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BACHELOR THESIS

BUSINESS PROCESS REDESIGN: AN OPTIMAL PROCESS MODELING REPRESENTATION FOR KNOWLEDGE INTENSIVE ORGANIZATIONS

A Field experiment | A. Bakker

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Abstract

The current researches on business process redesign have focused on the use of process representations that are well-aligned with a production orientated process view. According to Kock and Murphey (2001) not enough attention is given to analyzing the processes based on information flow. More and more companies are dependent on information and knowledge for their core processes. Therefore the knowledge of which process modeling representation fits knowledge intensive organizations is essential in order for them to perceive business process redesign success. This research focuses on the perceived success of business process redesign projects based on representational approaches.

Using three different process modeling representation approaches, an attempt is made to distinguish which is most beneficial to business process redesign success in a knowledge intensive organization: a (1) Communication flow approach, (2) Activity flow approach or a (3) combination in which the processes and communication flows will be depicted.
This research is conducted by means of a quantitative analysis of questionnaire results on specific modeling representations. Each model is rated based on five criteria: completeness of the models, ease of understanding, support for visualization of process change, usefulness of identifying opportunities for improvement, usefulness in the development of a generic IT solution.
This thesis contributes to the existing process modeling representation theory by addressing the gap in existing knowledge by studying the different modeling approaches in an actual organizational context as opposed to an experimental setting with students. The outcome of this thesis is valuable not only for business process analysts and employees within organizations, but also for academics.
To business process analysts, this thesis presents theoretical knowledge that can be used to improve practices of describing business processes within an organization, which then benefits the employees who use the business processes.

Keywords: Business process redesign, process modeling representations, Communication flow, Activity flow, Multivariate analysis.

Summary

What this research has shown is that the way a process is presented can be crucial to the success of the redesign project. From this research it also becomes clear that the choice of a business process modeling representation depends on the main goal of the modeling. The type of model used depends on whether the goals of the organization is to develop an understandable model or a model that is useful in the development of an IT solution. It is therefore crucial for a company to first state goals before deciding on a model.

The theoretical model used is based on the model proposed by Kock, Danesh & Komiak (2008). A comparison was made between three process modelling representation models: communication flow, activity flow and a combination. The main conclusions of this study are the following:

Communication versus Activity model representation

Even though the majority of current research has focused on the chronological flow of activities, this research supports the idea that a communication flow representation has a greater ease of understanding, better visualization of process change, is more useful in the identification of opportunities for improvement and in the development of a generic IT solution than an activity flow representation. There was however not enough evidence supporting the notion that the communication flow representation enables a greater degree of redesign success compared to the activity flow representation.

Communication versus Combination model representation

The combination model (the chronological flow of activities combined with the flow of information) did prove to provide a greater visualization of process change than the communication flow representation; Even though there was no support for superiority in the identification of opportunity for improvements. The ease of understanding of the communication flow representation was higher than that of the combination model and in total there was enough statistical evidence to support the fact that the communication flow representation enables a greater degree of redesign success than the combination model.
The study therefore suggests that a communication flow representation is likely to have a positive effect on the success of a business process redesign project.

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1 Motivation for research

Today more and more companies are dependent on information and knowledge for their core business processes. Meanwhile the current researches on business process redesign have focused on the use of process representations that are well-aligned with a production oriented process view. According to Kock and Murphy (2001) not enough attention is given to analyzing the processes based on information flow. Often students are used as subject in process modeling research; This study will focus on experienced employees in an organizational context.

Mooney (2001) created a typology of business processes as shown in figure 1. The above stated productions oriented process can be seen as the operational processes while the processes described by Kock and Murphy are based on the management processes; A shift is suggested, away from an operational process view to a management process view. Mooney (2001) states that this typology is "used to (...) distinguish between processes associated with primary business operations (Operational processes), and the associated information handling, coordination, and control processes required to ensure the efficiency and effectiveness of the primary operations (management processes)".

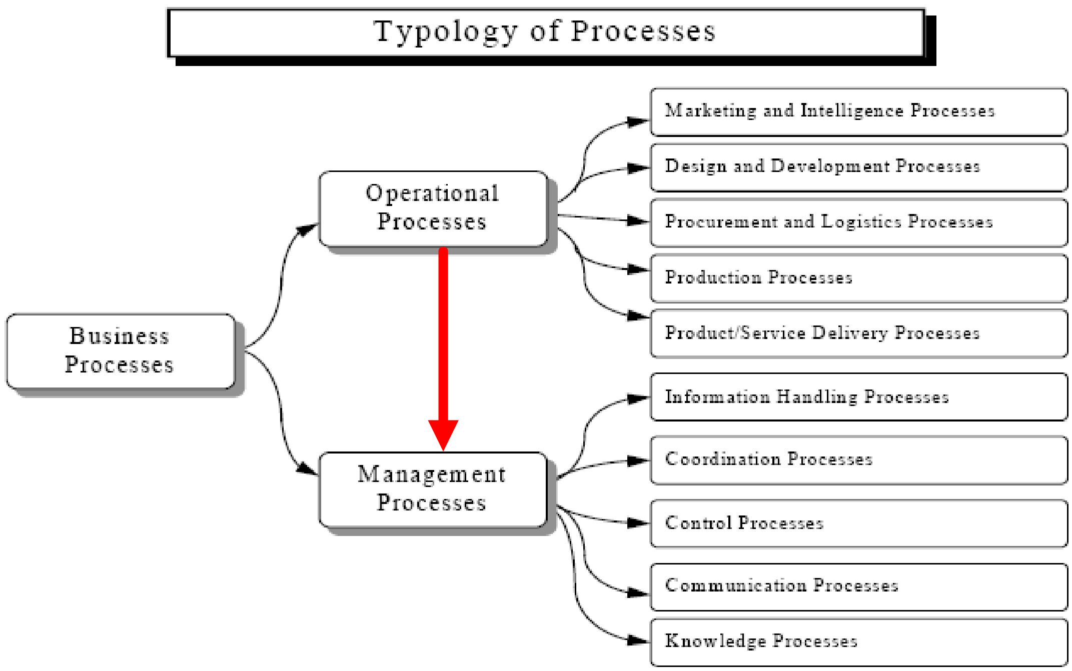


Figure 1 Typology of Business processes by Mooney (2001) with shift toward management processes

In short, this shift calls for more research on the success of business process redesign projects based on representational approaches.

2 Research defined

2.1 Research scope

This research will be conducted for a bachelor thesis. Therefore the time scope will be relatively small, about three full-time months. The research population is limited to employees of OHRA. Three types of business process representation models will be used: Communication Flow, Activity Flow and a combination. Their impact on perceived business process redesign success will be examined.

2.2 Research statement

Which process modeling representation approach is most beneficial in business Process Redesign of a knowledge intensive service organization like OHRA: A Communication Flow Approach, an Activity Flow modeling approach or a combination?

2.3 Practical and theoretical significance of research

This research is based on and continues that of Kock, Danesh and Komiak (2008): A discussion and test of a communication Flow Optimization approach for Business Process Redesign. Their research describes the key success factors involved in organizational change through business process redesign. One of the limitations is that the subjects of testing are students enrolled in junior and senior level courses: in a college context. Clearly, college students will have a different perspective from those who have already graduated and entered the workforce (Kock, Danesh, Komiak, 2008, p. 83).
The present research question addresses a gap in existing knowledge by studying the different modeling approaches in an actual organizational context as opposed to an experimental setting with students. Therefore this theoretical knowledge can be used to improve practices of describing business processes within an organization. Secondly, a third type of model is introduced, a combination (between an activity and communication) model, next to the basic two (1) activity and (2) communication described by Kock et al (2008). The theoretical model proposed by Kock et al. (2008) was not changed; there is construct equalization. The model was created using a literature study, which, as opposed to their research itself did not focus on students but on an actual organizational context.

2.4 Main objectives

The goal is to measure the results of the business process modeling representations in an organization actually dealing with a redesign project to extend the knowledge of which process modeling approach is more beneficial to the implementation of a business process redesign: the communication flow modeling representation, the activity flow process modeling representation or a combination.

The most beneficial model will then be used to create a report for OHRA depicting the business processes involved in the Portfolio management, which can be used to identify opportunities for process improvements. The content of this report will be shown in a second report: ‘Portfolio management Rapport 2008’ (Dutch).

2.5 Research questions

From the research statement two research questions are derived and stated below. This study relies on the work of Kock and Murphey (2008); their theoretical model is used as basis here to find the most beneficial process modeling representation approach within OHRA, though using different process modeling representation types and a different population. A comparison of the results of these two researches will then reflect the differences attributed to it.

1. What are the main similarities and differences between the results of the research by Kock, Danesh and Komiak (2008) and this research?

2. Which process modeling representation approach is most beneficial within OHRA?

3 Theoretical framework

The following section has two functions. First of all to clearly define and create insight in this research. Secondly, it will define the terminology used.

3.1 Assumptions research scope

As stated in the former section this research's focus is to identify which business process model is most suitable for a knowledge intensive organization, OHRA, through an experiment with employees.

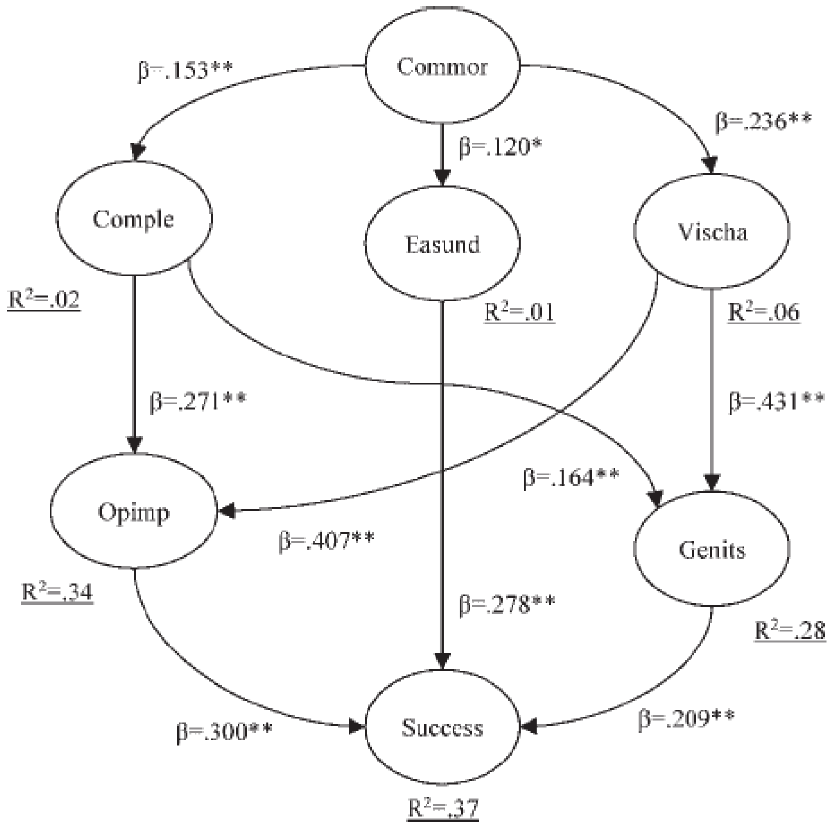
"The category of knowledge-intensive companies refers to firms where most work is said to be of an intellectual nature and where well-educated, qualified employees form the major part of the work force. The company claims to produce qualified products and/or services (as cited in Mats Alvesson, 2001)". OHRA, the insurance company used in this experiment, fits the profile as a knowledge intensive organization and therefore qualifies for this research.

Barr & Hitt (1986) did research on differences in decision making between students and managers in evaluating applicants for jobs. Their findings were that managerial decision models vary significantly from student decision models. For one, "significantly more explanatory power is noted in the managerial decision models than in the student decision models. Furthermore managers also used substantially fewer factors in evaluating applicants than did the students (Barr, H & Hitt, A, 1986, p. 610)". Surely this could mean that the decision model for students and managers differ in the evaluation of business process models.

Management information systems (MIS) research seeks to find methods for reducing the communication gap between top management and the organizational information systems (IS) function. Business process models contribute to this goal. "However, it is not always practical or parsimonious to conduct these methods using top managers. Therefore, researchers often rely on students acting as surrogates for organizational managers and decision makers.(…) Findings from this study indicate that students are poor surrogates for measuring the perceptions and attitudes of CEOs (Walstrom, K.A. 2006)". Peterson (2001) also emphasizes the importance of replicating research based on college student subjects with nonstudent subjects before attempting any generalizations in research.

3.2 Business Process Redesign Success model (Kock et al.)

According to Kock, Danesh and Komiak (2008) BPR success is predicted by six factors: flow representation, completeness, ease of understanding, visualization, opportunities for improvement, and generic IT solutions. A proposed model of these factors was created to predict perceived BPR success:



Commor= communication flow orientation
Comple= completeness of model
Vischa= support for visualization of process change
Easund= ease of understanding
Opimp= Usefulness in identification of opportunity for process improvements
Genits= usefulness in the development of generic IT solution
Success= redesign Success

Figure 2 BPR success model proposed by Kock, Danesh and Komiak (2008)

In the section below the results of the research of Kock, Danesh and Komiak (2008) will be described. In appendix 4 an overview of the literature and hypotheses of Kock et al. is given. The hypotheses in this research are based on their work.

The findings of Kock's research were that the ease of understanding, opportunities for improvement, and generic IT solutions were all significantly ($p<0.01$) positively related to the perceived success of a BPR project. Furthermore approximately 37% of the variance in perceived BPR success was accounted for by the six independent variables. In total the proposed model was acceptable.
Their findings on their hypotheses related to the variables were the following:
A Communication flow representation, business process model with a higher communication flow orientation, will be perceived to produce a better visualization of process change and a more complete model than a model with a lower communication flow orientation
A business process model that is perceived to produce a better visualization of process changes and is more complete is also perceived as more useful for the identification of opportunities for improvement and in the development of generic IT solutions than a model with lower visualization and less complete.
A business process model that is perceived as more useful for the identification of opportunities for improvement, the development of generic IT solutions and is easier to understand is perceived as enabling a greater degree of redesign success than a model that is less useful for the identification of opportunities for improvement, less useful in the development of generic IT solutions and less easy to understand (N. Kock, A. Danesh and P. Komiak, 2008, p. 82).

The whole idea is that the amount of orientation toward communication flow in a BPR project is reflected in the BPR success. The underlying assumption of Kock et al. (2008) is that organizations are highly dependent on structured communication in order to create action to produce and deliver services. They conclude that the majority of business process inefficiencies are due to communication related problems.

Students who have no past experience in a work environment have not undergone these problems and therefore are less able to act upon them in choosing an appropriate model.

This theoretical model proposed by Kock et al. (2008) was not changed; there is construct equalization. The model was created using a literature study, which, as opposed to their research itself did not focus on students but on an actual organizational context.

3.3 Proposed Theoretical model

This research is theory testing, which means that from the literature review, predictions or hypothesis are made. Then data is collected within the organizational context to refine the theory. The theoretical model used by Kock, Danesk and Komiak (2008) (figure 3) shows the following **latent variables** –

- Flow representation
- Completeness
- Ease of understanding
- Support for visualization of process change
- Usefulness in identification of opportunities for improvement
- Usefulness in the development of generic IT solutions

The independent variable is the Flow representation type and the dependent variable is BPR success. The semantic definitions of the variables are stated below:

Flow representation	Communication flow, Activity flow or combination
Ease of understanding	Ease of interpreting the symbols and understanding the relations between the model constructs
Completeness of the model	Degree to which the model contains/reflects all parts necessary to work with the model
Visualization of process change	Degree to which possible changes in the process can be made graphically visual
Opportunities for improvement	To which extent improvement opportunities can be identified from the model
Usefulness in the development of a generic IT solution	Degree to which the model can be used in the representation of the information technology as it relates to the proposed process after the redesign has been fully implemented; A generic IT solution is a diagram about the computer- based solution used for the proposed redesign.
Redesign success	Degree of accomplished improvements by means of elevating efficiency and effectiveness of the business process that exist

From the findings of Kock & Murphey (2008) the following basic predictions or hypotheses can be made, which are split into two groups. The first group hypothesizes the differences between the communication flow model and the activity flow model toward the variables; The second is related to the differences between the combination model and the communication flow representation model.

	Communication flow versus activity flow model		Combination model versus communication flow model
H1	A communication flow model has a higher communication flow orientation than an activity flow model and therefore will be perceived to produce a more complete model than an activity flow model.	H11	The combination model representation will be perceived to produce a more complete model than a communication flow model (according to assumption 1).
H2	The communication flow model will be perceived to have a lower ease of understanding than an activity flow model.	H 12	The combination model representation will be perceived to have a lower ease of understanding than a Communication flow model (according to assumption 2).
H3	A communication flow model has a higher communication flow orientation than an activity flow model and therefore will be perceived to produce a better visualization of process change.	H 13	The combination model representation will be perceived to produce a better visualization of process change than a communication flow model (according to assumption 1)
H4	A communication flow model is perceived to produce a better visualization of process change and therefore will also be perceived as more useful for the identification of opportunities for improvement	H14	The combination model representation will be perceived to produce a better visualization of process change than a communication flow model (H13). Therefore it will also be perceived as more useful for the identification of opportunities for improvement than a Communication flow model.
H5	A communication flow model is perceived to produce a more complete depiction of processes and therefore will also be perceived as more useful for the identification of opportunities for improvement.	H15	Due to H1 the combination model will also be perceived as more useful for the identification of opportunities for improvement than a Communication flow representation.
H6	A communication flow model is perceived to produce a more complete view of processes and therefore will also be perceived as more useful in the development of generic IT solutions than an activity flow model.	H16	The combination model representation is perceived to produce a more complete view of processes and therefore will also be perceived as more useful in the development of generic IT solutions than a Communication flow representation.
H7	A communication flow model is perceived to produce a better visualization of process change and therefore will also be perceived as more useful in the development of generic IT solutions than an activity flow model.	H 17	The combination model representation is perceived to produce a better visualization of process change and therefore will also be perceived as more useful in the development of generic IT solutions than a Communication flow representation.
H8	A communication flow model is perceived as more useful in the development of generic IT solutions and therefore is also perceived as enabling a greater degree of redesign success than an activity flow model.	H 18	The combination model representation is perceived as more useful in the development of generic IT solutions and therefore is also perceived as enabling a greater degree of redesign success than a Communication flow representation.
H9	A communication flow model is perceived as more useful for the identification of opportunities for improvement and therefore is also perceived as enabling a greater degree of redesign success than an activity flow model.	H19	The combination model representation is perceived as more useful for the identification of opportunities for improvement and therefore is also perceived as enabling a greater degree of redesign success than a Communication flow representation.
H10	A communication flow model is perceived as having a lower ease of understanding than an activity flow model and therefore is also perceived as enabling a lower degree of redesign success than an activity flow model.	H20	The combination model representation is perceived as having a lower ease of understanding and therefore is therefore perceived as enabling a lower degree of redesign success than a Communication flow representation.

Table 1: Hypotheses for research question 2

Figure 3 links the hypotheses to the theoretical model:

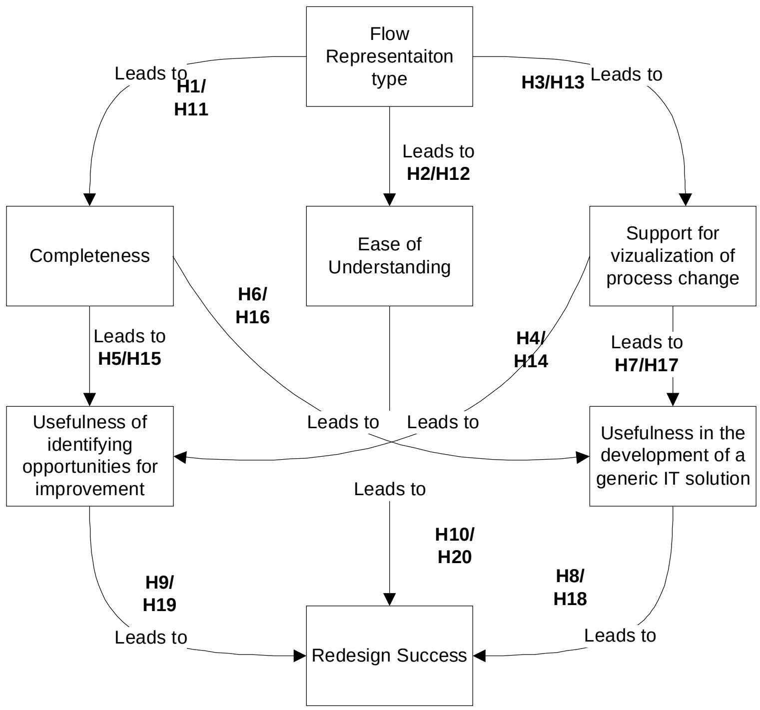


Figure 3 Theoretical model (N. Kock, Danesh and Komiak (2008), p.) specified for hypotheses 1 to 20

Throughout this research certain terminology will be used. To avoid confusion on the meaning of these terms, table 1 will give an overview of definitions used within this research.

Business process	A set of actions, automated or manual, that transform some input (data) into output (other data or information) (Katsma, 2005)
Process model representation	
Process modeling language	
Business process redesign (BPR)	Fundamental rethinking of business processes (Aalst, van der W.M.P. & Hee, van K.M, 1996)
Activity	A set of actions to realize a process
Activity flow representation	The chronological flows of activities in processes ((Kock & Danesh, 2008)
Communication flow representation	Process modeling representation in which the information flow in processes is central
Data	Characters that are accepted as input to an information system for further storing and processing. After processing, the data may become information. (Katsma)
Information	Data that have been processed and organized into output that is meaningful to the person who receives it. (Katsma) (Information can be mandatory, essential, or discretionary)
Knowledge	a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers (Davenport & Prusak, 1998).

Table 2: Basic definitions

4 Research design

The section below describes the research method, data collection method and gives an overview of the experiment and the process models used for the experiment.

4.1 Research method

Employees within OHRA will evaluate the three process modeling representation approaches through a questionnaire. This research is a field experiment; A Field setting is almost always preferred over laboratory for reasons of better external validity, though sacrificing some level of control of internal validity. As the research question states, the focus will be on three approaches: the Communication flow representation, the Activity Flow representation and a combination of the two approaches in which an Activity diagram with information flow will be used. The data type required is quantitative. This research is theory testing, in which hypothesis on the use of different process modeling representations will be tested. Quantitative research results in answers that are useful in accepting or rejecting the predictions made in the next section. Figure 4 shows the steps to be taken in this research. A detailed description follows below.

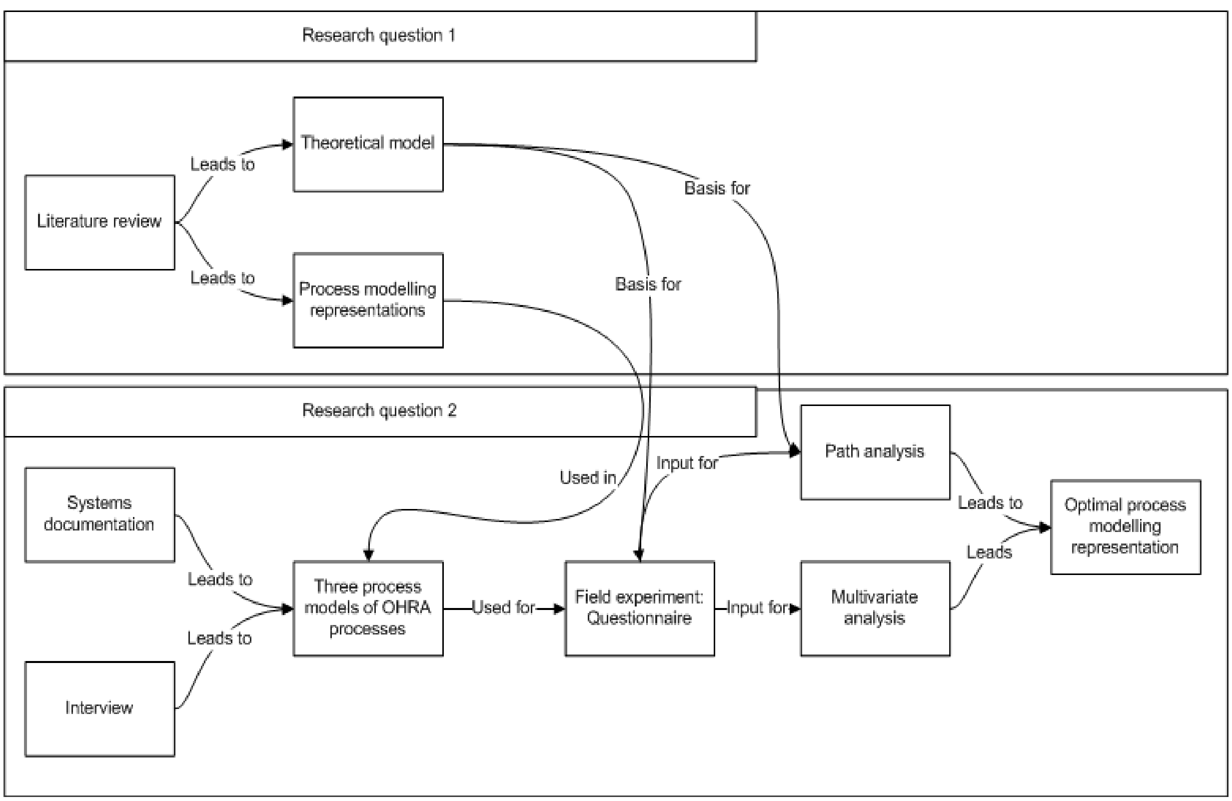


Figure 4 Research steps

4.2 Data Collection methods

During the reorganization project of OHRA **systems documentations** was made. Insight in these documents should lead to a greater objective understanding of the system. This

documentation can be used as starting point for the interviews. Any contradicting information in the documentation can be clarified in the interviews.
Data gathering will require **interviews** with subject matter experts who perform their jobs within the pricing process (see figure 5). A semi-structured interview is the method of choice. Interviewing can be time-consuming and can lead to personal biases. Self-interest may produce inaccurate information. A semi-structured interview has an open framework. Only a few questions are formulated beforehand. A matrix containing the basic topics is sufficient. This allows for flexibility to probe for details and follow up with new questions.

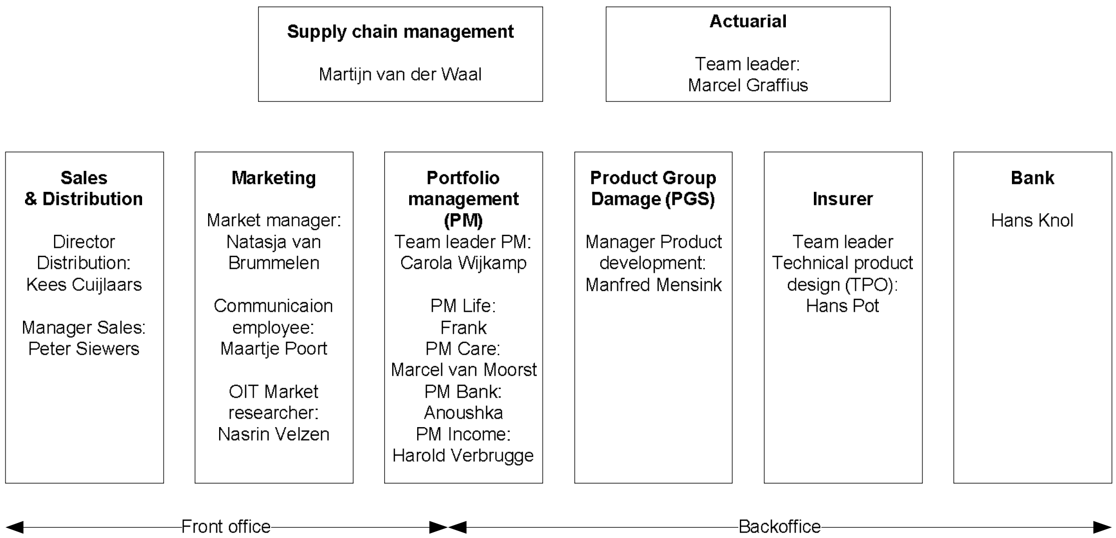


Figure 5: People interviewed per department

Observations are not feasible in this research due to the physical distance between actors. The employees within OHRA work on different locations in different cities: Arnhem, Zwolle or Amsterdam. Furthermore the above two methods should give sufficient information on the process. The information collected through interviews was based on facts on processes and was compared to the documentation. The data and information collected in the above phase combined with the process modeling theories from the literature review will be used to create the three context models.

4.3 Overview of the experiment

The three flow representation models described above will be used in the field research in which participants will each examine one of the three models. Then a questionnaire will be administered to convey their opinion on the modeling representation . The results of the questionnaire should ultimately lead to the choice of a process modeling representation for perceived business process redesign success.

4.3.1 Design and Measures

The factor that varies between the participants is the type of representation: communication flow, activity flow or a combination. The dependent measure is perceived business process redesign success. This is measured using the following five dependent variables:

- Completeness
- Ease of understanding
- Support for visualization of process change
- Usefulness in identification of opportunities for improvement
- Usefulness in the development of generic IT solutions

4.3.2 Materials

Three modeling diagrams were created: a Data flow diagrams, the second an Activity diagram and the third a combination (Activity diagram with information flow). Each participant received four forms: one to fill in their personal information, one description of the assignment, one type of model and the questionnaire questions.

4.3.3 Participants

Participants in the field experiment are 15 employees within OHRA who work in portfolio management or interact with Portfolio management: The Portfolio management team itself, Marketing, Sales, Distribution, OHRA Insurer and OHRA Bank. The participant had previous experience with process modeling, mainly activity diagrams, as the year before they had participated in the modeling of the processes in a redesign project (REFRESH).

4.3.4 Procedure

The participants are divided into three groups using stratified random sampling: Employees from each department (Portfolio, Marketing, Sales, Distribution, OHRA Insurer and OHRA Bank) were randomly split into three groups. Each groups is randomly assigned to assess one of the three modeling representations. The administration of the questionnaires leads to three data sets: one for DFD, one for AFD and one for AFDI each containing five questionnaires. The participants conduct the experiment individually. They first received two forms, one to fill in personal information as occupation and department and one on the procedure of the experiment. Then an instruction form was given in which the goal of the experiment was stated and the semantics of the specific modeling representation were described. The model and the questionnaire are given simultaneously; the participants are allowed to review the model while filling in the questionnaire. There is no time limit to complete the questionnaire.

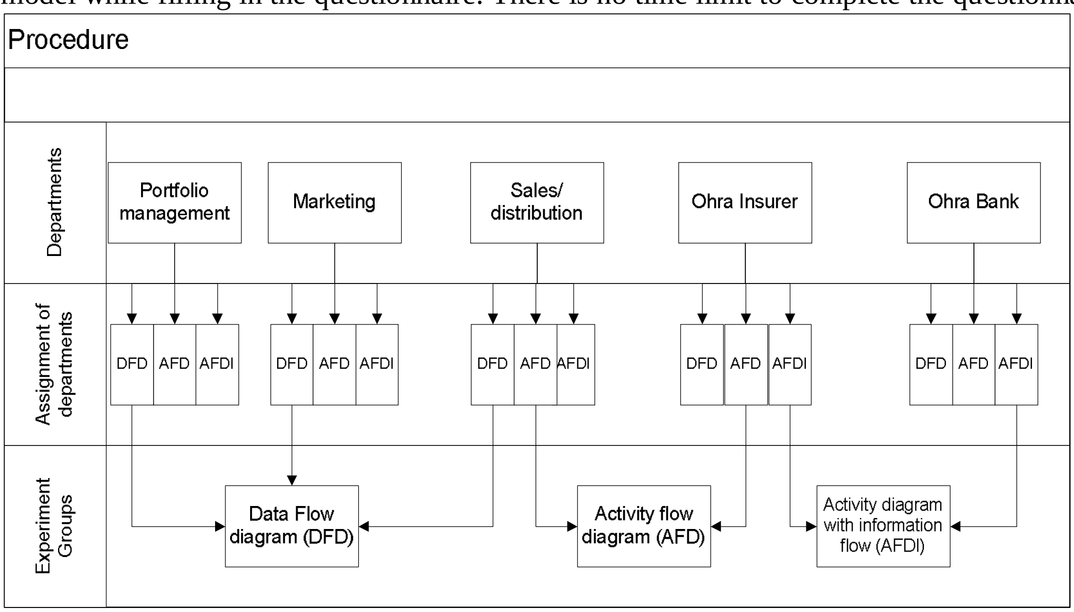


Figure 6 DFD= data flow diagram, AFD = Activity flow diagram, AFDI – Activity flow diagram with information flow

4.3.5 Questionnaire type

In the former research of Kock & Danesh, on which this research is based, a questionnaire was designed and pre-tested. In this questionnaire two or three statements were made using positively and negatively worded items per latent variable and a seven item Likert scale was used. The full questionnaire can be found in appendix 5.

In this research a six point Likert scale was chosen. It is often used in instruments measuring opinions, beliefs, and attitudes, in this case attitudes toward different representation models. It is useful for these statements to be fairly strong when used in a Likert format (DeVellis R.F. 2003, p. 79). The choice for six response items as opposed to seven stems from the fact that a definite preference for side A or side B is wanted. There is no midway.

4.4 Characteristics of the process modeling representation approaches

Although overlap occurs, process modeling representations must not be confused with the process modeling language used. Here, the representation refers to the actual graphical representation of the business processes in terms of a business process model; In this case the possible models are activity, communication or a combination. While the process modeling language refers to the semantics used in the model. This research focuses on the various process modeling representation.

Process representations may differ between process modeling techniques. An Activity flow representation model describes processes as a set of interrelated chronological flows of activities whereas a Communication flow model is based on information flow.

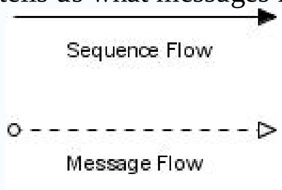
> "A successful modeling requires the use of an adequate notation or language. The primitives of a software process modeling language have to be chosen so that process concepts can be naturally expressed. Nevertheless, we should be aware that probably "the" process language will never be defined (Armenise et al. 1993)".
>
> The effectiveness of (…) a process description language in particular, depends on the context in which it is used, the objectives it is used for and the degree to which its features are understood and used (Rombach, D, 1990).

The above two statements show that the choice of a process modeling language is not a trivial decision. Yet BPMN is becoming the standard. An adaptation of BPMN was chosen for this research; Why? The answer is quite simple:
The most important aspects in choosing a language are (1) that the language depends on the context in which it is used, (2) the objectives and (3) the degree to which its features are understood.

Within OHRA the shapes (language notations) shown in table 3 and figure 7 for the activity flow diagram were already being used in the organization. To comply with the context in which the models were used and the degree to which the features are understood these symbols were used in the modeling representations. In the next section the different process representations and languages will be explained.
BPMN uses four groups of elements, flow objects, connecting objects, swim lanes and artifacts. Here, each of these groups will be explained.

Flow Objects: Events, Activities, Gateways
Event: An Event is represented with a circle and is something that happens. It could be Start, Intermediate or End. This element is a trigger or a result.
Activity: An Activity is represented with a rounded-corner rectangle and shows us the kind of work which must be done. It could be a task or a sub-process. A sub-process also has a plus sign in the bottom line of the rectangle.
Gateway: A Gateway is represented with a diamond shape and will determine different decisions. It will also determine forking, merging and joining of paths.
Connecting Objects: sequence flow and message flow
The Flow Objects are connected to each other with Connecting Objects such as:

Sequence Flow: A Sequence Flow is represented with a solid line and arrowhead and shows in which order the activities will be performed. A diagonal slash across the line close to the origin indicates a default choice of a decision.
Message Flow: A Message Flow is represented with a dashed line and an open arrowhead. It tells us what messages flow between two process participants.



Artifacts: allow developers to bring some more information into the model/diagram. In this way the model/diagram becomes more readable. There are three pre-defined Artifacts and they are: Data Objects, Group, Annotation.
Within and between the standerd BPMN models, many types of Diagrams can be created depending on the objective and representation.

4.4.1 Activity flow representation

In an activity flow representation, in this case a BPMN activity diagram, the main process being modelled (e.g. product development) consists of swim lanes. These represent the organizational functions (e.g. Marketing, Distribution etc). In swim lanes the rectangles depict the activities performed by that specific function.

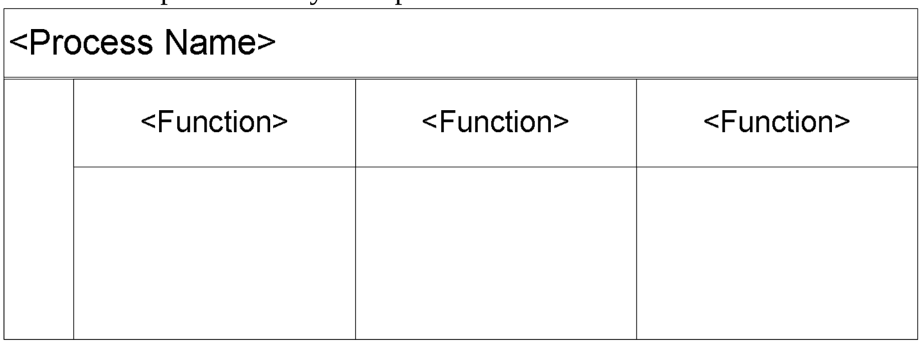


Figure 7: Example of swimlane in Activity flow representation

The arrows represent the direction of execution, or the chronological flow of activities. The diamonds represent decisions to be made. The parallelogram is the data that flow from a specific activity and the curved rectangle an actual tangible document. These are types of artifacts in BPMN. Table 2 shows the main symbols used in the adapted activity diagrams in this research.

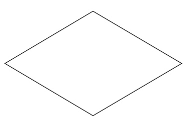
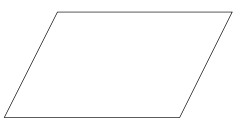
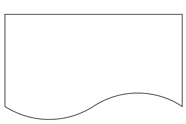
	(Computer) processing	A (computer) performed processing function. Usually results in a change in data or information.
	Decision	A decision-making step; used to show branching to alternative paths.
	Data	A unit of data that is considered indivisible and may consist of data items.
	Document	A document or report: the document may be prepared by hand or printed by a computer.
	Document or processing flow	Direction of processing or document flow; normal flow is down and to the right.

Table 3 Activity diagram symbols

For an example of an activity diagram appendix 1 can be referred to. It contains the activity diagram belonging to the flow model used in this research.

4.4.2 Communication flow representation

A data flow diagram is used as communication flow representation. In this representation plain rectangles represent the organizational functions which are data sources or destinations, which were the swim lanes in the activity flow representation. These functions can be individuals, departments or external organizations. The circles depict the activities and the double horizontal lines represent the information repositories. The arrows in this model represent the flow of information in the process. Chronology of activities is not shown.

Data flow diagram

Data Flow Diagrams (DFD) can be used to map the business processes and the data flows between the processes. The four most important components of this DFD are:

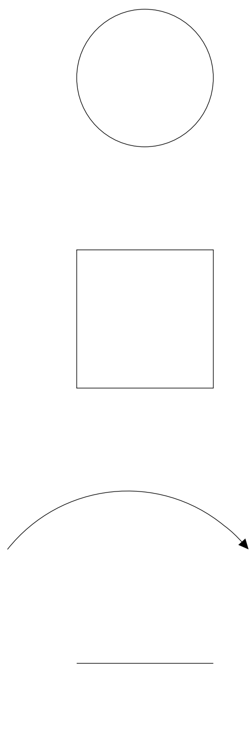
	**Transformation Process**	The processes that transform data from input to outputs are represented by circle.
	Data sources and destinations	The people and organizations that send data to and receive data from the system are represented by square boxes.
	Data flows	The flow of the data into or out of a process is represented by curved or straight lines with arrows.
	Data repository	The storage of data is represented by two horizontal lines

Table 4 Data flow diagram symbols

For an example of a Data flow diagram appendix 2 can be referred to. It contains the Data flow diagram belonging to the communication flow model used in this research.

4.4.3 Combination: Activity diagram with information

The same BPMN language was used in the creation of this third business process modeling representation. The swim lane construction as in the activity diagram will be used in this representation as for the chronology of activities. The symbols for data and documents of the activity diagram also apply in this model representation.

The element of the communication flow representation that will be used is the flow of information between functions through activities. Therefore there will be two types of arrows as shown in the diagram below.

	Activity flow	Direction of processing activity
	Information flow	Direction of information flow

Table 5 Extra symbols for combination model

An example of a combination model can be found in appendix 3. This is the combination model from OHRA used in this research.

4.5 Data analysis methods

The data analysis requires various steps and tests which will be described here.
Steps in data analysis:

First all the questions are changed into variables in SPSS. The scaling for all the variables is interval. Then a last variable is made for representational approach in which a communication flow approach is given value one, an activity diagram a value two and the combination model value three. Then the data from the questionnaires is filled in the data view. In this section the numbers of the questionnaire results of the negatively worded questions are reversed for an unproblematic analysis. Now the analysis can proceed.

1. The reliability of the questionnaire items scaling in measuring the corresponding variables is found using Cronbach's alpha coefficient. This will be done to determine whether the contructs are reliable measures of the latent variables.
2. Correlation coefficients are determined. These show if there is any relationship between the variables in the theoretical model. Pearsons correlations are used to answer the question if two or more variables are related to each other. This correlation can be positive, negative or non-existing, but does not say anything about the direction of the relation (which variable causes the other). This is a starting point for the next two analyses.
3. Path analysis is done to verify the path of the theoretical model; In this section the direction of the relationships will be determined; Path analysis will be done to assess the direct and indirect effects of the variables that were theorized to be causes of other variables and what amount of the variation of perceived BPR success is accounted for using the latent variables as suggested by Meyers et al. (2006). Regression analysis is used to determine to what extent the independent variables (the variables "doing the pointing") are good predictors of the dependent variables (the variables "being pointed towards") in the theoretical model to assess the prediction power of perceived BPR success. This model is a "multistage model" meaning that there is more than one independent variable. For each independent variable a separate regression analysis needs to be done; Here, a total of five analyses need to be done.
4. Multivariate analysis of variance (MANOVA): Rarely is one behaviour (variable) so isolated from other aspects of the overall response that it can paint a comprehensive picture of a situation. MANOVA (multivariate analysis of variance) is applied to designs with multiple dependent measures, which is very relevant in this research.

In measuring the perceived BPR success, the three variables Ease of understanding, development of a generic IT solution and Opportunities for improvement may affect it. The variables Opimp and Genits are on their turn influenced by multiple variables (Comple and Vischa). With MANOVA many dependent variables are simultaneously analyzed within a single ANOVA design; The dependent variables in a MANOVA design are combined into a weighted linear composite in which the variate is maximally distinguished between the groups.

There are circumstances under which we would either not want to use MANOVA or approach MANOVA with considerable caution (see Bray & Maxwell, 1985, as cited in Meyers, p.366). They suggest that MANOVA should not be used if the dependent variables are uncorrelated or highly correlated and that the ideal situation for using MANOVA is when the dependent variables are moderately correlated.

In this research the number of responses per variable varies between ten and fifteen. A confidence level of 95% which is used in most tests is on the high side for this research because of the low number of responses (10 to 15 per variable). Dealing with a population with a normal distribution, a confidence level of 88% was chosen even though 95% is more common. This means that a two-sided significance of 0.24 is required, corresponding to a one-sided test of 0.12.

To answer the hypotheses two separate MANOVA tests will be done. One in which the means of the communication flow and activity flow representation will be compared and one for the communication flow and the combination model representations. MANOVA tests exist in which three or more variables can be compared simultaneously; due to the hypothesis statements and the researchers lack of experience with statistical analysis, this is discouraged (Meyers, Gamst and Guarino).

In this analysis μ_{1j}, μ_{2j}, μ_{3j} are the means of the scores on each criteria of respectively the (1) Communication flow representation, (2) the Activity flow representation and (3) the Activity flow representation with information flow. In which j represents the individual variable scores for that specific approach.

Name	**Factor**	**μ_{ij}, where i=approach (1,2,3), j=variable (1,..,6)**
Easund	Ease of understanding	μ_{i1}
Comple	Completeness	μ_{i2}
Genits	Identification of generic IT solution	μ_{i3}
Opimp	Opportunities for improvement	μ_{i4}
Vischa	Visualization of process change	μ_{i5}
Succes	Perceived BPR success	μ_{i6}

MANOVA (Hotelling T^2) creates a vector (variate or weighted linear composite) that best separates the levels or categories of the independent variable. Hotelling's T^2 in this research tests a multivariate null hypothesis of the form:

$$H_0: \begin{bmatrix} \mu_{1,1} & = & \mu_{2,1} \\ \mu_{1,2} & = & \mu_{2,2} \\ \mu_{1,3} & = & \mu_{2,3} \\ \mu_{1,4} & = & \mu_{2,4} \\ \mu_{1,5} & = & \mu_{2,5} \\ \mu_{1,6} & = & \mu_{2,6} \\ \mu_{1,7} & = & \mu_{2,7} \\ \mu_{1,8} & = & \mu_{2,8} \\ \mu_{1,9} & = & \mu_{2,9} \\ \mu_{1.10} & = & \mu_{2.10} \end{bmatrix} H_1: \begin{bmatrix} \mu_{1,1} & > & \mu_{2,1} \\ \mu_{1,2} & < & \mu_{2,2} \\ \mu_{1,3} & > & \mu_{2,3} \\ \mu_{1,4} & > & \mu_{2,4} \\ \mu_{1,5} & > & \mu_{2,5} \\ \mu_{1,6} & > & \mu_{2,6} \\ \mu_{1,7} & > & \mu_{2,7} \\ \mu_{1,8} & > & \mu_{2,8} \\ \mu_{1,9} & > & \mu_{2,9} \\ \mu_{1.10} & < & \mu_{2.10} \end{bmatrix} \text{ and } H_0: \begin{bmatrix} \mu_{3,1} & = & \mu_{1,1} \\ \mu_{3,2} & = & \mu_{1,2} \\ \mu_{3,3} & = & \mu_{1,3} \\ \mu_{3,4} & = & \mu_{1,4} \\ \mu_{3,5} & = & \mu_{1,5} \\ \mu_{3,6} & = & \mu_{1,6} \\ \mu_{3,7} & = & \mu_{1,7} \\ \mu_{3,8} & = & \mu_{1,8} \\ \mu_{3,9} & = & \mu_{1,9} \\ \mu_{3.10} & = & \mu_{1.10} \end{bmatrix} H_1: \begin{bmatrix} \mu_{3,1} & > & \mu_{1,1} \\ \mu_{3,2} & < & \mu_{1,2} \\ \mu_{3,3} & > & \mu_{1,3} \\ \mu_{3,4} & > & \mu_{1,4} \\ \mu_{3,5} & > & \mu_{1,5} \\ \mu_{3,6} & > & \mu_{1,6} \\ \mu_{3,7} & > & \mu_{1,7} \\ \mu_{3,8} & > & \mu_{1,8} \\ \mu_{3,9} & > & \mu_{1,9} \\ \mu_{3.10} & < & \mu_{1.10} \end{bmatrix}$$

To determine which model is most beneficial for perceived business process redesign success the twenty hypotheses will be tested. The first ten hypotheses are a comparison of the communication flow and the activity flow model. The last ten hypotheses have to do with the combination and communication flow model.

5 Results

In this section the hypothesized causal relationships between the variables in the theoretical model will be tested to determine how well they fit the data; The technique, Path analysis, will be used. Then, the mean values of the variables of the different process models will be compared to determine which process model is most suitable; Here MANOVA proves to be an appropriate test.

5.1 Cronbach's Alpha

Table 6 shows on the left side the variables as stated in the theoretical model and on the right the results of the analysis. Appendix 4 shows the Study measures and the corresponding questionnaire items and in appendix 6 the full list of alpha's can be found.
The reliability of the constructs is determined using Cronbach's alpha coefficient of internal validity.

Variable	Abbreviation	Cronbach's Alpha (CA)	CA of Kock, Danesh, Komiak
Ease of understanding	Easund	0.831	0.908
Completeness	Comple	0.321	0.893
Visualization of change	Vischa	0.560	0.919
Opportunities for improvement	Opimp	0.389	0.894
Identification of generic IT solution	Genits	0.701	0.928
Perceived BPR Success	Succes	0.822	0.923

Table 6 Construct validity refers to the degree to which inferences can legitimately be made from the operationalizations in a study to the theoretical constructs on which those operationalizations were based.

The response items belonging to the variables Easund, Vischa, Genits and Succes all have high reliability (>0.5); The items or constructs belonging to these variables relate well to each other in measuring the variables. The two variables Comple and Opimp on the other hand have relatively low values. Kock, Danesh and Komiak (2008) have already verified the reliability of the construct in a larger research population. Therefore I conclude that the difference in values of the constructs in this research and that of Kock et. Al. is due to the low amount of respondents in this research.

5.2 Correlation coefficient

In table 7 the correlations between all variable are depicted. Figure 8 shows only those that are relevant according to the theoretical model. For the original tables from SPSS appendix 8 should be consulted.

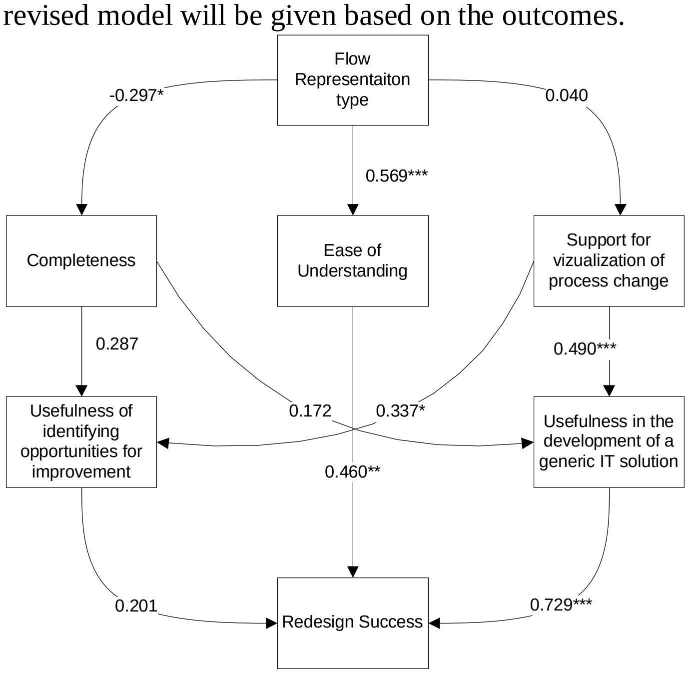
	Easund	Comple	Gentis	Opimp	Vischa	Succes
Easund	1					
Comple	-0.20	1				
Genits	0.432**	0.172	1			
Opimp	0.320***	0.287	0.204	1		
Vischa	0.238	0.121	0.490**	0.337*	1	
Succes	0.460**	0.317***	0.729**	0.201	0.427**	1
Approach	0.569***	-0.297*	0.174	0.297**	0.040	0.192

*Correlation is significant at 0.12-level
**Correlation is significant at 0.05-level
***Correlation is significant at 0.01-level

Table 7: Correlation coefficients between variables

The stars mark the level at which the correlation is significant; in this research an alpha-level of 0.12 is significant. Of the significant correlations the categorization can be made of large, moderate and small correlation. Using the categorization provided by Cohen (1988) (correlation: 0.5= large, 0.3=moderate and 0.1=small) the blue boxes reflect large correlation, the purple the moderate. Of course the context in which the correlation is judged has effect on the appropriate appraisal of the statistical significance of a correlation coefficient. Smaller samples require higher correlations for statistical significance. For that reason the test of significance at α= 0.05 and α=0.01 is mentioned as well as the significance level used in this research 0.12.

As one can see in the table, the theoretical model does not contain all significant relationships and needs to be adjusted. First we will go on with testing this model, in a next section (5.5) a revised model will be given based on the outcomes.



*correlation is significant at 0.12-level
**correlation is significant at 0.05-level
***correlation is significant at 0.01-level

5.3 Path analysis

In the test, the adjusted R-squared or determination coefficient reflects the explained variance. In other words the correlation between the observed value of perceived BPR success and the predicted value of perceived BPR success. The β coefficients table presents the regression weights produced by the analysis and describe the relative importance of each independent variable in the multiple regression equation.

The SPSS output for the regression analysis is given in appendix 7 and that of the path analysis per dependent variable in appendix 12. Figure 8 shows the theoretical model with R-squared and β coefficients. The blue colored arrows show significant Beta-values; The thicker the arrow, the stronger the predictive power of that variable on the dependent variable is.

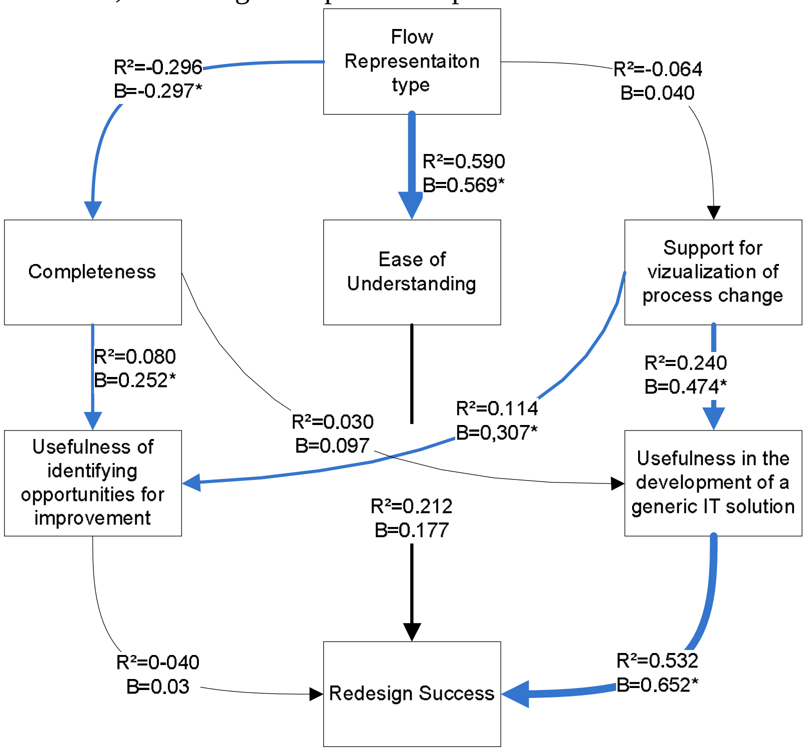


Figure 8: Model of perceived BPR success with R² coefficients

For the dependent variable perceived BPR success, the R² coefficient of 0.557 (see table 5) means that 55.2% of the variation in the dependent variable BPR success was explained by the three variables ease of understanding, support for generic IT solution and opportunities for process change meaning they are good predictors of perceived BPR success. A value of R² larger than 0.5 corresponds to a large interpretation power. Appendix 12 presents a summary of the R² and β coefficients between the independent and dependent variables in the theoretical model. The main conclusion will be discussed below.

Of the three predicting variables of BPR success, support for generic IT solution is the variable that most powerfully predicts BPR success.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,747[a]	,557	,502	,639

a. Predictors: (Constant), Genits, Opimp, Easund

Table 8: Model summary of regression analysis for prediction of perceived BPR success

In predicting the usefulness of opportunities for improvement, which is (in the theoretical model) determined by the variables completeness and visualization of change, both variables proved significant predictors. While for the variable “the development of a generic IT solution”, only the variable visualization of change provides a statistically significant unique contribution ($p<0.12$).

These results can to some extent be used to say something about the hypotheses stated on the various modeling representation approaches. For example, considering the relationship between visualization of process change and the identification of a generic IT solution; The initial theoretical model shows a strong positive causal relationship between them, meaning that a high value in visualization of process change will result in a high value of identification of a generic IT solution. These figures however were not specified for the different groups of hypotheses separately (communication versus activity and combination versus communication). This could have been done, but this was not the objective of this analysis. The objective of the path analysis was to test the causal relationships stated in the theoretical model *in general* for all three types of process modeling approaches. Now that the causal relationships have been determined, the next section (MANOVA) will test the mean differences of the variables using different process modeling approaches. These two results together (causal relationships and mean differences) can be used to accept or reject the hypotheses.

5.4 Multivariate analysis of variance

In this research the dependent variables have small to moderate correlations with each other. Appendix 8 shows the correlation matrix. One warning is in its place; There exists a moderate correlation between Genits and Easund (0.432). For the other dependent variables the correlation varies between 0.17 and 0.32 corresponding to small and moderate correlations. Furthermore under the assumption that the population has a normal distribution and the fact that the variables have an interval scale MANOVA is an acceptable model for analysis. The results of the two separate multivariate analyses of variance consisting of (1) the communication flow versus activity flow and (2) the communication flow versus combination model will be presented in this section.

5.4.1 Communication flow versus activity flow model

The descriptive statistics in table 9 shows that the communication group had somewhat higher mean scores than the Activity group on the variables Ease of understanding (Easund), Completeness of the model (Comple), development of a Generic IT solution (Genits), Visualization of process change (Vischa) and perceived BPR success (Succes). Only on the variable Identification of opportunities for improvement (Opimp) did the Activity group score higher. Further analysis will show if this difference is statistically significant or not and what the implications are for the hypotheses.

Descriptive Statistics

	Approach	Mean	Std. Deviation	N
Easund	Communication	4,80	,789	10
	Activity	4,38	1,061	8
	Total	4,61	,916	18
Comple	Communication	3,80	1,549	10
	Activity	2,75	1,488	8
	Total	3,33	1,572	18
Genits	Communication	4,40	,843	10
	Activity	3,75	1,165	8
	Total	4,11	1,023	18
Opimp	Communication	3,20	1,317	10
	Activity	4,00	1,309	8
	Total	3,56	1,338	18
Vischa	Communication	4,40	,843	10
	Activity	3,63	1,061	8
	Total	4,06	,998	18
Succes	Communication	4,20	,789	10
	Activity	3,88	1,126	8
	Total	4,06	,938	18

Table 9: Descriptive statistics of Communication versus Activity

Bartlett's Test of Sphericity[a]

Likelihood Ratio	,000
Approx. Chi-Square	47,483
df	20
Sig.	,001

Tests the null hypothesis that the residual covariance matrix is proportional to an identity matrix.

a. Design: Intercept+Approach

Bartlett's test of sphericity is shown to be statistically significant in table 8. This indicates that there is sufficient correlation between the dependent variables to proceed with the analysis.

Table 10: Bartlett's test of Sphericity

Now the multivariate test results in table 10 will be reviewed. The Hotelling's T^2 value is translated into four multivariate test statistics that are expressed as F values. Because this is a two group comparison, all four values are equal. In this research the test shows that Roy's largest root yields an F value of 97.223, which is statistically significant. Now that statistical significance is detected, a deeper analysis of the variables can be done.

Table 11 also depicts a partial eta-squared value of 0.637 indicating that nearly 65% of the variance is accounted for by the combined dependent variables. The significance level of 0.045 ($<p=0.05$) shows that it is not probable that this occurred due to chance.

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	,981	97,223[a]	6,000	11,000	,000	,981
	Wilks' Lambda	,019	97,223[a]	6,000	11,000	,000	,981
	Hotelling's Trace	53,031	97,223[a]	6,000	11,000	,000	,981
	Roy's Largest Root	53,031	97,223[a]	6,000	11,000	,000	,981
Approach	Pillai's Trace	,637	3,212[a]	6,000	11,000	,045	,637
	Wilks' Lambda	,363	3,212[a]	6,000	11,000	,045	,637
	Hotelling's Trace	1,752	3,212[a]	6,000	11,000	,045	,637
	Roy's Largest Root	1,752	3,212[a]	6,000	11,000	,045	,637

a. Exact statistic

b. Design: Intercept+Approach

Table 11: Multivariate test for dependent variables

The means and standard deviations of the two types of representations are shown in table 12 together with the results of the MANOVA. The variables Comple, Vischa, Genits and Opimp show statistical significance, meaning that there is a significant difference in means between the two groups Activity and Communication (see table 11). The variables Easund and Success on the other hand do not show statistical significance. A summary of the implication of these finding for the hypothesis will be given in the next section. The SPSS output that lead to table 12 is presented in appendix 13.

Variable	Mean		Std. deviation		F	Sig.
	G1	G2	G1	G2		
Easund	4.80	4.30	0.789	0.945	0.953	0.343
Comple	3.80	3.10	1.549	1.542	2.113	0.165*
Genits	4.40	3.75	0.843	1.165	1.890	0.188*
Opimp	3.27	3.80	1.438	1.082	1.649	0.217*
Vischa	4.40	3.56	0.843	1.014	2.992	0.103*
Succes	4.27	3.82	0.884	0.982	0.519	0.482

G1= Communication flow model
G2= Activity flow model
Table 12: Summary of MANOVA for dependent variables

Hypothesis 1 The difference between Completeness of the Activity and Communication model was significant. Therefore H_0 , suggesting that the means of the two models would be equal, will be rejected and therefore the hypothesis is statistically accepted: A communication flow model is perceived to produce a more complete model than an activity flow model.
Hypothesis 2 In this case the H_0 of equal means is accepted; There is insufficient evidence to support the hypothesis and it is rejected: A communication flow model is not perceived to have a lower degree of ease of understanding than an activity flow representation.
Hypothesis 3 is accepted: A communication flow model has a higher communication flow orientation than an activity flow model and therefore will be perceived to produce a better visualization of process change.
Hypothesis 4 states that a communication flow model is perceived to produce a better visualization of process change and therefore will also be perceived as more useful for the identification of opportunities for improvement. The MANOVA results show that the opposite is the case: There is statistical evidence that the Activity flow model is more useful for the identification of opportunities for improvement than the Communication flow model despite the lower visualization of process change. So although path analysis determined that Visualization for change was a significant predictor of the variable Opportunities for process improvement this hypothesis is rejected.
Hypothesis 5 A statistically significant difference between the variable Opportunities for Improvement and Completeness of the model of the Activity and Communication model was found. Path analysis furthermore found a significant causal relation between the Completeness of the model and the usefulness in finding opportunities for improvement. Therefore this Hypothesis is accepted: A communication flow model is perceived to produce A more complete depiction of processes and will therefore lead to a higher perceived usefulness for the identification of opportunities for improvement.
Hypothesis 6 As in the case of hypothesis 5, in testing both the variables Completeness of the model and the development of a generic IT solution, a statistical difference was found in the advantage of the Communication flow model. But here the Path analysis showed that the completeness of the processes depiction is not a good predictor of the application of a generic IT solution for that model. Therefore this hypothesis is rejected.
Hypothesis 7 From path analysis the conclusion was drawn that Visualization of process change was a good predictor of the perceived usefulness in the development of a generic IT

solution. The MANOVA test supports this: there is a statistical significant mean difference for the variables 'development of a generic IT solution' and 'Visualization of process change' in the advantage of the communication flow model. Therefore this hypothesis is accepted: A communication flow model is perceived to produce a better visualization of process change and therefore will also be perceived as more useful in the development of generic IT solutions than an activity flow model.
Hypothesis 8 As stated before, there was a significant difference between the models, looking at the development of a generic IT solution. Furthermore, the path analysis showed that the development of a generic IT solution was a strong predictor of perceived BPR success. But even though there is a strong relationship between Genits and Succes and Genits' mean was significantly different in both models, the difference in means between the Activity flow and Communication model was not statistically significant for the variable perceived Success of BPR and the hypothesis is rejected. Obviously the contributions of the other variables to BPR success also played a role.
Hypothesis 9 Path analysis found that Opportunities for process improvement was a weak predictor of perceived BPR success, meaning that the values of the one variable does not predict the values of the other. Secondly, as stated in hypothesis 8 there was no significant difference in means of the variables BPR success in the Activity and Communication model. Therefore this hypothesis is rejected: A communication flow model is perceived as more useful for the identification of opportunities for improvement but is therefore not perceived as enabling a greater degree of redesign success than an activity flow model.
Hypothesis 10 This hypothesis is rejected: A communication flow model is not perceived as having a lower ease of understanding than an activity flow model and is therefore also not perceived as enabling a lower degree of redesign success than an activity flow model.

5.4.2 Communication flow versus Combination model

Table 13 containing the descriptive statistics shows that the Communication group had somewhat higher mean scores than the Combination group on the variables Easund, Genits, Vischa and Succes. On the variables Comple and Opimp the Combination group scores higher. In the next section the statistical significance of these differences will be tested.

Descriptive Statistics

	Approach	Mean	Std. Deviation	N
Easund	Combination	2,60	,699	10
	Communication	4,80	,789	10
	Total	3,70	1,342	20
Comple	Combination	4,10	,994	10
	Communication	3,80	1,549	10
	Total	3,95	1,276	20
Genits	Combination	3,40	,699	10
	Communication	4,40	,843	10
	Total	3,90	,912	20
Opimp	Combination	2,80	,422	10
	Communication	3,20	1,317	10
	Total	3,00	,973	20
Vischa	Combination	3,50	,527	10
	Communication	4,40	,843	10
	Total	3,95	,826	20
Succes	Combination	3,40	,699	10
	Communication	4,20	,789	10
	Total	3,80	,834	20

Table 13: Descriptive statistics of Combination/ communucation approaches

The multivariate test, which is depicted fully in appendix 13 reveals that the MANOVA test found statistical significance, with an F value of 12.062. Further analysis of the separate variables shows that the variables Easund, Genits, Vischa and Succes show statistical significance. The difference in mean values for these variables is significant when comparing the Communication with the Combination model. The difference between the mean values of the Communication and Combination model are not statistically significant for the variables Comple and Opimp (See table 14).

Variable	**Mean**		**Std. deviation**		**F**	**Sig.**
	G1	G2	G1	G2		
Easund	4.80	2.60	0.789	0.945	43.566	000*
Comple	3.80	4.10	1.549	1.542	0.266	0.613
Genits	4.40	3.40	0.843	1.165	8.333	0.010*
Opimp	3.20	2.80	1.438	1.082	0.837	0.372
Vischa	4.40	3.50	0.843	1.014	8.191	0.010*
Succes	4.20	3.40	0.884	0.982	5.760	0.027*

G1= Communication flow model G2= Combination model

Table 14: Summary of MANOVA for dependent variables

For the hypotheses, this leads to the following conclusions. The judgement on the first three hypotheses are easily determined, only by examining the MANOVA results. Later hypotheses will require MANOVA as well as path analysis to determine whether to accept or reject it.

Hypothesis 11 This hypothesis is rejected. The MANOVA test found that the combination model representation will be not be perceived to produce a more complete model than a communication flow model.

Hypothesis 12 This hypothesis is accepted according to the above findings: The combination model representation will be perceived to have a lower ease of understanding than a Communication flow model.

Hypothesis 13 The Communication, and NOT the Combination model representation, was found, according to the MANOVA test, to be perceived to produce a better visualization of process change. Therefore this hypothesis is rejected.

Hypothesis 14 No statistical significance was found for the difference in mean for either the Completeness of the model or for the usefulness in Opportunities for improvement. Therefore this hypothesis is rejected. Furthermore, path analysis found Comple to be a weak predictor of Opimp.

Hypothesis 15 The hypothesis is rejected: The combination model representation will not be perceived to produce a better visualization of process change than a communication flow model, as stated in hypothesis 3. Furthermore, there was no statistical evidence that the Combination model will be perceived as more useful for the identification of opportunities for improvement than a Communication flow model.

Hypothesis 16 The combination model representation was perceived to produce a more complete view of processes, but the mean value of the Communication model was statistically higher than that of the Combination model in relation to the development of a generic IT solution. The path analysis further showed a weak relationship between Comple and Genits. For these two reasons the hypothesis is rejected: The combination model representation is perceived to produce a more complete view of processes but it does not lead to a higher perceived usefulness of the development of generic IT solutions than a Communication flow representation.

Hypothesis 17 As stated in hypothesis 3, the Communication model was perceived to produce a better visualization of process change than the Combination model. The relationship between the visualization of process change and development of a generic IT solution is large and positive according to the path analysis. This corresponds to the related higher mean of the Communication model of the development of a generic It solution. This leads to the conclusion that the hypothesis is rejected: The combination model representation is not perceived to produce a better visualization of process change and therefore will also not be perceived as more useful in the development of generic IT solutions than a Communication flow representation.

Hypothesis 18 Based on the conclusions of hypothesis 7 this hypothesis too is rejected. The combination model representation was not perceived as more useful in the development of generic IT solutions and therefore was also not perceived as enabling a greater degree of redesign success than a Communication flow representation. The opposite was found, that the mean value of the variable BPR success of the Communication model was statistically higher than that of the Combination model.

Hypothesis 19 Based on hypothesis 6 the conclusion can be drawn that this hypothesis should be rejected. The combination model representation is not perceived as more useful for the identification of opportunities for improvement and therefore is also not perceived as enabling a greater degree of redesign success than a Communication flow representation.

Hypothesis 20 The combination model representation was, just as in hypothesis 1, perceived as having a lower ease of understanding. According to this hypothesis this would lead to a lower perceived degree of redesign success than in a Communication flow representation. The MANOVA test results support this result: the BPR success mean value of the communication flow representation is statistically significantly higher than that of the combination model. This hypothesis is therefore accepted.

The differences in outcomes concerning the hypotheses between path analysis and MANOVA can be attributed to the fact that the analyses were done on different data sets. The path analysis was done on the whole data set, whereas two separate MANOVA tests were done: one containing the data on the communication and activity model representation approach and one containing the data on the communication and combination mode representation approach.

5.5 Suggested model

The results of the path analysis and pearsons correlation test suggest that the current theoretical model does not fit the data best. The primary goal of this research is to test the proposed theoretical model, not to create an optimal model. Therefore it is not necessary to use a model-fitting approach to revise the model. “It should be borne in mind that “retrofitting” a model is more on the exploratory side than on the confirmatory or theory-testing sid of the continuum” (Meyers et al., 2006, p. 608). Yet, in order to compare the results of this research with that of Kock (2008) an attempt will be done to re-specify the model. According to Meyers et al. (2006, p. 602) “the best we can do within this approach is to re-specify the model and run the necessary multiple regression analysis again. Then we can at least place the beta weights from these new analyses on the paths.”

The correlation and regression schemes seem to suggest a number of relationship:

1. BPR Success relates directly to the variables (1)visualization of process change, (2) identification of a generic IT solution, (3) completeness of the model and (4) ease of understanding.

These four variables in effect also relate to other variables:

2. Visualization of process change relates directly to identification of generic IT solution and opportunities for improvement
3. Identification of generic IT solution relates to approach
4. Approach relates to ease of understanding, completeness of the model and opportunities for improvement
5. Opportunities for improvement relates to visualization of change

This leads to the following figure containing the revised model and the subsequent analyses of the causal relationships (again using path analysis):

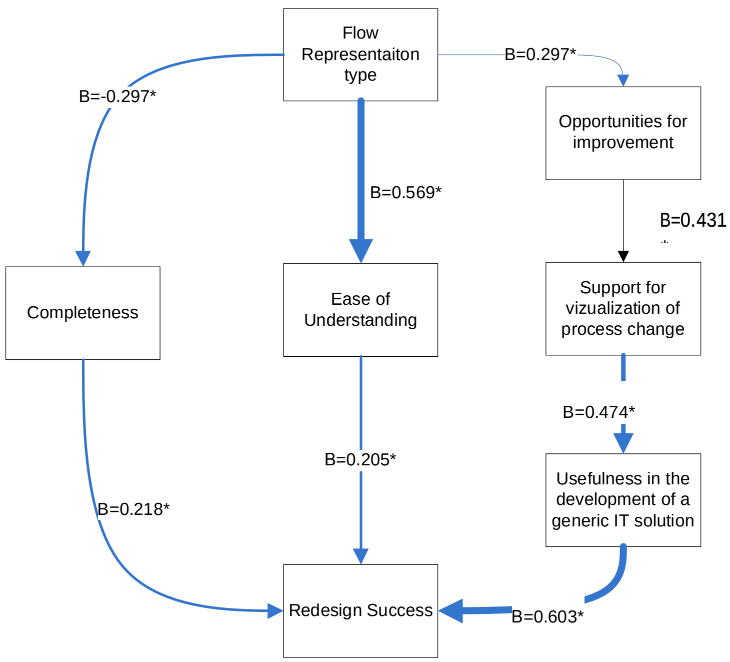


Table 15: Revised theoretical model

All the Beta's are significant assuming sound causal relationships between the variables in the model. The amount of explained variance though varies between the variables. For the dependent variable BPR success, the amount of explained variance due to the three variables Completeness of model, ease of understanding and identification of generic IT solution R-squared is 0.603 (as shown in the table below), suggesting high interpretation power.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,777[a]	,603	,553	,605

a. Predictors: (Constant), Easund, Comple, Genits

Table 15: Model summary for revised model

The R-squared coefficients contributing to the power of the other variables are low, suggesting that there are more variables that need to be identified that contribute to the explanation of those variables (see appendix 14).

6 Conclusions and recommendations

At the beginning of this research two research questions were stated. In this section the answers will be given; Two tables containing the hypotheses, the expected relations and the findings of this research will be given to further clarify the first research question. For the second research question the two theoretical models will be compared in words and graphically.

6.1 Answers to research questions

1. What are the main similarities and differences between the results of the research by Kock, Danesh and Komiak (2008) and this research?

The figures below give a comparison of the theoretical model fitting the data of Kock & Danesh(2008) and that of this research.

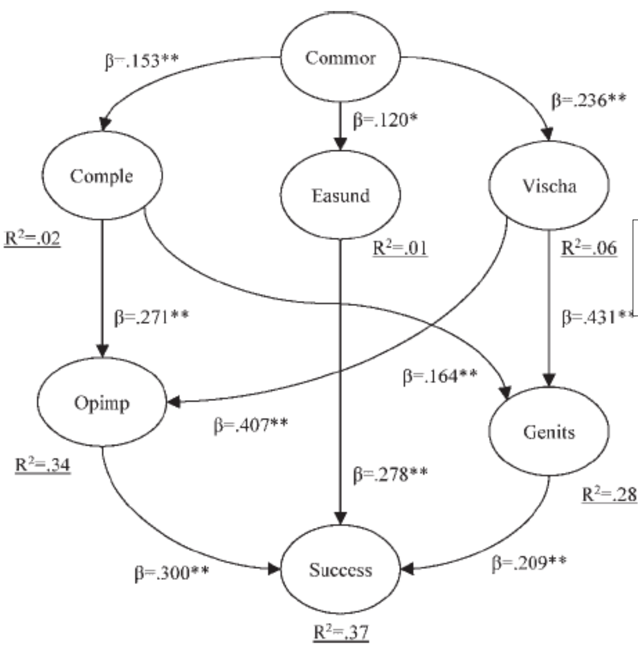


Figure 9: Model fitting data of Kock & Danesh (2008)

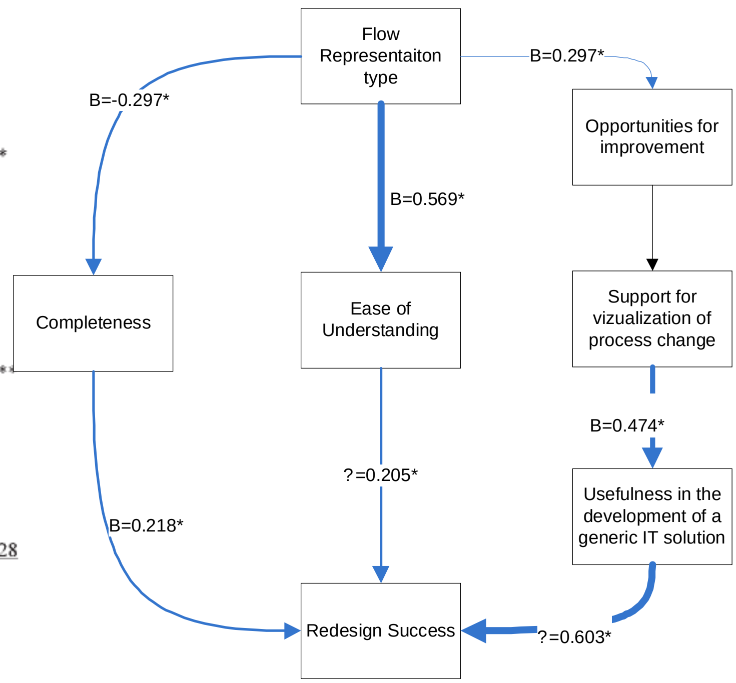


Figure 10: Revised model to fit data from this research

Kock, Danesh and Komiak's research found that, with the choice of the communication and activity flow representation, the communication model representation was most beneficial in BPR success for knowledge intensive organizations.
This research does not fully support the work of Kock , Danesh & Komiak (2008). This study did supported most of their hypotheses related to the communication versus activity flow representation. Namely, that the communication flow representation gives a more complete depiction of the processes and visualized change better. There was however not enough

evidence to support the hypothesis that the communication flow representation enables a greater degree of redesign success than the activity flow representation.

2. Which process modeling representation approach is most beneficial within OHRA?

What this research has shown is that the way a process is presented can be crucial to the success of the redesign project. So even though the majority of current research has been focused on the chronological flow of activities this research supports the idea that a communication flow representation has a greater ease of understanding, better visualization of process change, is more useful in the identification of opportunities for improvement and in the development of a generic IT solution than an activity flow representation. There was however not enough evidence supporting the notion that the communication flow representation enables a greater degree of redesign success compared to the activity flow representation.
The combination, the chronological flow of activities combined with the flow of information, did prove to provide a greater visualization of process change than the communication flow representation; Even though there was no support for superiority in the identification of opportunity for improvements. The ease of understanding of the communication flow representation was higher than that of the combination model and in total there was enough statistical evidence to support the fact that the communication flow representation enables a greater degree of redesign success than the combination model. The study suggests that a communication flow representation likely could have a positive effect on the success of a business process redesign project.

Tables 16 and 17 give an overview of the hypotheses, the expected relationships and the findings from this research.

Construct	Hypothesis	Expected relation	Findings
Completeness	A communication flow model will be perceived to produce a more complete model than an activity flow model.	Positive	Accepted
Ease of understanding	The communication flow model will be perceived to have a lower ease of understanding than an activity flow model.	Negative	Accepted
Visualization	Communication flow model will be perceived to produce a better visualization of process change.	Positive	Accepted
Identification of improvement opportunities	Communication flow model is perceived to produce a better visualization of process change and therefore will also be perceived as more useful for the identification of opportunities for improvement.	Positive	Rejected
	Communication flow model is perceived to produce a more complete depiction of processes=>perceived as more useful for the identification of opportunities for improvement	Positive	Accepted
Development of generic IT solution	Communication flow model is perceived to produce a more complete view of processes=>perceived as more useful in the development of generic IT solutions than an activity flow model.	Positive	Rejected
	Communication flow model is perceived to produce a better visualization of process change=> perceived as more useful in the development of generic IT solutions than an activity flow model.	Positive	Accepted
BPR success	A communication flow model is perceived as more useful in the development of generic IT solutions=>perceived as enabling a greater degree of redesign success than an activity flow model.	Positive	Rejected
	Communication flow model is seen as more useful for the identification of improvement opportunities => perceived as enabling a greater degree of redesign success than an activity flow model.	Positive	Rejected
	A communication flow model is perceived as having a lower ease of understanding =>perceived as enabling a greater degree of redesign success than an activity model.	Negative	Rejected

Table 16: Overview of hypotheses expectations and findings

Construct	Hypothesis	Expected relation	Findings
Completeness	The combination model representation will be perceived to produce a more complete model than a communication flow model	Positive	Rejected
Ease of understanding	The combination model representation will be perceived to have a lower ease of understanding than a Communication flow model	Negative	Accepted
Visualization	The combination model representation will be perceived to produce a better visualization of process change than a communication flow model	Positive	Rejected
Identification of improvement opportunities	The combination model representation will be perceived to produce a more complete model than a communication flow model=>perceived as more useful for the identification of opportunities for improvement than a Communication flow representation.	Positive	Rejected
	Combination model representation will be perceived to produce a better visualization of process change=> perceived as more useful for the identification of improvement opportunities than a Communication flow model.	Positive	Rejected
Development of generic IT solution	The combination model representation is perceived to produce a more complete view of processes=>perceived as more useful in the development of generic IT solutions than a Communication flow representation.	Positive	Rejected
	The combination model is perceived to produce a better visualization of process change => perceived as more useful in the development of generic IT solutions than a Communication flow model.	Positive	Rejected
BPR success	The combination model is perceived as more useful in the development of generic IT solutions=>perceived as enabling a greater degree of redesign success than a Communication flow representation.	Positive	Rejected
	The combination model representation is perceived as more useful in the identification of opportunities for improvement=> perceived as enabling a greater degree of redesign success than a Communication flow model.	Positive	Rejected
	The combination model is perceived as having a lower ease of understanding=> perceived as enabling a lower degree of redesign success than a Communication flow representation.	Negative	Accepted

Table 17: Summary of analysis results for hypotheses 11 to 15

6.2 Recommendations

What this study has shown is that the choice of a business process modeling representation depends on the main goal of the modeling. The type of model used depends on whether the goals of the organization is to (1) develop an understandable model (Ease of understanding) or a model that is (2) gives a complete depiction of the model, (3) gives a good visualization of the process change, (4) is useful in the development of an IT solution, or (5) can identify opportunities for improvement well. It is therefore crucial for a company to first state goals before deciding on a model.

For OHRA specifically this means that for various goals different models can be used:

- In a business process redesign project, it would be most beneficial for them to work with a communication flow or activity flow model.
- If though, the models are only used for new employees to understand the basic processes that occur in their job the ease of understanding and completeness of the model are more of interest and the communication flow model would fit best.
- If the model is only used to identify new opportunities in processes the activity flow model should be used.

The process models used for this research consist of the business processes within OHRA portfolio management. For their present reorganization, these models can be used as starting point to evaluate and change the current processes of portfolio management within OHRA.

Discussion

7.1 Population

Kock, Danesh and Komiak (2008) suggest that a communication flow representation is more necessary in knowledge intensive organization. This research did focus on a knowledge intensive organization: OHRA. Unfortunately it was limited to one company which means these results can't be generalized for all knowledge intensive organizations. Therefore further research on the effect of modeling representations on redesign success should be done with a larger population varying in type of organization: Service, production or variations of the two.

7.2 Modeling representation

In this research three types of modeling representations were used, for the communication flow representation a data flow diagram (DFD), for the activity flow representation a UML activity diagram and a combination between the two, in which only the communication arrows of the communication flow were used.
The choice of a specific model could determine the outcome of certain variables and therefore further research could focus on the choice of specific models in determining business process redesign success.

7.3 Procedure

The participants only evaluated the models, but did not create the models themselves. Short description of the models and the procedure of the experiment were administered. This could lead to lower commitment to the model and less knowledge on the subject. The experiment was done without an oral explanation or the researcher being present.

More extensive instructions on the models and even personal presence would have given a more optimal understanding of the models but would have jeopardized the objectiveness toward the modeling representations.

The scaling of the questionnaire was a Likert-scale with an even amount of response items. The number of response items was limited to six. Therefore the questionnaire required a forced choice response without indecisive answers. A negative effect of this could be that participants would choose a side while there was no preference.

7.4 Statistical power

Statistical power is the power to detect group differences. Three basic factors contribute to the level of statistical power (Meyers, L.S. 2006, p. 39):

- Sample size
- Alpha level
- Effect size

Greater power is achieved with increased sample size. Larger sample sizes are associated with lower standard errors of the mean and narrower confidence intervals and thus result in more stable and precise estimates of population parameters (Meyers, L.S. 2006, p. 41).
The participants of this research exist of employees within OHRA. Therefore the population was limited and only fifteen employees were used in this experiment. To achieve significance at a higher confidence level more data is necessary and thus more participants.

The alpha level selected for this research specifies the risk willingness to run when rejecting the null hypothesis, which was 0.12. According to Meyers (2006) if sample size is small, as in this research, setting alpha=0.10 or 0.15 is however quite reasonable.

7.5 Statistical test

MANOVA should not be used if the dependent variables are uncorrelated or with a set of dependent variables that is very highly correlated. The ideal situation for using MANOVA is when the dependent variables are moderately correlated. Weinfurt (1995, as cited in Meyers, L.M. 2006, p.368) uses an example in which the correlations between dependent variables ranged between 0.21 and 0.36 to illustrate the appropriateness of a MANOVA design. In this research the correlation between the dependent variables ranged between the 0.17 and 0.32, with an exception of the variables Genits and Succes for which the correlation is 0.432. Despite the limitations stated above, certain conclusions were drawn from the analysis of the questionnaire responses. These limitations state that the conclusions were drawn under certain conditions. Merely realizing and stating these drawbacks can improve further research on this subject.

7.6 Theoretical model

The revised theoretical model statistically fits the data of this research. Though, the predictive power of the independent variables in predicting the dependent variables is rather low for all variables expect BPR success. More research is therefore necessary to recover more predictive variables of the visualization of process change, the completeness of the model, the development of a generic IT solution and opportunities for improvement.

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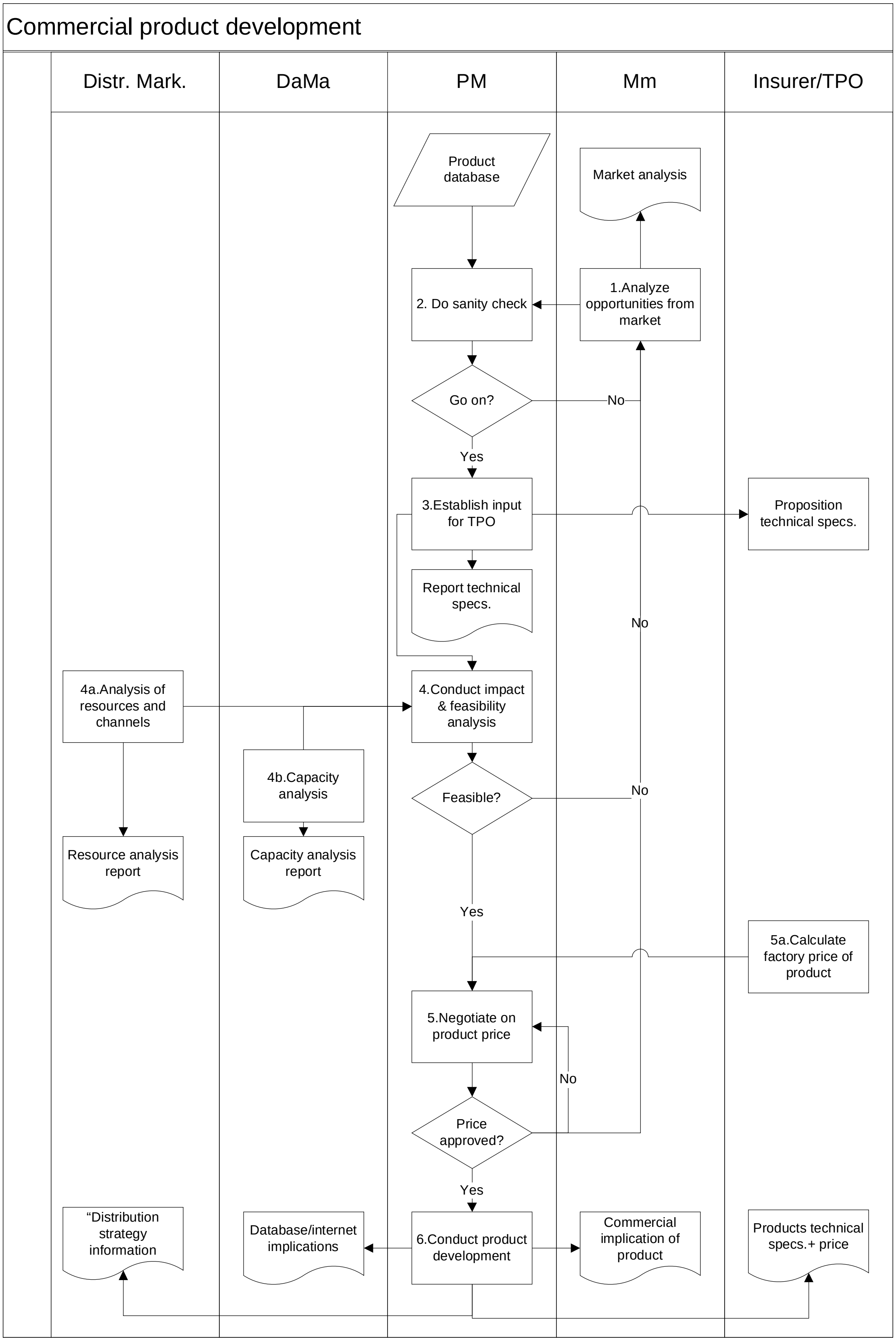
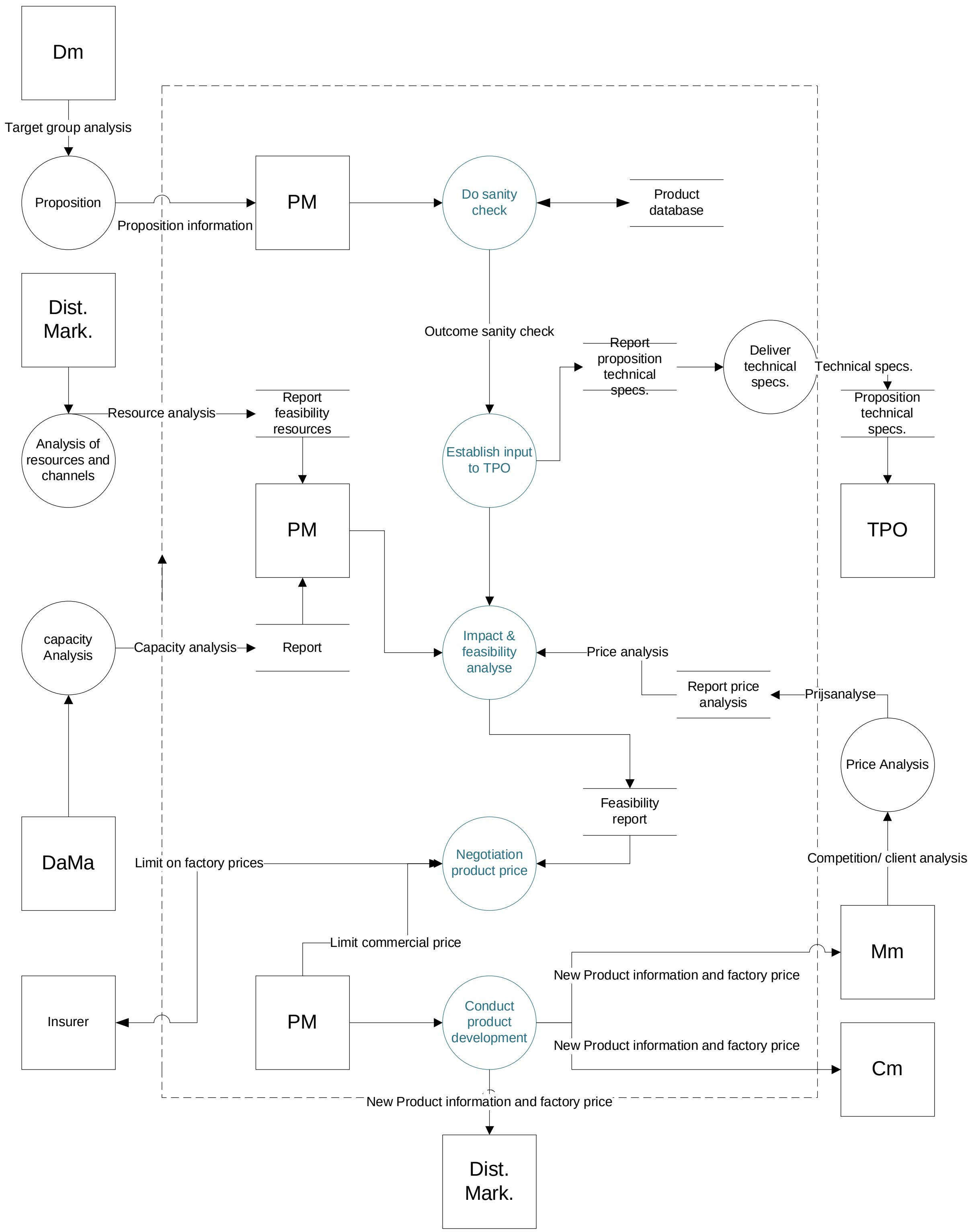
Appendix 1 Activity diagram

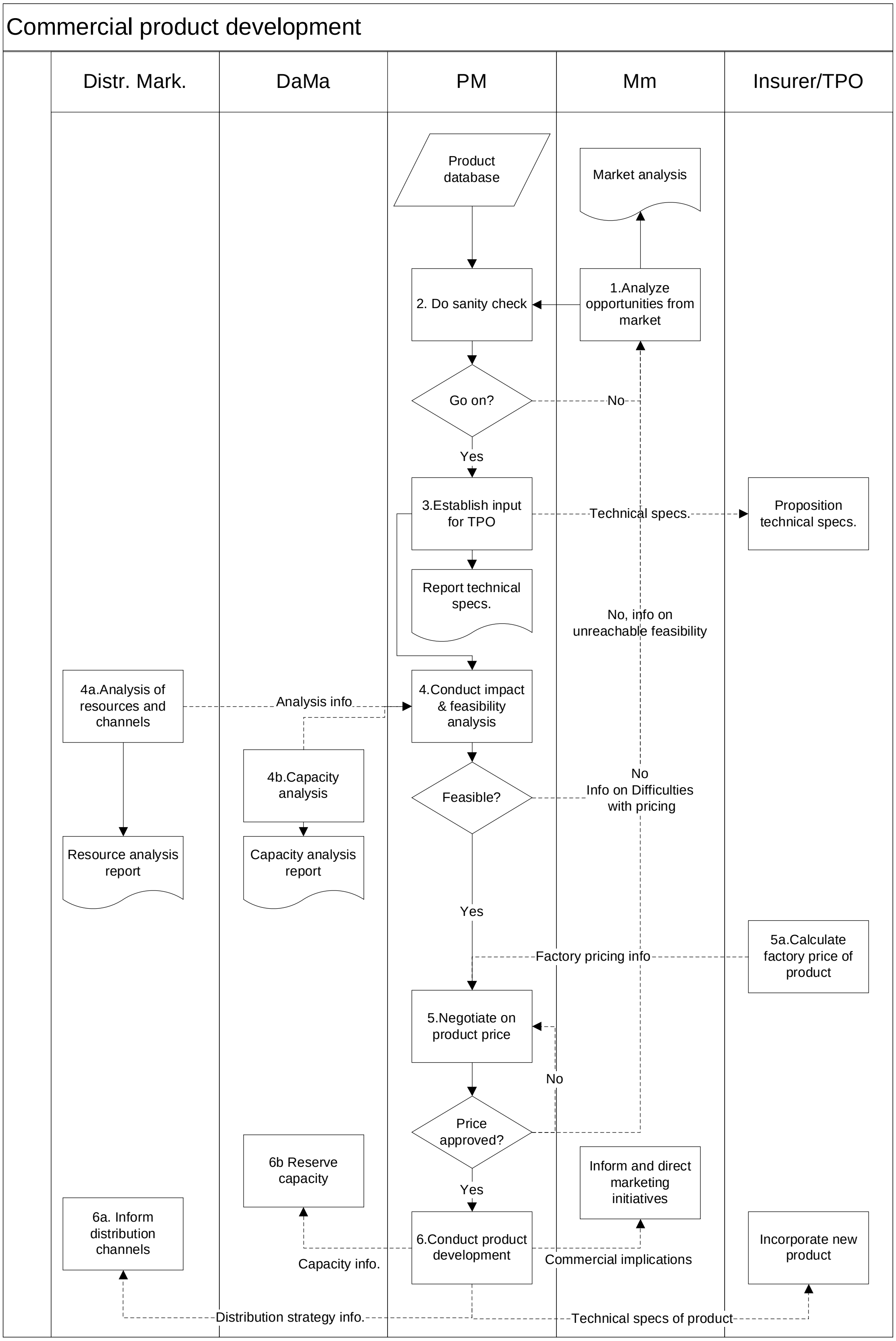


Appendix 2 Data flow diagram

Commercial Product development



Appendix 3 Combination



Appendix 4 Overview of hypotheses of Kock, Danesh and Komiak

"The communication flow optimization theory claims that the communication flow representation provides a more complete depiction of the business process than the activity flow representation" (Kock, Danesh and Komiak, 2008, p.76).
Having a complete view can contribute to the effectiveness and to the quality of the functionality of the design (Lin et al., 1977, from Kock, Danesk and Komiak, 2008).

H1 Completeness: A business process model with a higher communication flow orientation will be perceived as more complete than a model with a lower communication flow orientation.

Kock's study (2003) revealed that the communication flow representation was perceived as being more difficult to conceptualize and understand.

H2 Ease of understanding: A business process model with a higher communication flow orientation will be perceived as more difficult to understand than a model with a lower communication flow orientation.

The redesign group must visualize and identify the various internal and external flows of information and the communication channels in the process in order to facilitate the objectives of the BPR project—for example, eliminate duplicate activities, increase asynchronous communication, group interrelated activities together, simplify processes, and break down complex processes (Harrington, 1991; Hall et al.,1993; Kock, 2003).
H3 Visualization: A business process model with a higher communication flow orientation will be perceived to produce a better visualization of process changes than a model with a lower communication flow orientation.

By obtaining a clear understanding of the process, the redesign group is better able to identify the inefficiencies in the process that should be eliminated or modified (Kock, Murphey and Komiak, 2008, p. 77).
H4 Opportunities for improvement: A business process model that is perceived to produce a better visualization of process changes is also perceived as more useful for the identification of opportunities for improvement than a model with lower visualization.
When processes aren't depicted completely this will lead to dissatisfaction of the users because of a gap between expectations and reality of a process. Therefore, the model should provide a detailed understanding of the process and contain the relevant information which is important to the redesign team, enabling the team members to have a more complete and better viewof the activities within the process (Mantha, 1987, out of Kock, Danesh and Komiak, 2008, p 77).

H5 Opportunities for improvement: A business process model that is perceived as more complete is also perceived as more useful for the identification of opportunities for improvement than a model that is less complete.

Kock, Danesh and Komiak (2008) state that "because of the access to a better process depiction, the redesign group can more effectively and efficiently map the redesign model into a more successful generic IT solution for the redesign task".

H6 Generic IT solution: A business process model that is perceived as more complete is also perceived as more useful in the development of a generic IT solution than a model that is less complete.

H7 Generic IT solution: A business process model that is perceived to produce a better visualization of process changes is also perceived as more useful in the development of a generic IT solution than a model with lower visualization.

H8 BPR success: A business process model that is perceived as more useful in the development of a generic IT solution is also perceived as enabling a greater degree of redesign success than a model that is less useful in the development of a generic IT solution.

H9 BPR Success: A business process model that is perceived as more useful for the identification of opportunities for improvement is also perceived as enabling a greater degree of redesign success than a model that is less useful for the identification of opportunities for improvement.

H10 BPR Success: A business process model that is perceived as easier to understand is also perceived as enabling a greater degree of redesign success than a model that is harder to understand.

Appendix 5 Questionnaire items

Factors influencing Business process redesign	Questionnaire Questions
Ease of understanding	1.This process modeling approach leads to graphical models that are easy to understand 2.Process models generated using this approach are difficult to understand (reversed)
Completeness	1. Graphical process models created using this approach are complete 2. Process representations using this approach are very detailed
Usefulness in identification of opportunities for improvement	1.This modeling approach is useful in the identification of process redesign opportunities 2.This process modeling approach facilitates the discovery of all possible improvement opportunities 3.It is easy to identify process improvement opportunities using this process modeling approach
Support for visualization of process changes	1.Graphical process representations using this approach make clear the changes in an redesign process 2.Once a process is redesigned, it is easy to think about process changes using this modeling approach
Usefulness in the development of generic IT solutions	1.This process modeling approach is useful in the development of a generic IT solution to automate the redesign process 2.Creating a generic IT solution to enable the redesign process is easy based on this process modeling approach 3.Graphical process representations using this approach facilitate the generation of a generic IT solution to automate the redesigned process
Expected Redesign success	1.Using this process, modeling approach is likely to contribute to the success of a process redesign project 2.Success chances are improved if this process modeling approach is used 3.Using the graphical process representation in this approach is likely to make process redesign projects more successful

Appendix 6 Cronbach's alpha

Table 2 *Reliability coefficients, AVEs, and correlations between latent variables*

	CR	1	2	3	4	5	6
1. Completeness	**0.893**	**0.898**					
2. Support for visualization of process changes	**0.919**	0.472	**0.922**				
3. Redesign success	**0.923**	0.433	0.603	**0.894**			
4. Ease of understanding	**0.908**	0.413	0.425	0.444	**0.912**		
5. Usefulness in identification of opportunities for improvement	**0.894**	0.463	0.535	0.502	0.336	**0.859**	
6. Usefulness in the development of generic IT solution	**0.928**	0.367	0.509	0.452	0.312	0.519	**0.901**

Note: The bold shows the square root of the average variance extracted (AVE).

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,831	,831	2

Table 6: Cronbach alpha for easund

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,321	,321	2

Table 7: Cronbach alpha for comple

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,560	,560	2

Table 8: Cronbach alpha for vischa

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,350	,398	3

Table 9: Cronbach alpha for opimp

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,699	,701	2

Table 10: Cronbach alpha for genits

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,768	,822	3

Table 11: Cronbach alpha for succes

Appendix 7 Regression analysis

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	,983	,576		1,706	,101
	Easund	,125	,110	,177	1,136	,267
	Genits	,608	,141	,652	4,315	,000
	Opimp	,003	,113	,003	,023	,982

a. Dependent Variable: Succes

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1,070	,987		1,084	,288
	Comple	,202	,143	,252	1,408	,171
	Vischa	,392	,229	,307	1,712	,099

a. Dependent Variable: Opimp

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1,626	,810		2,006	,056
	Comple	,066	,120	,097	,554	,585
	Vischa	,517	,191	,474	2,701	,012

a. Dependent Variable: Genits

Revised model:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,297[a]	,088	,067	1,073

a. Predictors: (Constant), Approach

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2,556	,423		6,038	,000
	Approach	,400	,196	,297	2,042	,047

a. Dependent Variable: Opimp

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,337[a]	,114	,081	,852

a. Predictors: (Constant), Opimp

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,954	,495		5,969	,000
	Opimp	,264	,142	,337	1,862	,073

a. Dependent Variable: Vischa

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,777[a]	,603	,553	,605

a. Predictors: (Constant), Easund, Comple, Genits

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,592	,559		1,058	,300
	Comple	,139	,084	,218	1,662	,109
	Genits	,562	,136	,603	4,140	,000
	Easund	,144	,101	,205	1,427	,166

a. Dependent Variable: Succes

Appendix 8 Correlations between variables

Correlations

		Easund	Comple	Genits	Opimp	Vischa	Succes	Approach
Easund	Pearson Correlation	1	-,020	,432*	,320	,238	,460*	,569**
	Sig. (2-tailed)		,917	,022	,084	,214	,014	,001
	N	30	30	28	30	29	28	30
Comple	Pearson Correlation	-,020	1	,172	,287	,121	,317	-,297
	Sig. (2-tailed)	,917		,380	,125	,532	,100	,111
	N	30	30	28	30	29	28	30
Genits	Pearson Correlation	,432*	,172	1	,204	,490**	,729**	,174
	Sig. (2-tailed)	,022	,380		,298	,008	,000	,375
	N	28	28	28	28	28	28	28
Opimp	Pearson Correlation	,320	,287	,204	1	,337	,201	,297*
	Sig. (2-tailed)	,084	,125	,298		,073	,208	,047
	N	30	30	28	45	29	41	45
Vischa	Pearson Correlation	,238	,121	,490**	,337	1	,427*	,040
	Sig. (2-tailed)	,214	,532	,008	,073		,024	,835
	N	29	29	28	29	29	28	29
Succes	Pearson Correlation	,460*	,317	,729**	,201	,427*	1	,192
	Sig. (2-tailed)	,014	,100	,000	,208	,024		,230
	N	28	28	28	41	28	41	41
Approach	Pearson Correlation	,569**	-,297	,174	,297*	,040	,192	1
	Sig. (2-tailed)	,001	,111	,375	,047	,835	,230	
	N	30	30	28	45	29	41	45

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 9 Descriptive statistics per model type

Descriptive Statistics

	N	Mean	Std. Deviation
Easund	10	4,80	,789
Comple	10	3,80	1,549
Genits	10	4,40	,843
Opimp	15	3,27	1,438
Vischa	10	4,40	,843
Succes	15	4,27	,884
Valid N (listwise)	10		

Table 12 Descriptive statistics of communication flow representation=2

Descriptive Statistics

	N	Mean	Std. Deviation
Easund	10	4,30	,949
Comple	10	3,10	1,524
Genits	8	3,75	1,165
Opimp	15	3,80	1,082
Vischa	9	3,56	1,014
Succes	11	3,82	,982
Valid N (listwise)	8		

Table 13 Descriptive statistics of activity flow representation=3

Descriptive Statistics

	N	Mean	Std. Deviation
Easund	10	2,60	,699
Comple	10	4,10	,994
Genits	10	3,40	,699
Opimp	15	3,00	,535
Vischa	10	3,50	,527
Succes	15	3,47	,640
Valid N (listwise)	10		

Table 14 Descriptive statistics of combination model representation=1

Appendix 10 Inferential data- Communication versus activity

Group Statistics

	Approach	N	Mean	Std. Deviation	Std. Error Mean
Easund	Communication	10	4,80	,789	,249
	Activity	10	4,30	,949	,300
Comple	Communication	10	3,80	1,549	,490
	Activity	10	3,10	1,524	,482
Genits	Communication	10	4,40	,843	,267
	Activity	8	3,75	1,165	,412
Opimp	Communication	15	3,27	1,438	,371
	Activity	15	3,80	1,082	,279
Vischa	Communication	10	4,40	,843	,267
	Activity	9	3,56	1,014	,338
Succes	Communication	15	4,27	,884	,228
	Activity	11	3,82	,982	,296

Table 15a Comparison of communication and activity flow means and standard deviations (SD)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									76% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Easund	Equal variances assumed	,069	,796	1,282	18	,216	,500	,390	,026	,974
	Equal variances not assumed			1,282	17,420	,217	,500	,390	,025	,975
Comple	Equal variances assumed	,059	,810	1,019	18	,322	,700	,687	-,135	1,535
	Equal variances not assumed			1,019	17,995	,322	,700	,687	-,135	1,535
Genits	Equal variances assumed	2,053	,171	1,375	16	,188	,650	,473	,073	1,227
	Equal variances not assumed			1,325	12,403	,209	,650	,491	,044	1,256
Opimp	Equal variances assumed	5,136	,031	-1,148	28	,261	-,533	,465	-1,091	,024
	Equal variances not assumed			-1,148	26,012	,261	-,533	,465	-1,092	,025
Vischa	Equal variances assumed	,560	,464	1,982	17	,064	,844	,426	,326	1,363
	Equal variances not assumed			1,962	15,666	,068	,844	,430	,319	1,370
Succes	Equal variances assumed	,013	,911	1,220	24	,234	,448	,367	,006	,891
	Equal variances not assumed			1,200	20,297	,244	,448	,374	-,004	,901

Table 22b Levene's test and t-test for equality of means

Appendix 11 Inferential data- Communication versus combination

Group Statistics

	Approach	N	Mean	Std. Deviation	Std. Error Mean
Easund	Combination	10	2,60	,699	,221
	Communication	10	4,80	,789	,249
Comple	Combination	10	4,10	,994	,314
	Communication	10	3,80	1,549	,490
Genits	Combination	10	3,40	,699	,221
	Communication	10	4,40	,843	,267
Opimp	Combination	15	3,00	,535	,138
	Communication	15	3,27	1,438	,371
Vischa	Combination	10	3,50	,527	,167
	Communication	10	4,40	,843	,267
Succes	Combination	15	3,47	,640	,165
	Communication	15	4,27	,884	,228

Table 16a Comparison of means and Standard deviations (SD) of the combination model and communication flow representations

Table 23b Levene's test and t-test for equality of means

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									76% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Easund	Equal variances assumed	,063	,805	-6,600	18	,000	-2,200	,333	-2,605	-1,795
	Equal variances not assumed			-6,600	17,744	,000	-2,200	,333	-2,605	-1,795
Comple	Equal variances assumed	2,448	,135	,515	18	,613	,300	,582	-,407	1,007
	Equal variances not assumed			,515	15,340	,614	,300	,582	-,412	1,012
Genits	Equal variances assumed	,643	,433	-2,887	18	,010	-1,000	,346	-1,421	-,579
	Equal variances not assumed			-2,887	17,403	,010	-1,000	,346	-1,421	-,579
Opimp	Equal variances assumed	39,116	,000	-,673	28	,506	-,267	,396	-,742	,209
	Equal variances not assumed			-,673	17,798	,509	-,267	,396	-,748	,215
Vischa	Equal variances assumed	1,642	,216	-2,862	18	,010	-,900	,314	-1,282	-,518
	Equal variances not assumed			-2,862	15,100	,012	-,900	,314	-1,285	-,515
Succes	Equal variances assumed	1,188	,285	-2,840	28	,008	-,800	,282	-1,138	-,462
	Equal variances not assumed			-2,840	25,516	,009	-,800	,282	-1,139	-,461

Appendix 12 Path analysis

Opportunities for improvement

The variables Visualization of change and Completeness of the model are in the theoretical model the predictors of opportunities for improvement.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,420[a]	,177	,113	1,071

a. Predictors: (Constant), Vischa, Comple

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6,396	2	3,198	2,789	,080[a]
	Residual	29,811	26	1,147		
	Total	36,207	28			

a. Predictors: (Constant), Vischa, Comple

b. Dependent Variable: Opimp

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,070	,987		1,084	,288
	Comple	,202	,143	,252	1,408	,171
	Vischa	,392	,229	,307	1,712	,099

a. Dependent Variable: Opimp

Generic IT solution

The variables Visualization of change and Completeness of the model are in the theoretical model the predictors of a generic IT solution.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,499[a]	,249	,189	,874

a. Predictors: (Constant), Vischa, Comple

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6,329	2	3,165	4,143	,028[a]
	Residual	19,099	25	,764		
	Total	25,429	27			

a. Predictors: (Constant), Vischa, Comple

b. Dependent Variable: Genits

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,626	,810		2,006	,056
	Comple	,066	,120	,097	,554	,585
	Vischa	,517	,191	,474	2,701	,012

a. Dependent Variable: Genits

BPR Success

The variables Opportunities for improvement, Generic IT solution and Ease of understanding are predictors of perceived BPR success

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,747[a]	,557	,502	,639

a. Predictors: (Constant), Opimp, Genits, Easund

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12,323	3	4,108	10,075	,000[a]
	Residual	9,784	24	,408		
	Total	22,107	27			

a. Predictors: (Constant), Opimp, Genits, Easund

b. Dependent Variable: Succes

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,983	,576		1,706	,101
	Easund	,125	,110	,177	1,136	,267
	Genits	,608	,141	,652	4,315	,000
	Opimp	,003	,113	,003	,023	,982

a. Dependent Variable: Succes

Ease of understanding

The representation approach is the predictor of the Ease of understanding

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,569[a]	,323	,299	1,039

a. Predictors: (Constant), Approach

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14,450	1	14,450	13,375	,001[a]
	Residual	30,250	28	1,080		
	Total	44,700	29			

a. Predictors: (Constant), Approach

b. Dependent Variable: Easund

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,200	,502		4,382	,000
	Approach	,850	,232	,569	3,657	,001

a. Dependent Variable: Easund

Completeness of model

The representation approach chosen is the predictor of the completeness of the model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,297[a]	,088	,056	1,358

a. Predictors: (Constant), Approach

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5,000	1	5,000	2,710	,111[a]
	Residual	51,667	28	1,845		
	Total	56,667	29			

a. Predictors: (Constant), Approach

b. Dependent Variable: Comple

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4,667	,656		7,112	,000
	Approach	-,500	,304	-,297	-1,646	,111

a. Dependent Variable: Comple

Visualization of change

The representation approach is the predictor of the Visualization of change

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,040[a]	,002	-,035	,905

a. Predictors: (Constant), Approach

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,036	1	,036	,044	,835[a]
	Residual	22,102	27	,819		
	Total	22,138	28			

a. Predictors: (Constant), Approach

b. Dependent Variable: Vischa

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3,742	,442		8,474	,000
	Approach	,044	,208	,040	,210	,835

a. Dependent Variable: Vischa

Appendix 13 MANOVA

Communication versus Activity

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Easund	,803[a]	1	,803	,953	,343	,056
	Comple	4,900[b]	1	4,900	2,113	,165	,117
	Genits	1,878[c]	1	1,878	1,890	,188	,106
	Opimp	2,844[d]	1	2,844	1,649	,217	,093
	Vischa	2,669[e]	1	2,669	2,992	,103	,158
	Succes	,469[f]	1	,469	,519	,482	,031
Intercept	Easund	374,136	1	374,136	444,243	,000	,965
	Comple	190,678	1	190,678	82,233	,000	,837
	Genits	295,211	1	295,211	297,068	,000	,949
	Opimp	230,400	1	230,400	133,565	,000	,893
	Vischa	286,225	1	286,225	320,813	,000	,952
	Succes	289,803	1	289,803	320,335	,000	,952
Approach	Easund	,803	1	,803	,953	,343	,056
	Comple	4,900	1	4,900	2,113	,165	,117
	Genits	1,878	1	1,878	1,890	,188	,106
	Opimp	2,844	1	2,844	1,649	,217	,093
	Vischa	2,669	1	2,669	2,992	,103	,158
	Succes	,469	1	,469	,519	,482	,031
Error	Easund	13,475	16	,842			
	Comple	37,100	16	2,319			
	Genits	15,900	16	,994			
	Opimp	27,600	16	1,725			
	Vischa	14,275	16	,892			
	Succes	14,475	16	,905			
Total	Easund	397,000	18				
	Comple	242,000	18				
	Genits	322,000	18				
	Opimp	258,000	18				
	Vischa	313,000	18				
	Succes	311,000	18				
Corrected Total	Easund	14,278	17				
	Comple	42,000	17				
	Genits	17,778	17				
	Opimp	30,444	17				
	Vischa	16,944	17				
	Succes	14,944	17				

a. R Squared = ,056 (Adjusted R Squared = -,003)

b. R Squared = ,117 (Adjusted R Squared = ,061)

c. R Squared = ,106 (Adjusted R Squared = ,050)

d. R Squared = ,093 (Adjusted R Squared = ,037)

e. R Squared = ,158 (Adjusted R Squared = ,105)

f. R Squared = ,031 (Adjusted R Squared = -,029)

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	,992	258,867[a]	6,000	13,000	,000	,992
	Wilks' Lambda	,008	258,867[a]	6,000	13,000	,000	,992
	Hotelling's Trace	119,477	258,867[a]	6,000	13,000	,000	,992
	Roy's Largest Root	119,477	258,867[a]	6,000	13,000	,000	,992
Approach	Pillai's Trace	,848	12,062[a]	6,000	13,000	,000	,848
	Wilks' Lambda	,152	12,062[a]	6,000	13,000	,000	,848
	Hotelling's Trace	5,567	12,062[a]	6,000	13,000	,000	,848
	Roy's Largest Root	5,567	12,062[a]	6,000	13,000	,000	,848

a. Exact statistic

b. Design: Intercept+Approach

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Easund	24,200[a]	1	24,200	43,560	,000	,708
	Comple	,450[b]	1	,450	,266	,613	,015
	Genits	5,000[c]	1	5,000	8,333	,010	,316
	Opimp	,800[d]	1	,800	,837	,372	,044
	Vischa	4,050[e]	1	4,050	8,191	,010	,313
	Succes	3,200[f]	1	3,200	5,760	,027	,242
Intercept	Easund	273,800	1	273,800	492,840	,000	,965
	Comple	312,050	1	312,050	184,161	,000	,911
	Genits	304,200	1	304,200	507,000	,000	,966
	Opimp	180,000	1	180,000	188,372	,000	,913
	Vischa	312,050	1	312,050	631,112	,000	,972
	Succes	288,800	1	288,800	519,840	,000	,967
Approach	Easund	24,200	1	24,200	43,560	,000	,708
	Comple	,450	1	,450	,266	,613	,015
	Genits	5,000	1	5,000	8,333	,010	,316
	Opimp	,800	1	,800	,837	,372	,044
	Vischa	4,050	1	4,050	8,191	,010	,313
	Succes	3,200	1	3,200	5,760	,027	,242
Error	Easund	10,000	18	,556			
	Comple	30,500	18	1,694			
	Genits	10,800	18	,600			
	Opimp	17,200	18	,956			
	Vischa	8,900	18	,494			
	Succes	10,000	18	,556			
Total	Easund	308,000	20				
	Comple	343,000	20				
	Genits	320,000	20				
	Opimp	198,000	20				
	Vischa	325,000	20				
	Succes	302,000	20				
Corrected Total	Easund	34,200	19				
	Comple	30,950	19				
	Genits	15,800	19				
	Opimp	18,000	19				
	Vischa	12,950	19				
	Succes	13,200	19				

a. R Squared = ,708 (Adjusted R Squared = ,691)

b. R Squared = ,015 (Adjusted R Squared = -,040)

c. R Squared = ,316 (Adjusted R Squared = ,278)

d. R Squared = ,044 (Adjusted R Squared = -,009)

e. R Squared = ,313 (Adjusted R Squared = ,275)

f. R Squared = ,242 (Adjusted R Squared = ,200)

Appendix 14 Revised model regression analysis

Dependent variable: Vischa

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,337[a]	,114	,081	1,090

a. Predictors: (Constant), Vischa

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4,121	1	4,121	3,468	,073[a]
	Residual	32,086	27	1,188		
	Total	36,207	28			

a. Predictors: (Constant), Vischa

b. Dependent Variable: Opimp

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,659	,910		1,824	,079
	Vischa	,431	,232	,337	1,862	,073

a. Dependent Variable: Opimp

Dependent variable: Genits

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Genits[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Vischa

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,490[a]	,240	,210	,792

a. Predictors: (Constant), Genits

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,124	,624		3,405	,002
	Genits	,449	,157	,490	2,863	,008

a. Dependent Variable: Vischa

Dependent variable: Succes

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Easund, Comple, Genits[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Succes

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,777[a]	,603	,553	,605

a. Predictors: (Constant), Easund, Comple, Genits

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13,333	3	4,444	12,156	,000(a)
	Residual	8,774	24	,366		
	Total	22,107	27			

a Predictors: (Constant), Easund, Comple, Genits
b Dependent Variable: Succes