected and concepts identified to describe process harmonization. The concepts found include: standardization, adaptation, integration, alignment, collaboration, centralization, modularization, coordination, homogenization and customization.
<table>
<thead>
<tr>
<th>No.</th>
<th>Article</th>
<th>Standardization</th>
<th>Adaptation</th>
<th>Integration</th>
<th>Alignment</th>
<th>Collaboration</th>
<th>Centralization</th>
<th>Modularization</th>
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<td>2</td>
<td>Hofreiter et al (2005)</td>
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<td>3</td>
<td>Boersma and Kingma (2005)</td>
<td>X</td>
<td>X</td>
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<td>5</td>
<td>Carmichael (1997)</td>
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<td>7</td>
<td>Girod and Bellin (2011)</td>
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<td>8</td>
<td>Helfert (2009)</td>
<td>X</td>
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<td>9</td>
<td>Hufgard and Gerhardt (2011)</td>
<td>X</td>
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<td>11</td>
<td>Kubicke et al (2011)</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>12</td>
<td>Kumar and Harm (2004)</td>
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<td></td>
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<td>16</td>
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<td>Moffat and Archer (2004)</td>
<td>X</td>
<td>X</td>
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<tr>
<td>18</td>
<td>Mortensen and Lemoine (2007)</td>
<td>X</td>
<td>X</td>
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<td>21</td>
<td>Münstermann et. al_2 (2010)</td>
<td>X</td>
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<td></td>
<td></td>
<td>X</td>
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<tr>
<td>22</td>
<td>Norta and Eshuis (2010)</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>23</td>
<td>Perego and Salgaro (2010)</td>
<td>X</td>
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<td>24</td>
<td>Rohloff (2011)</td>
<td>X</td>
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<tr>
<td>26</td>
<td>Schäfermeyer (2010)</td>
<td>X</td>
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<td></td>
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<tr>
<td>28</td>
<td>Shang and Seddon (2007)</td>
<td>X</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Sorenson and Sorenson (2001)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>30</td>
<td>Tregear (2010)</td>
<td>X</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>33</td>
<td>Zhao (2004)</td>
<td>X</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>23</strong></td>
<td><strong>2</strong></td>
<td><strong>10</strong></td>
<td><strong>2</strong></td>
<td><strong>2</strong></td>
<td><strong>1</strong></td>
<td><strong>2</strong></td>
<td><strong>3</strong></td>
<td><strong>1</strong></td>
<td></td>
</tr>
</tbody>
</table>
Process standardization was the concept mostly related with process harmonization in the literature in 69% of the documents selected, followed by integration in only 30%. Therefore, only the concept of process standardization will be selected to understand how it has been measured previously in the literature and the specific underlying aspects that different authors captured in their measures. Therefore, the next step is to identify in the literature some measures of process standardization.

**Step 2: Defining aspects**

In this step, different measures of “process standardization” are identified and classified based on the type of process aspects that they measure. The output of this step is a set of the main aspects of process standardization that must be considered to derive new measures of process harmonization. Additionally, measures of process standardization are further used to assess the validity and reliability of the measurement model in step 6.

**Unit of analysis**

The unit of analysis of this step is a combination of literature and a group of participants selected according to a set of criteria. From the documents found in the literature research in the previous step, only research papers which present measures of process standardization were selected. Additionally, a group of professionals in Procurement and academics in business process management was selected for a workshop. The selection of practitioners from only one specific process type “Procurement” was made to focus on identifying aspects and measures of process harmonization, for a process which was well-known by all the participants to reduce the scope of discussions. The workshop included nine participants organized in two mixed groups with three academics and four practitioners.

**Procedure for step 2**

Measures of process standardization identified in the literature are summarized in Table 2. Each measure was classified looking at words in the text that capture aspects of the process that they measure. For instance, “During the execution of the process we follow a well-regulated process cycle” refers to the order in which the activities in the process are performed. In this example the keyword is “process cycle”. Therefore, the aspect associated with this measure is control flow. The same analysis was done with all the measures indicated in Table 2 and indicated in the column Aspect.

Additionally, a workshop was conducted to identify the set of aspects relevant for process harmonization from a practical perspective. Participants were asked to identify factors that exert an influence in the harmonization level of a procurement process and specific aspects of process harmonization related to these factors. As part of the outputs of this workshop we collected a set of aspects of harmonization from a practical perspective. Table 2 shows a list of aspects identified though the literature review, compared with the output of both professional groups in the workshop. All the aspects identified at least by two sources were included as an input for next step.

**Results of step 2**

Table 2 shows the different measures and the aspects of a business process standardization that they evaluate. Most of the measures defined evaluate one specific aspect, besides measures 14 and 15 which are general, and evaluate the level of standardization of the process as a whole. The list of aspects identified includes: activities, control flow, data, management, information technology and resources. Activities refer to the level of standardization of specific steps in the process. Control-flow measures the level of standardization of the sequence of activities. Data measures the level of standardization of input and output data used in the process. Management measures the standardization of the process assessment. Information Technology refers to the level of
standardization of IT systems.

Table 2 - Aspects derived from measures of process standardization

<table>
<thead>
<tr>
<th>No.</th>
<th>Measures</th>
<th>Citation</th>
<th>Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There are mandatory specifications for each step of the process.</td>
<td>Beimborn et al (2009)</td>
<td>Activities</td>
</tr>
<tr>
<td>2</td>
<td>Business units have similar or overlapping operations.</td>
<td>Ross et al (2009)</td>
<td>Activities</td>
</tr>
<tr>
<td>4</td>
<td>We have documented all actions of the business process to a great extent.</td>
<td>Münstermann et al (2009, 2010); Schäfermeyer (2010); Wüllenweber et al (2008)</td>
<td>Activities/ Control flow</td>
</tr>
<tr>
<td>5</td>
<td>There is a fixed procedure for the collaboration between departments.</td>
<td>Münstermann et al (2009, 2010)</td>
<td>Control flow</td>
</tr>
<tr>
<td>6</td>
<td>The process runs through mandatory process steps.</td>
<td>Beimborn et al (2009)</td>
<td>Activities</td>
</tr>
<tr>
<td>9</td>
<td>Data is standardized across business units.</td>
<td>Ross et al (2009)</td>
<td>Data</td>
</tr>
<tr>
<td>10</td>
<td>Process performance is reported globally.</td>
<td>Tregear (2010)</td>
<td>Data/ Management</td>
</tr>
<tr>
<td>11</td>
<td>IT decisions are centralized.</td>
<td>Ross et al (2009)</td>
<td>Information technology</td>
</tr>
<tr>
<td>12</td>
<td>There are globally integrated business processes often with support of enterprise systems.</td>
<td>Ross et al (2009)</td>
<td>Information technology</td>
</tr>
<tr>
<td>17</td>
<td>There is a centralized control over business process design.</td>
<td>Ross et al (2009)</td>
<td>Resources / Management</td>
</tr>
</tbody>
</table>

The aspects derived from the literature were compared with those identified during the workshop. Table 3 includes a list of all the aspects of process harmonization identified using the literature and two professional teams who participated in the workshop. Aspects identified through at least two sources were included.
Activities and control-flow are considered together, because in some cases the distinction to what extent a measure evaluates each individual activity or the collection of activities with a predefined order. Therefore, both activities and the relationship between these activities are included in one aspect.

**Step 3 - Defining measures**

To evaluate how the different aspects previously identify really reflect different parts of the concept under study, empirical research was conducted. This step consists of defining measures for each aspect previously identified.

**Unit of analysis**

Units of analysis in this stage were two professionals engaged in harmonization projects in large scale companies and three academics. Two interviews were conducted with these experts. One expert is a professional responsible to conduct a large scale harmonization project in a governmental organization in the last six years. The other expert conducted a study about the impact of factors such as information technology in process standardization versus harmonization in value chain management. This study included six multinational companies, in which two of them show successful results in their harmonization efforts. The academics are participating in a project of process harmonization and were exposed to literature and practical experiences in the topic.

These professional and academic experts were selected considering their experience, to identify indicators of process harmonization that they have seen in practice in the companies studied and in previous literature on the topic.

**Procedure for step 3**

Interviews were conducted using a questionnaire with open questions to identify specific measures that they have used in the companies involved, to evaluate the level of harmonization after their harmonization initiatives were conducted. They were also asked about the motivation and expected benefits when conducting these initiatives. These questions helped to identify which measures are significant for the companies. The meeting with academics was performed after the interviews and was performed informally as a brainstorming to generate ideas of more measures aligned with those gathered in practice. The original list of measures was rewritten considering that its wording was as simple and precise as possible, as suggested in the literature by Tourangeau et al (2000). This process was not exhaustive because it was only intended to generate a first set of measures which allows a quantitative validation of the aspects proposed.

**Results of step 3**
A first set of measures of process harmonization were gathered as a result of this step. An initial list of eight measures was developed and is depicted in Table 4. Table 4 shows the measures related to each one of the aspects: Activities and control flow, data, Information Technology (IT) and Human Resources. This initial set includes one indicator for activities (IA1), two related to Data aspect (ID1 and ID2), two related to resources (IR1 and IR2) and finally three defined for Information Technology (IT1, IT2 and IT3).

<table>
<thead>
<tr>
<th>ID</th>
<th>Measures</th>
<th>Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA1</td>
<td>The percentage of common activities in the process.</td>
<td>Activities</td>
</tr>
<tr>
<td>ID1</td>
<td>The number of different documents used as input for the same process.</td>
<td>Data</td>
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<tr>
<td>ID2</td>
<td>The number of different output reports.</td>
<td>Data</td>
</tr>
<tr>
<td>IR1</td>
<td>The percentage of common roles in the process.</td>
<td>Resources</td>
</tr>
<tr>
<td>IR2</td>
<td>The number of different roles executing the same activity.</td>
<td>Resources</td>
</tr>
<tr>
<td>IT1</td>
<td>The number of different software applications in used in the process.</td>
<td>IT</td>
</tr>
<tr>
<td>IT2</td>
<td>The number of different supplier's paid for the software applications.</td>
<td>IT</td>
</tr>
<tr>
<td>IT3</td>
<td>The amount of money paid for the software applications.</td>
<td>IT</td>
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</table>

Using this set of measures we built a measurement model which evaluates the level of harmonization of a business process in an organization. This initial measurement model derived is depicted in Figure 2. It shows that the level of harmonization is composed by four different aspects as identified before (data, activities, resources and IT). Each one of these aspects is measured through a set of indicators. The indicators are represented as reflective because within each aspect, they are expected to be correlated. As a results, a hierarchical model (reflective first order (for data, Activities (ACT), Resources (RES) and IT) with a formative second order (business process harmonization- BPH) model was derived.

![Figure 2 – Initial hierarchical model (reflective first order and formative second order)](image)

Empirical research is conducted in the next step to assess the number of different dimensions
underlying this model and its structure.

**Confirmatory Phase**
The confirmatory phase is a staged process whereby the measurement model built in the exploratory phase is assessed in terms of dimensionality, validity and reliability. The assessment is performed following three steps: (1) Collecting data for model validation; (2) Assessing the model dimensions; and (3) Validating the measurement model derived.

**Step 4: Collecting data**
Empirical research was conducted to identify how much the current set of measures actually reflects different aspects of the harmonization level. An online survey was conducted to achieve the goal of this step, using the constructs derived in the previous steps (Data, resources, Activities and IT), and using two reflective constructs taken from the literature for validation. These constructs are business process standardization (BPS) operationalized by a 3-item instrument developed by Münstermann et al (2010), and business process complexity (BPC) operationalized with a 5-item instrument developed by Schäfermeyer et al (2012). Details about these constructs are further provided.

**Unit of analysis**
The targeted respondents for the online survey were professionals with experience in business process management (BPM) practices. The survey instrument was distributed in two languages: English and Dutch, targeting a different group of professionals within BPM. The Dutch questionnaire was sent to the members of the BPM round table at Eindhoven University of Technology, with more than 300 members registered when the survey was conducted. The questionnaire translated to English was distributed throughout BPM experts worldwide invited through advertisements made on LinkedIn in a group called BPMInstitute.org with 1,311 members. It was also published though an internal communication portal used in an international consultancy firm in The Netherlands (with 1,779 members registered). Professionals in BPM assumed the role of key informants because they provide information on an aggregate unit of analysis (in this case a harmonization project) by reporting on organizational characteristics (Dillman, 2007).

**Procedure for step 4**
The survey instrument is included in Appendix A and it requires around 20 minutes for completion. It was built using a Google document and the link for access was distributed to the targeted population. A set of criteria described in Dillman (2007) were considered to design the questionnaire. This set of criteria focuses on reducing the sources of error when conducting survey research, to be able to generalize sample results to a defined population.

The sources of error include: coverage error, sampling error, measurement error and nonresponsive error. The coverage error is “the result of all units in a defined population not having a known nonzero probability of being included in the sample drawn to represent the population”. The sampling error is “the result of surveying a sample of the population rather than the entire population”. The measurement error is “the result of inaccurate responses that stem from poor question wording, poor interviewing, survey mode effects and/or some aspect of the respondent’s behavior”. And the nonresponse error is “the result of no response from people in the sample, who, if they had responded, would have provided different answers to the survey questions than those who did respond to the survey”. This section shows the decisions made to reduce the sources of errors described before when designing the survey instrument.
To reduce the *coverage error*, the survey was promoted through a group called BPMInstitute.org using a social network (LinkedIn). Using the link provided to access the survey, respondents do not need any password or type of authorization, facilitating their access to the survey.

To reduce *sampling error*, three big communities of BPM professionals were selected: BPM round table (300 members), BPMInstitute.org (1,313 members) and professionals from an international consultancy firm in The Netherlands (with 1,779 members registered). They received an invitation online to fill the survey with a link. Two weeks after the initial invitation, they received a reminder to fill the questionnaire. This enhances the chances to reach a representative population, because they are more likely to accept the invitation. Results of the questionnaire were gathered four weeks after the first invitation. Additionally, the questionnaire was translated in English and Dutch, considering that the members of the BPM round table are mainly speak Dutch. Even though most of them are familiar with English; they are more willing to fill a questionnaire in Dutch because it requires less effort on translation. This can guarantee that we do not exclude a significant portion of the population for language barriers.

To reduce *measurement error*, a pretest was performed with a selected group of academics with expertise in BPM (6) and in survey research (2). Furthermore, an analysis of the responses was performed to check whether they understood the question and provided an appropriate answer.

To reduce *nonresponse error*, there are different design decisions that we considered when building this survey in order to get respondents to sign on to the survey site and to keep respondents motivated to complete the survey once begun. First, the invitation to fill the questionnaire included the main goal of this study and a description of their contribution to future research and the impact in the community. The invitation is critical in eliciting responses to Web survey (Crawford et al, 2001). The same text was included in the welcome screen, making it more motivational for the respondents (Dillman et al, 1998). The first questions were simple, just to access the level of experience and knowledge that the respondents has on process harmonization. Questions were stated very direct and using a simple language, using short line-length. They were also presented using a conventional format such as paper questionnaires, recommended in the literature (Dillman et al, 1998).

A few open questions were included to get information from the respondents. Open questions are not recommended because it requires extra effort (cognitive and psychomotor) from respondents and they can increase the abandonment rate (Crawford et al, 2001). However, in this case it is necessary for our research goal and it has been written that people are more willing to answer open questions in web surveys compared to other types of surveys (Dillman et al, 1998).

Each question has instructions on how to proceed, instead of providing them at the beginning of the questionnaire. We did include in any question the option to force people to answer before continuing to the next question, to give people the flexibility to scroll from question to question if necessary. In this case we could manage to do this considering that the order effect is not a major concern (Dillman et al, 1998). Some open questions were also included, even though there are not always recommended. They require extra effort (cognitive and psychomotor) from respondents and they can increase the abandonment rate. However, in this case it is necessary for our research goal and it has been written that people are more willing to answer open questions in web surveys compared to other types of surveys.
Following the decision of using open questions, we decided not to use a progress pointer. Basically, we consider that in our questionnaire with open questions, if we include a progress pointer based on number of items completed, this may produce the backfire effect of increasing the abandonment rate (Crawford et al, 2001; Couper et al, 2001). The main reason is because we may underestimate the duration of the survey due to the open questions. We made this decision even though there are contradictory findings with respect to the effect of progress pointers used in surveys. Some authors arguing that indicating progress through the survey increase the motivation to complete the survey while reducing abandonment (Dillman et al, 1998).

Another decision that we considered in the design of the survey instrument is the number of questions on a single screen. We decided to include only one question per screen, to reduce the correlation in responses among items sharing one single screen (Couper et al, 2001), except for question 7 and 9 in which they are related. The downside of this decision is that it can increase the time taken to answer the survey. This is not very critical in this case, considering that the survey is relatively short with few questions. In questions 4 and 8, we used check boxes, but we restricted it to only a few options to avoid that the respondent only focus the attention on the first options ignoring the last ones (Couper et al, 2001).

In the survey besides the set of indicators derived in the previous phase, two constructs were evaluated: business process standardization and business process complexity. Measures of these two concepts can be seen as reflective measures of process harmonization, because if the level of harmonization increases we can expect that the level of standardization also increases while the process complexity decreases. They were operationalized using instruments provided in the literature and depicted in Table 5. Business process standardization (BPS) was operationalized by a 3-item instrument developed by Münstermann et al (2010), which assess the level of standardization of a set of business processes. This was a measurement model selected in Step 2 to be used for further validation. The second construct operationalized is business process complexity (BPC). It was operationalized with a 5-item instrument developed by Schäfermeyer et al (2012), and described as the level of difficulty reported by project managers and operators, during process standardization or execution.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPS</td>
<td>BPS1</td>
<td>The execution of the business process is strongly standardized.</td>
</tr>
<tr>
<td></td>
<td>BPS2</td>
<td>We have documented all actions of the business process to a great extent.</td>
</tr>
<tr>
<td></td>
<td>BPS3</td>
<td>During the execution of the process we follow a well-regulated process cycle.</td>
</tr>
<tr>
<td>BPC</td>
<td>BPC1</td>
<td>The employees executing the business process need to be able to flexible adjust themselves to the differing process sequences</td>
</tr>
<tr>
<td></td>
<td>BPC2</td>
<td>The set of inputs necessary for process execution differ often</td>
</tr>
<tr>
<td></td>
<td>BPC3</td>
<td>The business process is characterized by uncertainty</td>
</tr>
<tr>
<td></td>
<td>BPC4</td>
<td>The business process is very complex</td>
</tr>
<tr>
<td></td>
<td>BPC5</td>
<td>A lot of information is needed to execute the business process</td>
</tr>
</tbody>
</table>

After the survey questionnaire was complete, a pre-test was conducted using cognitive interviewing. The questionnaire used for the pre-testing is included in Appendix B. The pretest included 6 academics with experience in BPM and two with experience in conducting research in social science, to evaluate the survey instrument (Collins, 2003). After the results of the pre-test were collected, the survey questions were further improved and an additional check was performed but only with
informal experts’ interviews. The online survey was sent with a reminder two weeks later, to increase the respondent rate. The data was collected after four weeks for further analysis.

Finally, when the data was collected we assumed that responses from people who did not participate in the survey are no different than those who did participate. This assumption was represented using the following hypothesis:

\[ H_0: \mu_{\text{respondents 1}} = \mu_{\text{No-respondents 2}} \]
\[ H_1: \mu_{\text{respondents 1}} \neq \mu_{\text{No-respondents 2}} \]

This assumption was tested conducting a non-response bias analysis to evaluate the extent to which our sample represents the population of this study and the biases observed in the responses due to nonresponse. An extrapolation method was carried over successive waves of the survey. We identified two waves of questionnaire returns. Respondents in the first (early) wave are those who replied after the survey was made available for the first time. The second (late) wave includes respondents who replied after a reminder was sent, two weeks after the first invitation to fill the survey.

The analysis includes the comparison of descriptive statistics of the demographic data and comparison of key variables (Sheikh and Mattingly, 1981; Etter and Perneger, 1997). The demographic considered were: the origin of respondents divided per language (Dutch and International sample), the experience in process harmonization projects (yes/no, and the time of experience), and the role of respondents in harmonization projects. The key variables include the indicators of process harmonization evaluated in the survey (ID1, ID2, IA1, IR1, IR2, IT1, IT2, IT3) and the comparison was conducted using an Independent sample two-tailed T-test with a level of significance of 0.05. We compared differences in their perception about the extent to which the indicators derived in our measurement model actually reflect the level of harmonization of a process. Additionally, we evaluate that the assumptions of the T-test were met using Levene's Test for Equality of Variances. In both tests, two paired T-test and Levene’s test, the null hypothesis can be rejected if the p-value calculated is smaller than 0.05.

Results of step 4

Table 6 shows the demographics of participants divided in two groups early and late respondents. In total, 119 responses were gathered. They are composed by sample groups: the Dutch sample and the International sample. The response rate for the Dutch sample is 16.7%, with 50 complete surveys out of a targeted population of 300 members of the BPM round table by the time the survey was conducted; And 2.23% for the International sample with 69 responses out of a population of 3,092 members (1,313 form the LinkedIn community and 1,779 from an international consultancy company).

Our response rate of 16.7% in the Dutch sample slightly exceeds the 10–12% rate that Hambrick et al. (1993) describe as typical for surveys of executives. However, for the International sample this response rate was significantly reduced to 2.23%. Even though the survey was implemented following guidelines such as Dillman (1978), we expected to obtain a low response rate due to the subject of the survey. A difficulty to obtain a higher response rate is that not everyone in the sampling frame may be familiar with the subject of the survey. They are professionals in business process management (BPM) but not necessarily focused on process harmonization within BPM. For the Dutch sample we have closer contact with the potential participants and have more control over their expertise in BPM, compared to the International sample. Therefore, potential respondents which are unfamiliar with the topic may not feel interested or uninformed to provide enough input to the survey.
Table 6 - Participants demographics divided early and late respondents

<table>
<thead>
<tr>
<th>Demography</th>
<th>Category</th>
<th>Respondents (early)</th>
<th>Non-respondents (late)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percentage</td>
<td>Frequency</td>
</tr>
<tr>
<td>Language</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dutch</td>
<td>38</td>
<td>38,0</td>
<td>12</td>
</tr>
<tr>
<td>English</td>
<td>62</td>
<td>62,0</td>
<td>7</td>
</tr>
<tr>
<td>Experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>53</td>
<td>53,0</td>
<td>13</td>
</tr>
<tr>
<td>No</td>
<td>47</td>
<td>47,0</td>
<td>6</td>
</tr>
<tr>
<td>Experience time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>47</td>
<td>47,0</td>
<td>6</td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>30</td>
<td>30,0</td>
<td>8</td>
</tr>
<tr>
<td>1 to 3 years</td>
<td>20</td>
<td>20,0</td>
<td>5</td>
</tr>
<tr>
<td>More than 3 years</td>
<td>3</td>
<td>3,0</td>
<td>0</td>
</tr>
<tr>
<td>Role</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project manager</td>
<td>50</td>
<td>50,0</td>
<td>0</td>
</tr>
<tr>
<td>Manager</td>
<td>2</td>
<td>2,0</td>
<td>4</td>
</tr>
<tr>
<td>Process architect</td>
<td>20</td>
<td>20,0</td>
<td>4</td>
</tr>
<tr>
<td>Business analyst</td>
<td>8</td>
<td>8,0</td>
<td>1</td>
</tr>
<tr>
<td>Consultant</td>
<td>14</td>
<td>14,0</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>6,0</td>
<td>8</td>
</tr>
</tbody>
</table>

Comparing the level of experience between both samples, we can observe that the percentage of people with experience in harmonization projects increased by 15% in the late response sample compared to the early response. However, the time of experience was reduced. It can be observed that in the late response sample none of the respondents had more than three years of experience. Significant differences were observed in terms of the role in both samples. The majority of early respondent were project managers while in the late response sample these group is distributed among managers and others. It is possible that the term project manager is too specific and therefore, several terms for managers with the same type of function can be used. However, in terms of the role we can conclude that significant differences are register in the early and late respondent’s sample.

After observing differences in demographic characteristics of both samples, we decided to evaluate to what extent these differences influence their responses. The descriptive statistics for all the responses are shown in Appendix C and Appendix D. Appendix C shows the descriptive statistics of each of the indicators collected for two groups (1- early and 2- late respondents). For each of the indicators, the mean, standard deviation and standard error mean was calculated. They are further used for the t-test.

The results gathered show that for all the indicators, the significance p-value) of Levene’s test is greater than 0.05, except for IT3 which is 0.007. These results indicate that the assumption that the variances are equal cannot be rejected and therefore, the results of the T-test for equal variance should be conducted. Only for IT3 we considered the results for equal variance not assumed. The results of the T-test for all the indicators show a p-value greater than 0.05. Therefore, no significant differences are detected, and at 0.05 level of significance, the null hypothesis that early and late responses are not different (H₀:μ₁=μ₂) cannot be rejected, and we consider that there is no response bias in the results obtained.
Step 5: Assessing model dimensions

Factor analysis is used in this step to suggest the number of dimensions underlying the level of harmonization of a business process. Data collected in the previous step was used as an input for factor analysis.

Unit of analysis

The unit of analysis in this stage is the responses gathered of 119 professionals in BPM. They are the responses provided using both the Dutch and English questionnaire. The answers provided were their opinion based on previous experience or knowledge on the topic. They needed to evaluate to what extent the provided measures actually assess an aspect of process harmonization. Their input was provided using a Likert scale from 1 until 5.

Procedure for step 5

Content validity of the items generated and the dimensionality of the construct under study are evaluated using Exploratory Factor Analysis (EFA), which is conducted using the software package for statistical analysis SPSS. Five steps were followed to conduct this Exploratory Factor Analysis as suggested by Hair et al. (2006): (1) Examine the factor loading matrix; (2) identify significant loadings in the matrix; (3) assess communalities; (4) Re-specify the factor model if needed; and (5) Label the factors.

There are three EFA decisions which are very important for the outcome of the analysis: (a) the factor extraction model used; (b) the number of factors retained; and (c) the method used to rotate factors, if more than one factor is retained (Conway and Huffcutt, 2003). Common factor analysis is the factor extraction model selected. It is more appropriate than the component factor analysis considering that the goal of this step is to identify latent dimensions represented in the original variables and we do not have previous knowledge about the amount of specific error variance (Hair et al., 2006).

The number of factors to retain was based on the following three criteria: (1) The latent roots or eigenvalues should be greater than 1; (2) The conceptual foundation, indicating the underlying dimensions of the concept based on the theory; And, the scree test criterion, which indicates the maximum number of factors that must be retained as the value where the inflexion point occurs.

Finally, an orthogonal rotational method was selected to rotate factors. Varimax was the method selected because it “has proved successful as an analytical approach to obtaining an orthogonal rotation of factors” (Hair et al., 2006 p.126).

Results of step 5

The analysis is performed with 119 responses, which constitutes more than 14:1 ratio of observations per variable. This ratio is more than adequate, a minimum of 50 observations and 5:1 ratio (Hair et al, 2006), for the calculation of the correlations between variables. The overall measure of sampling adequacy (MSA) of 0.761, and above 0.50 for each individual variable (0.775, 0.798, 0.793, 0.844, 0.679, 700, 729 and 840), indicate that sufficient correlation exists among variables and therefore it is appropriate to proceed with the factor analysis. An exploratory common factor analysis was conducted to examine whether the number of dimensions conceptualized could be verified empirically. Table 8 shows that the total variance can be explained by three factors which can explain 68.67% of the total variance. They also have an eigenvalue of 1 or more.
A three factor structure was considered for evaluation as suggested in the previous step. The next step was to identify the factor structure matrix shown in Table 7. For a sample size of 119, factor loadings above 0.50 should be considered significant based on a 0.05 significance level, a power of 80% and standard error assumed to be twice as those from correlation coefficients (Hair et al., 2006).

Table 7 - Total Variance Explained

<table>
<thead>
<tr>
<th>Factor</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadingsa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
<td>Cumulative %</td>
</tr>
<tr>
<td>1</td>
<td>3,285</td>
<td>41,058</td>
<td>41,058</td>
</tr>
<tr>
<td>2</td>
<td>1,209</td>
<td>15,107</td>
<td>56,164</td>
</tr>
<tr>
<td>3</td>
<td>1,000</td>
<td>12,505</td>
<td>68,669</td>
</tr>
<tr>
<td>4</td>
<td>.778</td>
<td>9,731</td>
<td>78,400</td>
</tr>
<tr>
<td>5</td>
<td>.605</td>
<td>7,559</td>
<td>85,960</td>
</tr>
<tr>
<td>6</td>
<td>.436</td>
<td>5,454</td>
<td>91,414</td>
</tr>
<tr>
<td>7</td>
<td>.388</td>
<td>4,852</td>
<td>96,265</td>
</tr>
<tr>
<td>8</td>
<td>.299</td>
<td>3,735</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Axis Factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

In the factor structure matrix depicted Table 8a, a clear factor structure cannot be identified, considering that IA1 and IR2 show high loadings on two factors. This suggested the need to delete some of the factors and re-evaluate the structure. To decide which factor should be removed we observed at the commonality level in Table 9a. The indicator which shows the lowest commonality level is IT1 with 0.525. This can also be observed in the correlation matrix in Appendix E, in which this indicator didn’t show a significant correlation with any of the other indicators. Therefore, IT1 was removed from the model and again the factor structure matrix and commonality level were assessed.

Table 8 - Factor Structure Matrix: a) Initial model and b) final model

<table>
<thead>
<tr>
<th>a)</th>
<th>Component</th>
<th>b)</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>IT3</td>
<td>0.86</td>
<td>0.125</td>
<td>0.156</td>
</tr>
<tr>
<td>IT2</td>
<td>0.859</td>
<td>0.197</td>
<td>0.075</td>
</tr>
<tr>
<td>ID1</td>
<td>0.182</td>
<td>0.863</td>
<td>0.038</td>
</tr>
<tr>
<td>ID2</td>
<td>0.274</td>
<td>0.802</td>
<td>0.189</td>
</tr>
<tr>
<td>IA1</td>
<td>-0.07</td>
<td>0.614</td>
<td>0.536</td>
</tr>
<tr>
<td>IR1</td>
<td>0.111</td>
<td>0.184</td>
<td>0.783</td>
</tr>
<tr>
<td>IT1</td>
<td>0.149</td>
<td>0.06</td>
<td>0.707</td>
</tr>
<tr>
<td>IR2</td>
<td>0.514</td>
<td>0.124</td>
<td>0.515</td>
</tr>
</tbody>
</table>

Rotation Method: Varimax with Kaiser normalization.
Table 9 - Commonality using a principal component analysis: a) Initial model and b) final model

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1D1</td>
<td>1,000</td>
<td>.780</td>
</tr>
<tr>
<td>1D2</td>
<td>1,000</td>
<td>.753</td>
</tr>
<tr>
<td>IA1</td>
<td>1,000</td>
<td>.669</td>
</tr>
<tr>
<td>IT2</td>
<td>1,000</td>
<td>.782</td>
</tr>
<tr>
<td>IT3</td>
<td>1,000</td>
<td>.780</td>
</tr>
<tr>
<td>IR1</td>
<td>1,000</td>
<td>.659</td>
</tr>
<tr>
<td>IR2</td>
<td>1,000</td>
<td>.545</td>
</tr>
<tr>
<td>IT1</td>
<td>1,000</td>
<td>.525</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1D1</td>
<td>1,000</td>
<td>.753</td>
</tr>
<tr>
<td>1D2</td>
<td>1,000</td>
<td>.748</td>
</tr>
<tr>
<td>IA1</td>
<td>1,000</td>
<td>.655</td>
</tr>
<tr>
<td>IT2</td>
<td>1,000</td>
<td>.807</td>
</tr>
<tr>
<td>IT3</td>
<td>1,000</td>
<td>.784</td>
</tr>
<tr>
<td>IR1</td>
<td>1,000</td>
<td>.836</td>
</tr>
<tr>
<td>IR2</td>
<td>1,000</td>
<td>.636</td>
</tr>
</tbody>
</table>

As a result, a three factor structure is proposed considering the clear structure shown in Figure 8b, in which all the variables have high loadings only with a single factor and the minimum level of commonality of all the factors is 0.636. The group of variables grouped in three factors is label based on the type of indicators that they represent. A revised measurement model is illustrated in Figure 3, composed by three factors: DATA, Resources and IT. Data is composed by the indicators IA1, 1D1 and 1D2; Resources by IR1 and IR2 and IT by IT2 and IT3.

![Figure 3 – Revised hierarchical model (reflective first order and formative second order)](image)

**Step 6: Validating measurement model**

In this step the internal consistency and reliability of the model derived is assessed. But internal consistency is not sufficient, we will also evaluate whether our model correlates with other related measure and whether it behaves as expected. Two constructs related to process harmonization were also included in the data gathering efforts to assess the measurement model under study, considering its hierarchical structure. They include: business process standardization (Münstermann et al, 2010) and business process complexity (Schäfermeyer et al, 2012).

**Unit of analysis**
The unit of analysis in this stage is the same as the previous step, 119 responses gathered of professionals in BPM.
Procedure for step 6

The measurement model was specified as a hierarchical factor model type II (reflective first order and formative second-order) as shown in Figure 3. Smart PLS software was used to measure the scale of measurement of the first and second order constructs. PLS was chosen for the analysis of this measurement model for three reasons: (1) it makes fewer demands regarding sample size than other methods; (2) It is able to handle both formative and reflective indicators; and (3) it is better suited for theory development than for theory testing.

The repeated indicator approach with mode B on the process harmonization construct and inner path weighting scheme is used to estimate the hierarchical latent variable model (Becker et al, 2012). This approach consists of using the indicators twice: (1) for the first-order constructs (Data, resources and IT) and (2) for the second-order construct (BPH). Having specified the measurement model in this way, the path coefficients between the first and second order constructs represent the loadings of the second order latent variable (Löhmoller, 1989; Becker et al., 2012). “This approach produces generally less biased, and therefore, more precise parameter estimates and a more reliable higher-order construct score.”(Becker et al, 2012).

The evaluation of the measurement model include: (1) an assessment of the first-order reflective constructs using the constructs and measures loadings, t-values, AVE, composite reliability and discriminant reliability; and (2) for the second order formative construct (BPH), evaluate the measures weights, significance of weights and multicolinearity among measures. The evaluation of the convergent validity is done using the using the constructs and measures loadings and weights and t-values. The values of factor loadings and AVE should be above 0.50 and composite reliability above 0.70 (Hair et al, 2006). The discriminant validity for the first-order constructs is evaluated following the criterion described by Fornell and Larcker (1981). The criterion is that the square root of AVE should be greater than the variance shared between the construct and other constructs in the model (Bollen, 1989). The variance inflator factor (VIF) test was used to evaluate multicolinearity among measures, which is mostly used by authors in the literature when using formative indicators (Ringle et al, 2012).

Finally, a nomological network is used to assess the validity of the multidimensional structure (MacKenzie's et al., 2011). The direct effect of an antecedent of process harmonization on each aspect of the concept (Data, Resources and IT) is measured. If they are equal, we consider this as a support of the multidimensional construct (Edwards, 2001). The antecedent construct selected in this study is business process complexity, using the construct provided by Schäfermeyer et al. (2012). The final endogenous construct used to build the nomological network is business process standardization, using the operationalization proposed by Münstermann et al (2010).

Results of step 6

The repeated indicator Mode B PLS-SEM model used for our analysis is depicted in Figure 4. It shows how the indicators of each individual first-order construct (Data, Resources and IT) are repeated in the second-order construct (BPH). An exogenous construct, business process complexity (BPC), is linked to both first and second order constructs. And finally, a construct of business process standardization (BPS) is used as a final endogenous construct, considering that its indicators (IS1, IS2 and IS3) can be used as reflective indicators of BPH.

The results gathered from the assessment of the reflective first-order construct are summarized in Table 10 and Table 11. Table 10 shows the loadings, t-values, average variance extracted (AVE) and
composite reliability values for all the indicators and first-order constructs. The results of convergent validity are satisfactory, considering that all the loadings are above 0.50, with a minimum value for the reflective indicators of 0.71 (IR1). All the reflectively measured first-order constructs (DATA, RES and IT) showed satisfactory values for convergent validity and reliability, with an AVE >0.50 and composite reliability above 0.70. This suggests that the indicators account for a large portion of the variance of each latent construct.

Figure 4 - A repeated indicator Mode B PLS-SEM model for process harmonization (BPM)

The R-squared of the measurement model of 0.995 shows that the formative higher order construct (BPH) is explained by its components (DATA, RES, IT). Looking at the t-values at the first-order construct level, all the weights are significant at a 0.05 level (t > 1.96).

Moreover, the variance inflator factor (VIF) used to test multicolinearity among measures provided values between 1.20 and 1.96 which is below the threshold of 3. Table 1 shows the correlations between first-order construct and the square root of average extracted variance (AVE) highlighted in bold. It shows evidence of discriminant validity, because the squared root of AVE for all the first-order constructs is greater than their correlation with other constructs in the model.
Table 10 - Results of the assessment of reflexive first-order construct: evidence of convergent validity

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Measures</th>
<th>Loadings</th>
<th>t-value</th>
<th>AVE</th>
<th>Composite Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA1</td>
<td>The percentage of common activities in the process.</td>
<td>0.7366</td>
<td>11.2811</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID1</td>
<td>The number of different documents used as input for the same process.</td>
<td>0.8485</td>
<td>43.6912</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID2</td>
<td>The number of different output reports.</td>
<td>0.8469</td>
<td>22.4686</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR1</td>
<td>The percentage of common roles in the process.</td>
<td>0.8165</td>
<td>9.4556</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR2</td>
<td>The number of different roles executing the same activity.</td>
<td>0.8826</td>
<td>28.7927</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT2</td>
<td>The number of different supplier's paid for the software applications.</td>
<td>0.9066</td>
<td>29.8478</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT3</td>
<td>The amount of money paid for the software applications.</td>
<td>0.9197</td>
<td>69.6419</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Business Process Standardization (BPS)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS1</td>
<td>The execution of the business process is strongly standardized.</td>
<td>0.8048</td>
<td>13.8649</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS2</td>
<td>We have documented all actions of the business process to a great extent.</td>
<td>0.5942</td>
<td>3.959</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS3</td>
<td>During the execution of the process we follow a well-regulated process cycle.</td>
<td>0.7987</td>
<td>10.9688</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Business Process Complexity (BPC)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC1</td>
<td>The employees executing the business process need to be able to flexible adjust themselves to the differing process sequences</td>
<td>0.5117</td>
<td>3.9149</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC2</td>
<td>The set of inputs necessary for process execution differ often</td>
<td>0.5046</td>
<td>3.6915</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC3</td>
<td>The business process is characterized by uncertainty</td>
<td>0.8210</td>
<td>25.2406</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC4</td>
<td>The business process is very complex</td>
<td>0.8066</td>
<td>23.613</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC5</td>
<td>A lot of information is needed to execute the business process</td>
<td>0.8374</td>
<td>28.1152</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 11 - Correlations of latent variables and evidence of discriminant validity

<table>
<thead>
<tr>
<th>Constructs</th>
<th>BPC</th>
<th>BPS</th>
<th>DATA</th>
<th>IT</th>
<th>RES</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.7131</td>
</tr>
<tr>
<td>BPS</td>
<td>0.5761</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATA</td>
<td>0.4686</td>
<td>0.7391</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT</td>
<td>0.4170</td>
<td>0.3985</td>
<td>0.8124</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RES</td>
<td>0.3547</td>
<td>0.4289</td>
<td>0.4575</td>
<td>0.9132</td>
<td>0.8502</td>
</tr>
</tbody>
</table>

Collectively, the results have shown that the entire measurement model derived satisfy all the requirements for validity and reliability.

Conclusions

The result of this study is a validated measurement model to assess the level of harmonization of business processes in an organization. It provides an answer to our research question: What measures can be used to evaluate the level of harmonization of business processes in an organization? A set of seven measures summarized in Table 4 can be used to evaluate the level of process harmonization in an organization. These measures assess three different aspects of a process that should be harmonized, including: Resources, Data and Information Technology (IT). This set includes two indicators related to Resources (IR1, IR2), three indicators related to Data aspect (ID1, ID2, IA1), and two related to Information Technology (IT2, IT3).

The findings above provide evidence that the model derived is a valid and reliable measurement model for process harmonization. This measurement model has certain strengths but also exhibits limitations. A significant strength of this paper is the multi-method approach followed, especially in the conceptualization step. It enriches the construct providing views from literature together with practice. The literature provided focus on the main aspects of the construct that were used for further operationalization. Using these initial set of aspects, practitioners defined measures from their practical experience.

One limitation of this study is that we do not have a large number of indicators per aspect. This can lead to an under-specification of aspects that must be considered in the assessment of process harmonization. The measurement model cannot be evaluated containing only one indicator per aspect. Therefore, in our current study a maximum number of four aspects could be identified with the initial set of indicators generated. This is the case with the indicator IA1 which was theoretically defined as an indicator of Activities, and during the confirmatory phase was further combined with indicators of Data. It was not a surprise that it was combined with Data considering that the correlation between the harmonization of the steps followed in a process and the data input or output used, is stronger than the correlation of data with the number of resources used in the process or IT systems.

By conceptually developing and empirically validating the process harmonization construct, this paper conveys an important message that effective harmonization initiatives requires an evaluation of the level of process harmonization achieved at different stages in the process to be able to link these measures with specific improvements in the organization. Our measurement model of process harmonization can be used by researchers and company executives to guide future research and practice.
Researchers can use this systematically developed and validated measurement model as a starting point in the examination of the effects of process harmonization on business performance, or the link between organizational factors and the level of harmonization. In practice, this measurement model can be used by firms for measuring its process harmonization level. Some firms can assess the ratio of input and output of a single process harmonization program. This may serve to justify investments in these types of improvement programs. The conventional approach of simply investing in IT does not automatically lead to success of harmonization initiatives. One of the results of our research is that IT related measures only evaluate one aspect of the level of process harmonization.

The findings of this study provide several opportunities for future research. First, future research may enrich the number of indicators per aspect and re-evaluate the dimensional structure for the identification of additional aspects. Second, measures considered in this paper involved the evaluation of process harmonization at the process level, but future research can extend this view to include some strategic measures that can also be of interest in practice.

References


43rd Hawaii International Conference. IEEE, pp. 1-10.


Appendix A

An online survey was conducted to generate indicators of process harmonization. The survey questionnaire is included below, including its access link. This section presents a description of the process followed for the survey development and data collection, and a justification of decisions made in the process.

A1. Questionnaire

This survey can be reached using the following link:
https://docs.google.com/spreadsheet/viewform?fromEmail=true&formkey=dEJ2N183S0MzZkFKc01hNXQ2cnpxM0E6MQ

Survey on Business Process Harmonization

The purpose of this survey is to identify indicators for measuring the level of harmonization of business processes in an organization. Business process harmonization is important for practitioners and researchers in the BPM community, because it is critical for a successful implementation of IT solutions and process improvement.

We appreciate your collaboration in this research answering a questionnaire of 14 questions that will take approximately 5 to 10 minutes of your time. It will help us to conduct further empirical research to investigate the appropriate level of harmonization for organizations in different contexts (i.e. multinational versus domestic organizations).

We would like you to share your opinions with us, and the information that you provide and your participation will be held as confidential. Please contact us with any questions or concerns about this survey at h.l.romero@tue.nl

Thank you for your participation in this survey!!

Contact person:
Heidi L. Romero
Tel. (+31) 40 247 3703 / 2290

Question #1
Have you participated in a project for process standardization or process harmonization in a company?
- Yes
- No

Question #2
What was your role in this project?
- Project manager
- Manager
- Process architect
- Business analyst
- Consultant
- Other: ____________________________

Question #3
Can you describe specific activities that were performed as part of this project and the processes involved?

Question #4
How long did you work on this project?

- ☐ Less than 1 years
- ☐ 1 to 3 years
- ☐ More than 3 years

Question #5
How would you score your knowledge about process harmonization?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Question #6
What is process harmonization according to you?

Illustrative example of process harmonization
In this survey we assume that process harmonization refers to how uniform and comparable two processes are. For example, the process of admitting a student to a university is fairly similar for different universities in the Netherlands, because it is regulated by the government. Therefore, we say that the level of harmonization for these admissions processes is high.

In contrast, the process of hiring new personnel probably differs for different Dutch organizations, because different organizations execute it differently, depending on their size, whether they have it outsourced. Therefore, we say that the level of harmonization for these hiring processes is low.

Use this assumption to answer the following questions. Press continue to proceed.

Question #7
To what extent do you agree with the following statements?
If processes are more harmonized…

<table>
<thead>
<tr>
<th>Completely disagree</th>
<th>Mostly disagree</th>
<th>Neither agree/disagree</th>
<th>Mostly agree</th>
<th>Completely agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>...the execution of the business process is strongly standardized.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...they can easily be learned via documentation and trainings.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...the process-cycle is well</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question #8

To what extent do you agree with the following statements?
If processes are less harmonized…

<table>
<thead>
<tr>
<th></th>
<th>Completely disagree</th>
<th>Mostly disagree</th>
<th>Neither agree/disagree</th>
<th>Mostly agree</th>
<th>Completely agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>…the employees executing the business process need to be able to flexible adjust themselves to the differing process sequences.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…the set of inputs necessary for process execution differ often.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…the business process is characterized by uncertainty.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…the business process is very complex.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>…a lot of information is needed to execute the business process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Question #9

If you want to evaluate the level of harmonization, which aspects are important to consider?

<table>
<thead>
<tr>
<th>Activities (including the order in which they are performed)</th>
<th>Not at all important</th>
<th>Not very important</th>
<th>Neutral</th>
<th>Somewhat important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information that is used in the processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resources that perform the processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software applications that are used in the process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Are there any other aspects that must be considered?

Question #10
To what extent do you agree with the following statements?
The level of harmonization of "information" can be quantified using the following measures:

<table>
<thead>
<tr>
<th>The number of different documents used as input for the same process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely disagree</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

What other measures can be used to quantify the level of harmonization of "information"?

Question #11
To what extent do you agree with the following statements?
The level of harmonization of "activities" can be quantified using the following measure:

<table>
<thead>
<tr>
<th>The percentage of common activities in the process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely disagree</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

What other measures can be used to quantify the level of harmonization of "activities" (including the order in which they are performed)?

Question #12
To what extent do you agree with the following statements?
The level of harmonization of "software applications" can be quantified using the following measures:

<table>
<thead>
<tr>
<th>The number of different software applications in used in the process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely disagree</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The number of different supplier's paid for the software applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely disagree</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
What other measures can be used to quantify the level of harmonization of "software applications"?

**Question #13**

To what extent do you agree with the following statements?
The level of harmonization of "resources" that perform the processes can be quantified using the following measures:

<table>
<thead>
<tr>
<th>Measures</th>
<th>Completely disagree</th>
<th>Mostly disagree</th>
<th>Neither agree/disagree</th>
<th>Mostly agree</th>
<th>Completely agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The percentage of common roles in the process.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>The number of different roles executing the same activity.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

What other measures can be used to quantify the level of harmonization of "resources"?

**Question #14**

In the last question of this survey we want to know, if you engage in a harmonization project and after the project your processes are more harmonized. Which elements (of your processes or your organization as a whole) do you expect to have changed? For example, the number of common activities increases.

Thank you for participating in this survey!

Please indicate your e-mail address, if you would like to receive a summary report of the findings of this research:
## Appendix B

*Questionnaire for pre-testing the survey instrument*

<table>
<thead>
<tr>
<th>Survey questions</th>
<th>Pre-test questions</th>
</tr>
</thead>
</table>
| For questions #1,2,3 and 4 | 1. When we asked questions about your experience in harmonization projects:  
  1.1. Did you have a particular time period in mind? (i.e. in the last five years)  
  1.2. How well do you remember this information? |
| For question #5 | 2. When we asked to evaluate your knowledge about process harmonization, how did you estimate your answer? |
| For question #6 | 3. What do the terms ‘process harmonization’ and ‘process standardization’ mean to you? |
| For question #7 | 4. What do the terms ‘level of similarity’ and ‘level of compatibility’ mean to you?  
  5. How sure of your answer are you?  
  6. Were you able to find your first answer to the question from the response option shown? |
| For question #8 and 9 | 7. What does the term ‘standard’ mean to you?  
  8. How sure of your answer are you?  
  9. Were you able to find your first answer to the question from the response option shown? |
| For question #10 | 10. How did you get your answer?  
  11. How sure of your answer are you?  
  12. How did you feel about answering this question? |
| General | 13. Do you have comments about the wording or how some specific question is described?  
  Please provide any additional comments to improve this survey instrument. |
### Appendix C

*Group Statistics of responses (ID1, ID2, IA1, IT1,IT2 and IT3) for 1 early respondents and 2 late respondents*

<table>
<thead>
<tr>
<th>RESP</th>
<th>Statistic</th>
<th>Bootstrapa</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bias</td>
<td>Std. Error</td>
</tr>
<tr>
<td>ID1</td>
<td>N 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean 3.22</td>
<td>,00</td>
<td>,12</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation 1,168</td>
<td>-.011</td>
<td>,095</td>
</tr>
<tr>
<td></td>
<td>Std. Error ,117</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N 19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean 2.79</td>
<td>,00</td>
<td>,23</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation 1,032</td>
<td>-.030</td>
<td>,147</td>
</tr>
<tr>
<td></td>
<td>Std. Error ,237</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA1</td>
<td>N 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean 3.50</td>
<td>,00</td>
<td>,12</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation 1,150</td>
<td>-.011</td>
<td>,095</td>
</tr>
<tr>
<td></td>
<td>Std. Error ,115</td>
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a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples
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<sup>a</sup> Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples.
Appendix D

Results of Independent sample T-test to compare the responses of (1) early and (2) late respondents, with respect to all the indicators evaluated during the survey

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Appendix E

Correlations matrix including eight indicators of initial measurement model

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** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).
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402 2013 **The Service Dominant Business Model: A Service Focused Conceptualization**

Egon Lüftenegger, Marco Comuzzi, Paul Grefen, Caren Weisleder

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