Business process innovation with QR Codes

A Case Study at the Dutch Archaeological Museum *Hunebed Centre*

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Executive summary

This report describes the field research that was conducted at the Dutch archaeological museum *Hunebed Centre*. The aim of the research is to investigate the potential use of new mobile augmented reality solutions to enrich the visitor experience at the museum. After documenting the current visitor process with BPMN (Business Process Modelling Notation) and after selecting QR codes as the best solution alternative because of ease of acquisition and ease of use, the desired visitor process is documented with BPMN. In this improved process model, the visitor process has been redesigned to integrate QR codes. Implementation of several QR codes at the Hunebed Centre shows that they effectively fulfill their purpose.

1 Introduction

This report describes an empirical business process study of the visitor process at a Dutch archaeological museum named the Hunebed Centre. The museum wants to examine its visitor process and investigate how the use of augmented reality with mobile (smart) phones can be integrated in the process to enrich the visitor experience. Augmented Reality (AR) technology integrates a computer-generated imagery into the user's real view of physical reality, that is, the real world is augmented by computer-generated sensory input such as sound, video, graphics or GPS data. In a museum context, the goal is to enhance the visitor's perception of reality by augmenting museum objects/areas. The wide availability of mobile phones with internet access and integrated cameras boost the commercial success of mobile AR solutions.

With the use of augmented reality, the Hunebed Centre hopes to extract more customers, especially youngsters who currently do not visit the museum a lot. Attracting new customers is necessary especially now the Dutch government is decreasing cultural subsidies. The objective of this report is threefold. First, the goal is to provide better insight in the current visitor process including the pre-visitor process, the indoor and outdoor museum visit, and the post-visitor process. The second goal is to examine which popular AR solutions can be used to innovate the visitor process. The third goal is to select the best solution, and conclude how and where it can be used to improve the visitor experience.

The following research question guides this report:
How can new mobile augmented reality solutions enrich the customer experience during the visitor process at the Hunebed Centre?

This question is answered through a business process study of the visitor process. The remainder of this report is structured as follows. Section 2 provides more information about the Hunebed Centre. After, Section 3 models the current visitor process with the Business Process Modelling Notation (BPMN)[1], the current industry standard for graphical process modelling. Section 4 reviews several popular mobile AR solutions and selects the best option for the Hunebed Centre. Next, Section 5 explains the possible uses and advantages of the selected solution alternative and then redesigns the visitor process with

[1] BPMN is a standard notation that defines a Business Process Diagram (BPD) that is understandable for all business users. A BPD is a graphical model of an organisations business process, which is based on flowcharting techniques. The diagram shows the network of activities performed and the flow controls that together create the product or service that is being delivered.

integration of the selected solution alternative. Finally, Section 6 presents the implementation of the selected solution at the Hunebed Centre.

2 Case description

The Hunebed Centre is an archaeological museum with almost 100.000 visitors on an annual basis. Yearly turnover is about 1.3 million Euros of which 80 percent consists of revenues from entrance fees, catering and (web) retail sales. The other 20 percent consists of subsidies, which are evenly granted by county and town government. The county government will cut its subsidy with 10 percent and the currently subsidized buss for visiting schools might not be free in the future.

The Hunebed Centre employs 25 people, both full time and part time, and has about 100 volunteers. Apart from a permanent exhibition, the Centre organizes small activities regularly, such as small exhibitions and thematic tastings. These special activities are small because of their costs and attendance, and are marketed extensively. The Centre also increases its brand awareness by selling region-related products under its brand, such as water and beer.

Most of the visitors are groups with an educational objective, elderly and couples with children. In addition, the number of visitors from other countries, young couples without children, and groups from special education is growing. Like in most museums, the Hunebed Centre recognizes that young people between the age of 12 and 17 years remain largely absent. The Centre would like to change this in the future, but is unsure how to attract this group.

The Hunebed Centre views itself as a "museological social enterprise" and thrives for both social and biological sustainability, and for influencing local politics. The Centre aims to be innovative in their positioning towards visitors. This includes integrating several ways of experiencing (hear, smell, see, taste and feel). Like every museum, the Hunebed Centre wants to expand the number of visitors and thus increase sales, especially with the upcoming reduction of subsidies. This can be done by increasing brand awareness, by better serving the current target groups, and by attracting a new target group (young people aged 12-17). In sum, by creating a richer visitor experience the Hunebed Centre hopes to attract more visitors. The use of new mobile AR solutions might be able to achieve this.

3 Current visitor process

The visitor process consists of three main sub processes: pre-visitor process, visitor process (indoor and outdoor), post-visitor process. There are slight differences in these processes for individual and group visits. Therefore, the sub processes are modelled and described separately for individuals and groups. Appendix A includes the BPMN model of the entire current individual visitor process and Appendix D includes the BPMN model of the entire current group visitor process. The models show the activities that are performed by the involved actors in the visitor process, the interaction between these actors, and the sequence in which the activities are performed. The involved actors are human actors (visitor and employees at the Hunebed Centre), software actors (information systems), and object actors (the exhibited object). The current information system consists of a website. The employees are divided into several functional groups: back-office employees (marketing, management, etc.), front-office employees (reception, telephone operator, etc.), educational employees (tour guide, activities monitor, lecturer, etc.), museum shop employees (retail and ticket sales), and museum café employees.

3.1 Pre-visitor process

Individuals
The first sub process is the pre-visitor process (see Appendix A). As the model shows, the process starts at the moment the future visitor becomes aware of the existence of the Hunebed Centre, and it includes different ways of receiving more information and making the decision to visit the Centre. Potential visitors receive information about the Hunebed Centre through several media: the news, newspapers, advertisements, the Hunebed Centre website, or other ways such as mouth-to-mouth marketing. The contact between the potential visitor and the Hunebed Centre is one-directional (i.e. the visitor gets in contact with the museum) and usually only includes simple questions about opening times and prices. With this information, the individual can decide whether to visit the Centre.

Groups
The pre-visitor process for groups can be viewed in Appendix D. As with individuals, the initial contact with groups is usually one-directional as well. In addition to the marketing tools mentioned in the individual pre-visitor process, schools are also contacted through special fairs. After groups have contacted the museum, the contact becomes bi-directional and includes planning and discussing the content and price of the visit. Groups that do not announce their visit in advance are considered individual visitors.

3.2 Main visitor process

Individuals
The second sub process is the actual visit to the Hunebed Centre. The Hunebed Centre consists of an indoor museum area, an outdoor area, a museum shop, a café and a Knowledge Centre. Individual visitors decide for themselves which of these areas they visit. Thus, an individual visit might include one, a few, or all of these areas. Visitors have to buy a ticket for the inside exhibitions. Entry into the outside area, café and museum is free of charge.

The BPMN model of the individual indoor visit is included in Appendix B. This model details the activity “Watch indoor objects” in the main model in Appendix A. The indoor museum consists of a permanent exhibition and a changing exhibition. The permanent exhibition provides information on the prehistoric era in general and the megalith grave builders in particular. This is supported by movies and motion objects, playing of sounds, games, images and texts, and by exhibiting real archaeological artefacts, a (re-)constructed megalith grave, house and landscape. The BPMN model of the individual outdoor visit is included in Appendix C. The outside area consists of the biggest megalith grave in the area, and a reconstructed farm and stone field.

In both the inside and outside area, there is a default route available; visitors, however, can choose their own route as they wish. The Hunebed Centre pays attention to stimulating all of the visitor’s senses for both an individual and group visit. Individual visitors usually only have contact with the personnel of the museum shop and café. In some cases, individual visitors are directed to the Knowledge Centre for their theme-related questions. Because this is not part of the default visit, it is not shown in the BPMN model.

Groups
Groups are welcomed in the reception room, which is located in the Knowledge Centre. After a welcoming word and first introduction to the subject, the groups watch a movie about the megalithic

grave builders (which is available for individual visitors as well). Depending on the size of the group, it is then divided into smaller groups, and guided through the inside and outside area by a tour guide. As mentioned before, the BPMN model of the entire group visitor process is included in Appendix D. Appendix E and F detail the inside and outside group visit, that is, they detail the "Watch indoor objects" and "Watch outdoor objects" in Appendix D. After the tour, classes and workshops in the Knowledge Centre are optional. In addition, the groups have some time to visit the museum shop or café on their own. The biggest differences between individual and group visits is that groups are welcomed in the Knowledge Centre, the route of the visit is predetermined for groups, and groups have a guide during the entire visit.

3.3 Post-visitor process

Individuals
The third and final sub process is the post-visitor process, which starts at the moment the visitor leaves the Hunebed Centre. Currently, there are no structural procedures in place for the post-visitor process. Therefore, this process has not been depicted in a BPMN model. After their visit, visitors can become members of the Hunebed Centre, but they are not informed about this option in a structural manner. The Centre has around 60 members and most of them are volunteers working at the Centre. Sometimes visitors receive posters or flyers after their visit.

Groups
Schools can receive teaching material after their visit. Moreover, their visits are sometimes evaluated as to improve future visits. Again, there is currently no structural procedure for this. Apart from the evaluation, a post-visitor process is basically non-existent.

4 Solution Alternatives

The objective of the Hunebed Centre is to create a richer visitor experience by using new mobile AR solutions. Based on existing applications and after consultations with key people from the Hunebed Centre, three popular mobile AR were input for reviewing: Layar, 7scenes, and QR codes.

4.1 Layar

Layar[2] can be used through a mobile (smart) phone. Layar shows the user what is "around" him/her by displaying real time digital information on top of the real world through the camera of the mobile (smart) phone (see Figure 1). Layar can display all sorts of different information to enhance the world around the user. Layar uses a combination of the camera, compass and GPS data on the mobile (smart) phone to give an accurate picture of the objects "around" the user. The content of the information displayed depends on the Layar theme that can be selected by the user. There are many different themes available.

[2] http://www.layar.com

Figure 1. Impression of the use of Layar on a mobile phone.

4.2 7scenes

7scenes[3] is a mobile storytelling platform. It is a software application for mobile (smart) phones that allows to explore and share places online (e.g. to create city experiences). Like Layar, it an AR solution that can be used as an application on mobile phones connected with the Internet (see Figure 2). The users is shown several icons where more information, photos, videos, interactive games or activities about the scene can be visited. There are several platforms (or: scenes) that show places of sight in cities all over the world and that use GPS to determine your position on the map. Visitors can make their own pictures and post them on the scene, but can also share their own experiences (i.e. storytelling).

Figure 2. Impression of the use of 7scenes on a mobile phone.

4.3 Quick Response (QR) codes

A QR code[4] is a two-dimensional barcode made up of a pattern of black and white boxes (see Figure 3). The codes can be scanned by specialized scanners and by (smart) mobile phones with a camera, internet access, and a downloadable reader application. Because QR codes store information in both vertical and horizontal directions, they are able to carry more data than a regular barcode. The information encoded can be text, URL's, or other data. When a QR code is scanned, the user is directed to a certain online

[3] http://7scenes.com/
[4] http://www.denso-wave.com/qrcode/index-e.html

content, such as a PDF, a podcast, a video or a photo album. Formally, QR codes are not a form of AR since the online content is not integrated into the user's view of the real world. Instead, the user is redirected to certain online content. However, in a museum context, QR codes can be considered an indirect form of AR since the online content provides additional information about the museum object/area where the QR code is placed. Therefore, it does enhance the visitor's experience of reality.

Figure 3. Impression of the use of a QR code with a mobile phone.

4.4 Solution Selection

In the presented case study, QR codes were chosen as the best option to enhance the visitor's experience at the Hunebed Centre. The selection of QR codes was based on several motivations. First and most importantly, they can be easily generated and printed using several free online generators or mobile apps. In addition, their use is free of any license with free mobile apps for scanning QR codes being widely available. The second argument also applies to Layar and 7scenes since these applications are freely available. However, their use requires software to be developed. Layar would require the Hunebed Centre to design and develop their own *theme* whereas 7scenes would require the Centre to design and develop their own *scene*. For example, a scene for 7scenes requires the Centre to make a storytelling platform with specific information and photos, visitor's routes, user instructions etc. Since the Hunebed Centre has no specialized software developers, this would require a substantial (financial) effort. Second, related to this, all three solutions are new and upcoming. In this regard, QR codes allow the Hunebed Centre to evaluate the use of mobile software applications by visitors without the need for a big upfront investment. Third, from the user's point of view, both Layar and 7scenes require the user to hold the mobile phone out in front of them at all times. This may limit the visitor in their perception of the real world. In contrast, QR codes only have to be scanned when the users wants to. Finally, with QR codes the online content to which they redirect is very easy and cheap to change. The QR code does not have to be modified but only the content to which it refers. With Layar and 7scenes, changing the content requires changing the theme or scene, which is more labour-intensive and time-consuming and thus more costly. Changing the content regularly is especially important to keep recurring visitors interested.

5 Redesigned visitor process

This section discusses the redesigned visitor process with QR codes at the Hunebed Centre. First, the functional use and advantages of QR codes in the visitor process are reviewed. Second, based on this review and the BPMN models of the current visitor process from Section 3, BPMN models of a redesigned visitor process with QR codes are presented.

5.1 Functional use and advantages of QR codes

The content linked to QR codes can offer quite a lot that a physical object (i.e. real-life artefact) cannot. Opportunities are information in the form of text, additional images or photos, videos, sounds, visitor interaction, quizzes, quests or games, a chat function or the application of AR. Each of these functions has its own advantages.

First, instead of overloading visitors with information by placing excessive texts at all museum objects, having access to additional texts via QR codes gives the user the opportunity to read more about objects of interest. Second, showing supporting images or photos of for example 'behind the scenes' events or digital reconstructions helps visitors envisioning the story behind a museum object and stimulates the brain in a different way than simply reading texts. Third, videos and sounds can enrich the visitor experience by encouraging the visitor to use more senses (i.e. not only sight, but sound as well).

An advantage of using QR codes is that the code itself does not contain the content. The code only contains the identifier (in most cases a URL) that redirects to a certain online content. Therefore, QR codes take less space than for instance a normal text or video display would in a museum. Related to this is the fact that small QR codes form less distraction from the associated museum object than the entire content would. In addition, because the content is no longer bound to limitations of space and distraction, more content and thus more information can be offered. Another advantage of the use of QR codes is that they might be experienced as more fun and more innovative, and may therefore be especially appreciated by young visitors that are currently neglecting to visit the Hunebed Centre. Yet another advantage is that, assuming that all (interested) visitors are able to scan the codes, they all have their own access point to all the information instead of e.g. just one screen for one certain video that has to be read by all visitors.

It is wise to add certain labels to the QR codes (e.g. Scan this code to access a video about the megalithic grave). In this way, visitors are aware of the type of target content before they scan the QR code. Another interesting feature for visitors (assuming that they bring their own mobile phones) is that the content that is accessed during the visit can also be viewed (and possibly shared) at home by accessing the phone's browser history. The visitor can thus watch the content again and/or share it to others.

5.2 BPMN models of the redesigned visitor process

QR codes offer different options in each sub process (i.e. pre-visitor process, visitor process and post-visitor process). For each sub process, a redesigned BPMN model has been created in which the use of QR codes has been integrated. To accomplish this, the BPMN models of the current visitor process from Section 3 were analysed with the acquired knowledge on the functional use and advantages of QR codes from Section 5.1.

Pre-visitor process
The redesigned BPMN models for the individual and group pre-visitor process can be found in Appendix G and H respectively. As the models show, the main use for QR codes in the pre-visitor process is to add them to advertisements (e.g. in papers, magazines, or billboards) and to print them on the products sold under the Hunebed Centre brand. The codes can link the user to the company's website or a special webpage for marketing purposes. The advantages for this sub process will be mainly because the codes enable the user to access a lot of information without needing much printing space. In addition, the use of the technology introduces the Centre as a fun and modern cultural Centre. Finally, instead of just reading the brand name or advertisement text the user is encouraged to explore the Centre's website and gain more information about the Centre, which in turn might trigger the user to visit the centre.

Main visitor process
The redesigned BPMN models for the individual and group main visitor process can be found in Appendix I and J respectively. For the main visitor process (i.e. the actual museum visit), most of the uses and advantages discussed in Section 5.1 apply. By placing QR codes with the exhibited objects, the visitor can access more information, choose which information to obtain, and experience the museum in a fun and innovative manner. The museum simply has more to offer and becomes a better fit with the visitor's wishes. As mentioned before, QR codes with the same type of content such as videos or games should ideally be labelled. In this way, the visitor not only knows about which object or subject the content is, but also what type of content he/she will access when the code is scanned.

Post-visitor process
The redesigned BPMN models for the individual and group main post-visitor process can be found in Appendix K and L respectively. There are three main options for the use of QR codes in the post-visitor process. The first option is that the visitors can access the consulted content again after leaving the museum as indicated in Section 5.1. This has the potential to keep the memory of what was experienced in the museum more alive and therefore it may leave a greater impression (this may in turn trigger a return visit). Second, the visitors have the ability to share their stories in a more accessible and fun way with others, which may encourage others to visit the museum themselves. Third, the use of this technology enables the Hunebed Centre to update the content more frequently, which may be an important reason for visitors to come visit the Centre again.

Groups and individuals
QR codes are available for both group and individual visits. The advantages for individual visitors are evident as most functions aim at supporting individual wishes and interests; QR codes can provide information that is normally provided by a tour guide. For groups, however, the technology might have some additional implications. The codes are primarily focused on providing a more extensive and personalized visitor experience. This might cause the group to fall apart and we might wonder whether the guide is able to keep the group's attention and to what extend the guide can provided any added value at all. A possible solution to promote interaction between the group members might be a chat function and quizzes, quests, games or other interactive contents that are accessible for several visitors at the same time, and make them collaborate or take part in a competition. However, the use of QR codes provides most benefits for the individual visitor.

6 Solution implementation

Currently, the Hunebed Centre displays six QR codes with different outdoor objects. One of them is located at the reconstructed Graanspieker (i.e. a grain storage). The picture at the frontpage of this report shows a visitor scanning this QR code. Moreover, Figure 4 shows a detail picture of this QR code. As a note to the reader, it is possible to scan this code using a mobile phone with camera and installed scanner software to check its workings.

Figure 4. The QR code displayed with the *Graanspieker* at the Hunebed Centre.

Figure 5 shows a screenshot of the website to which the QR code in Figure 4 redirects the visitor after scanning the code. The website provides additional background information about the grain storage including pictures. Moreover, it also provides links to websites with information on related subjects, and provides a link to the main website of the Hunebed Centre.

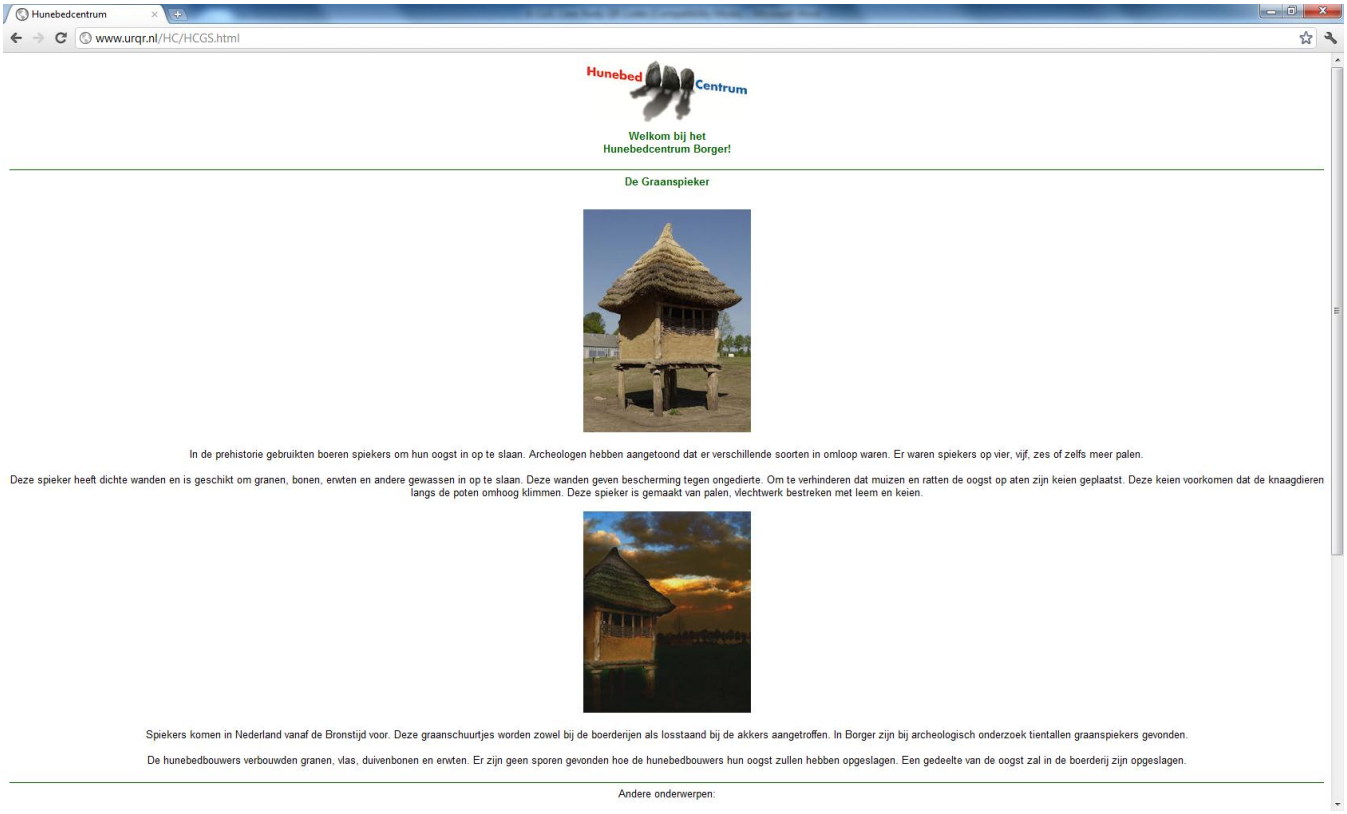


Figure 5. The website to which the QR code at the *Graanspieker* redirects the visitor.

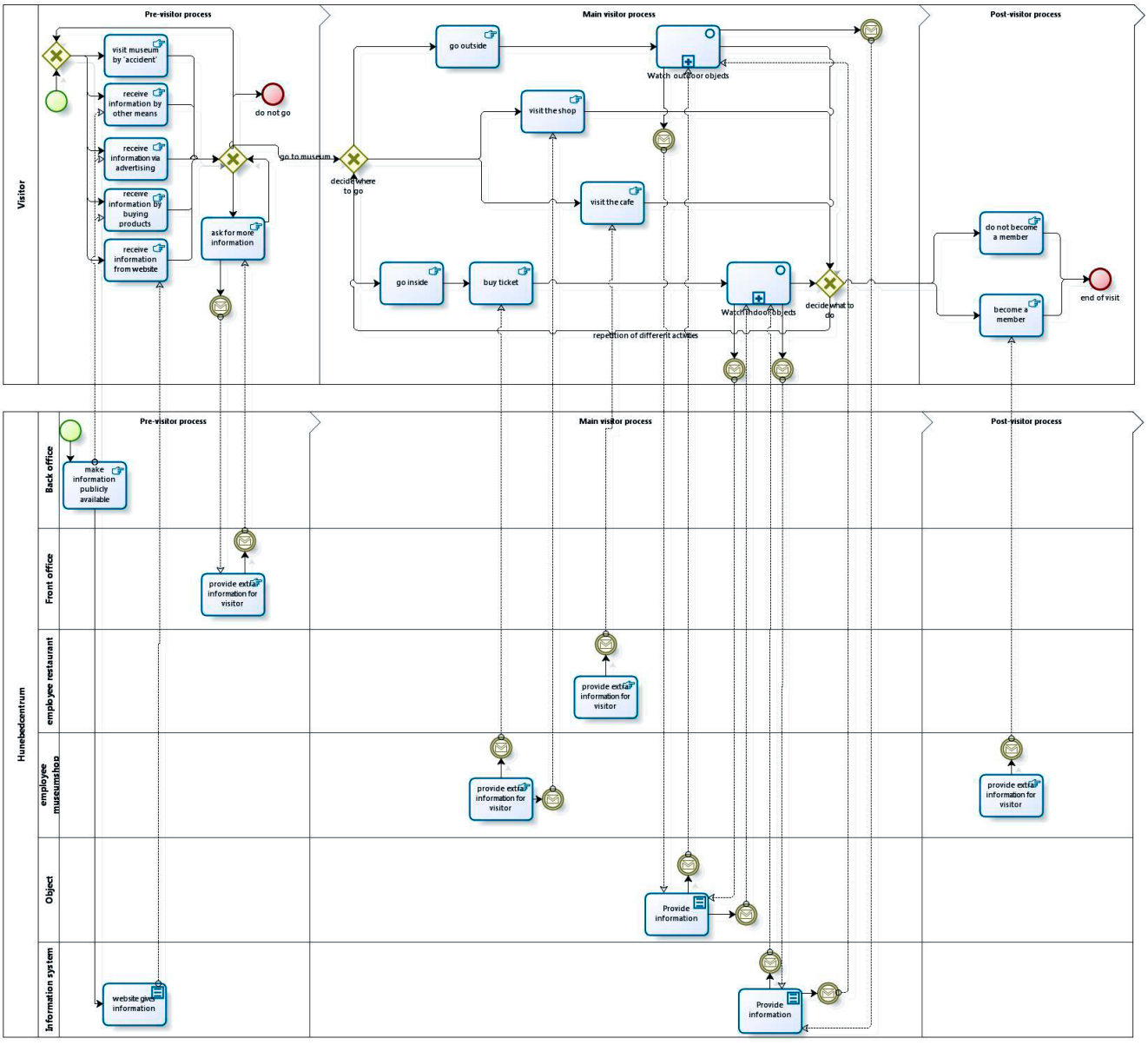
The reason to limit the QR codes to the outside area for now is that the mobile internet signal is weak inside. There are initiatives to make free Wi-Fi available to all visitors both in the inside and outside area.

It is likely that not all visitors possess a mobile phone that is able to scan the QR codes at the Hunebed Centre. However, the number of people that do is rapidly growing and is especially likely to include youngsters. The Hunebed Centre can also consider lending mobile phones to its visitors during their visit. Only, this would imply that the visitors can only experience the advantages of QR codes in the main visitor process and not in the pre and post-visitor processes. Overall, the advice to the Hunebed Centre is to keep implementing QR codes in all three sub processes because of two main advantages: (1) QR codes enrich the visitor's experience and (2) they are relatively easy and cheap to use.

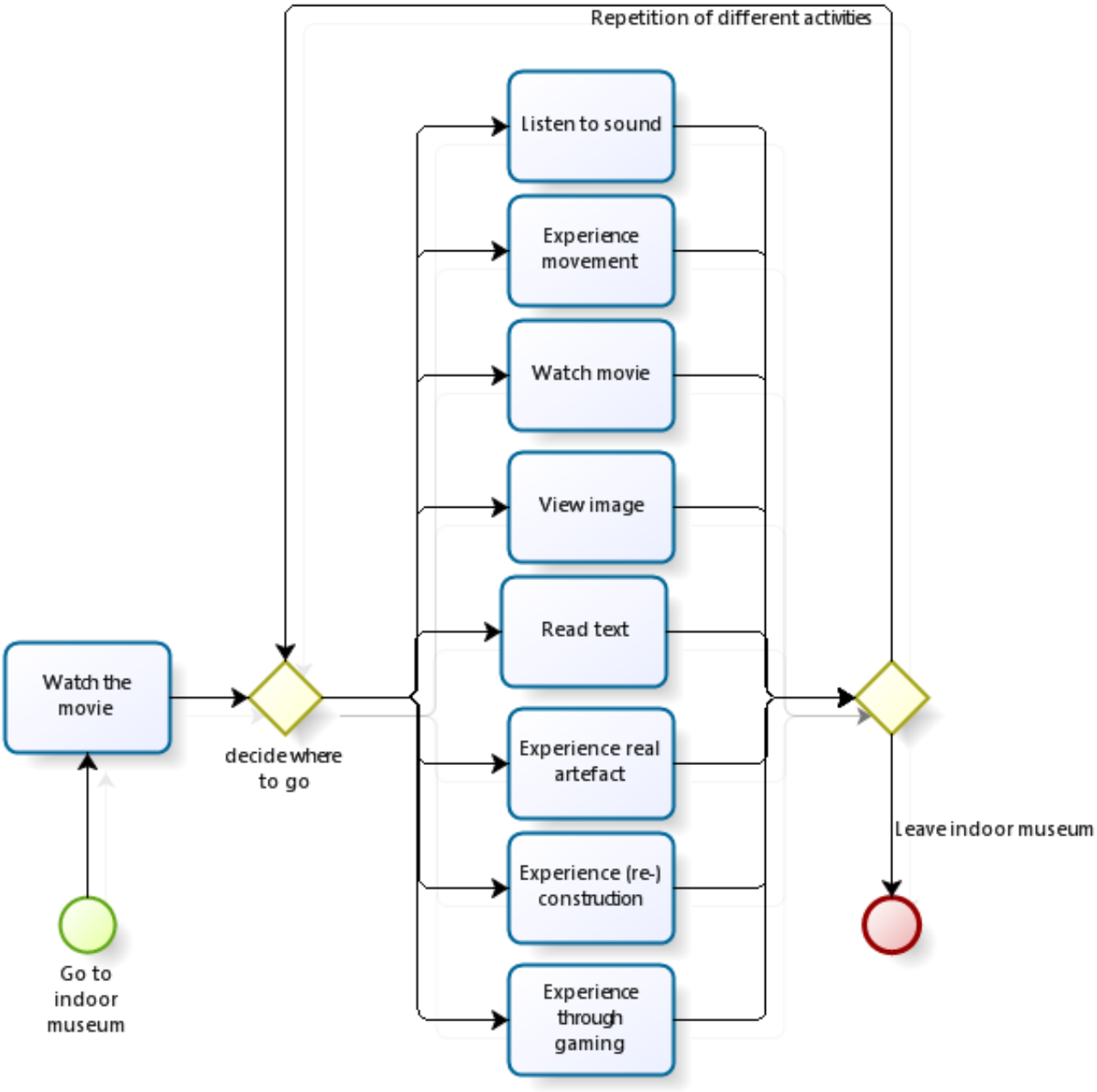
7 Participants

This research is based on bachelor thesis research conducted by Karijn Scholte, Johan Kasper, José de Bruin, and Sebastian König. The current report summarizes their field research at the Hunebed Centre, and uses text from their completed bachelor theses. The bachelor thesis research was part of the bachelor programmes *Business Administration* (Karijn, Johan, and José) and *International Business and Management* (Sebastian). The research was performed in the period September 2010 – February 2011.

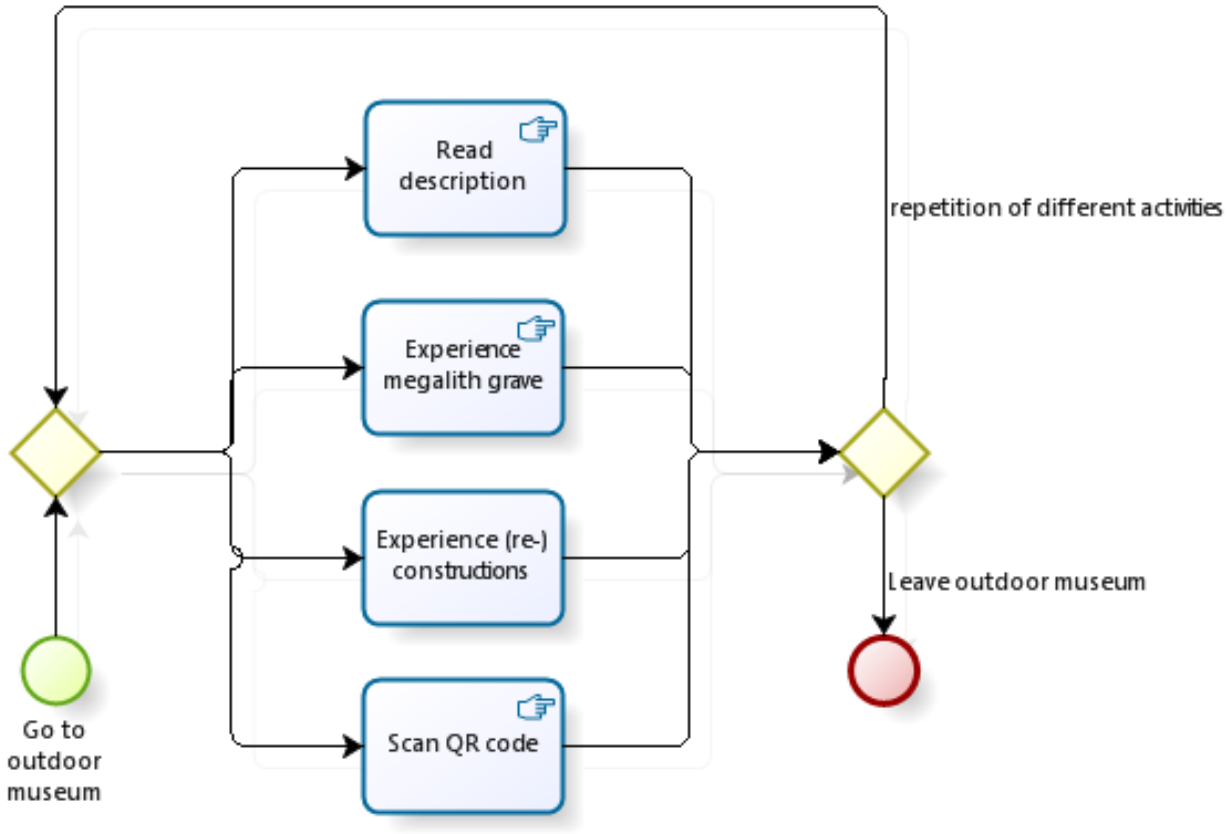
Appendix A - Current individual visitor process



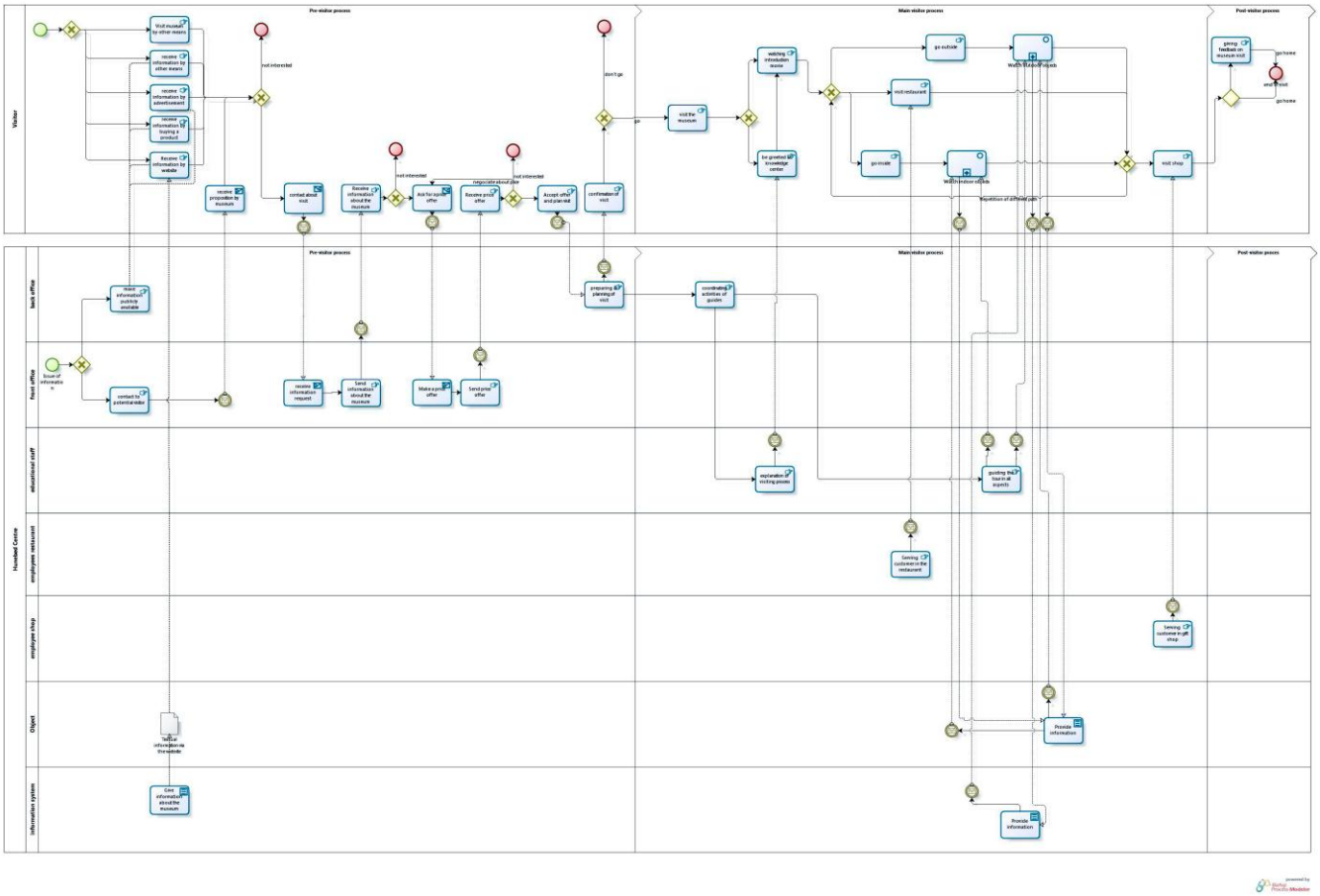
Appendix B – Sub process individual indoor visit



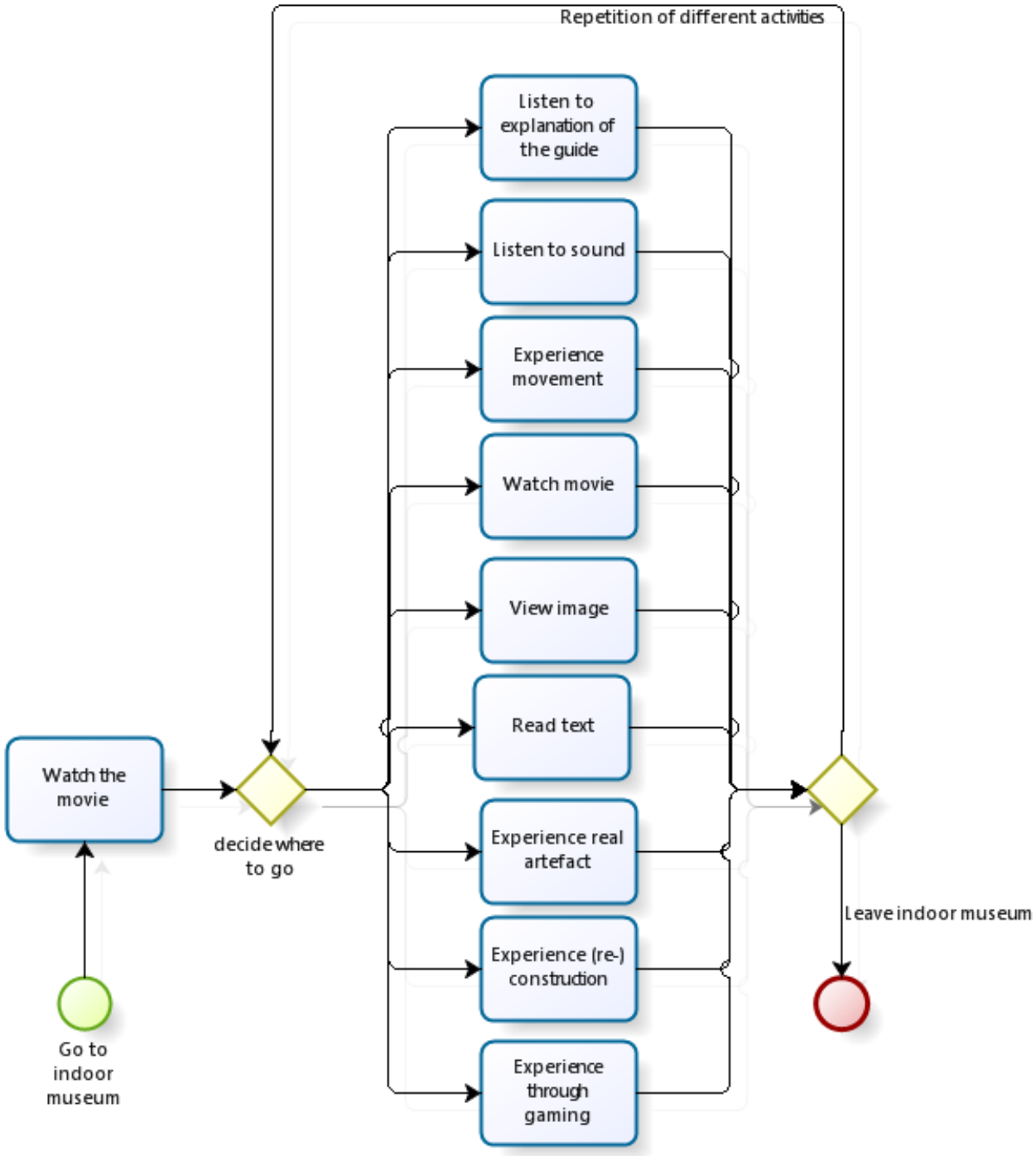
Appendix C – Sub process individual outdoor visit



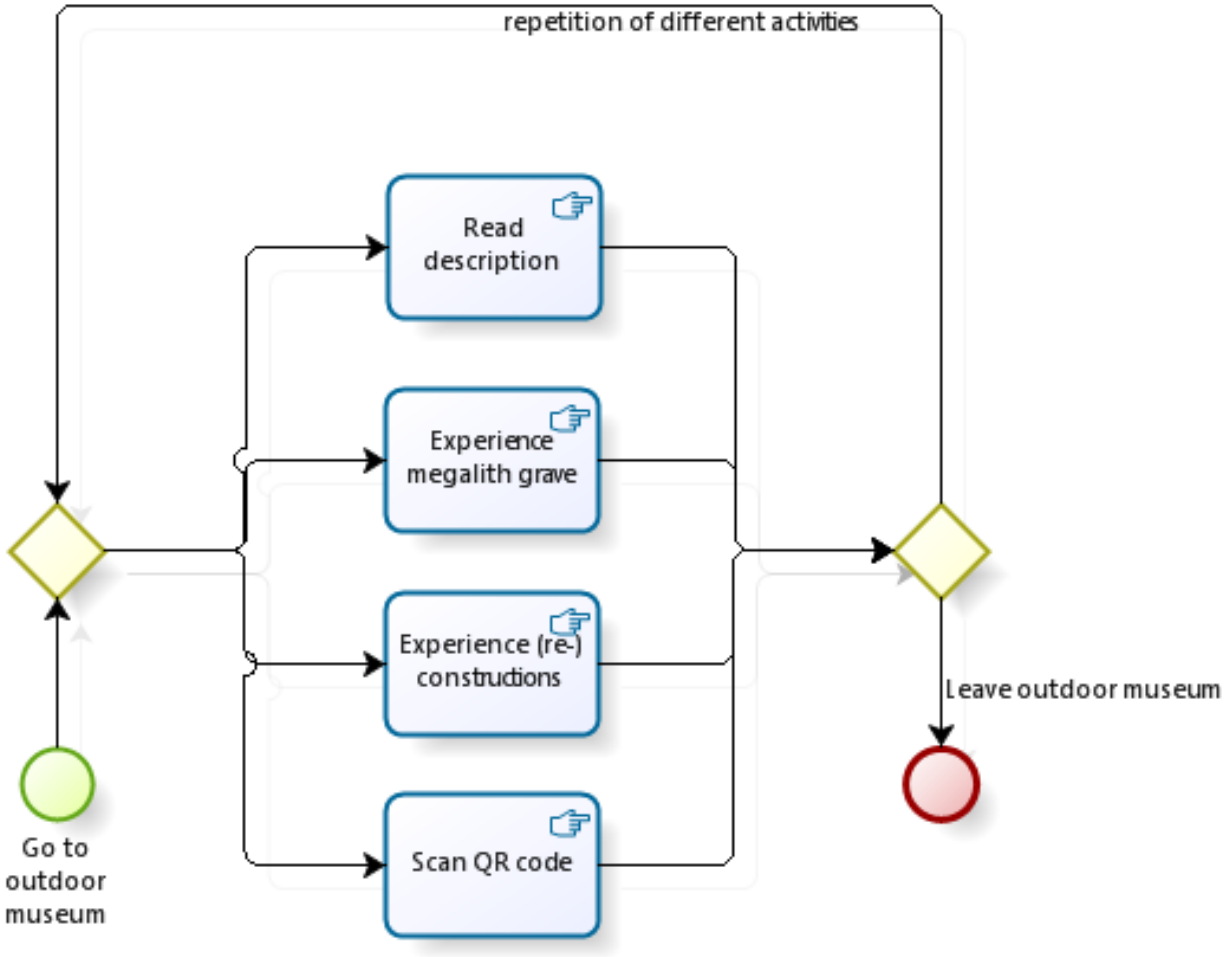
Appendix D – Current group visitor process



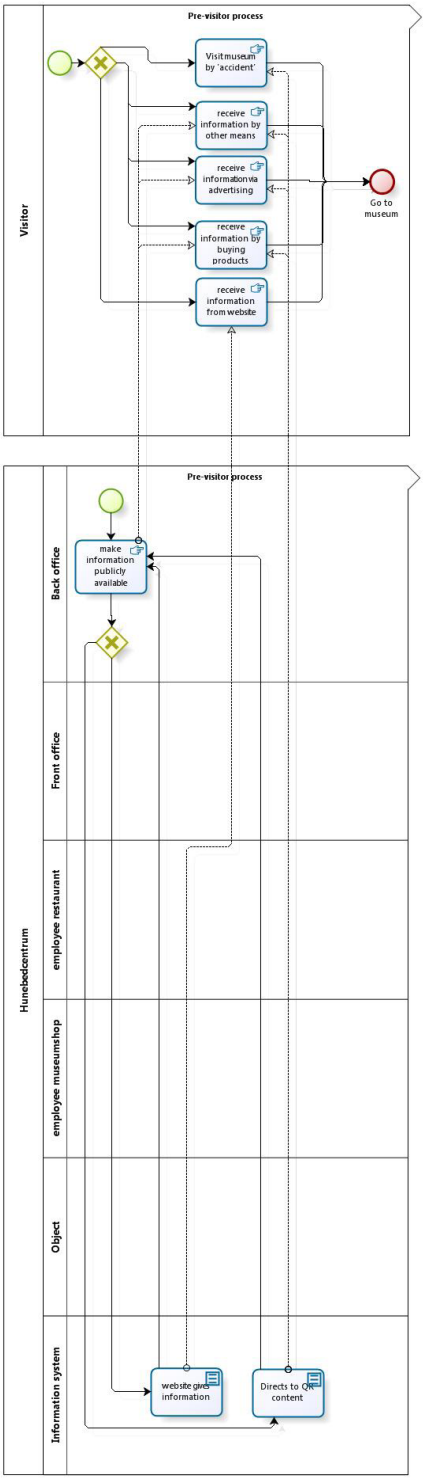
Appendix E – Sub process group indoor visit



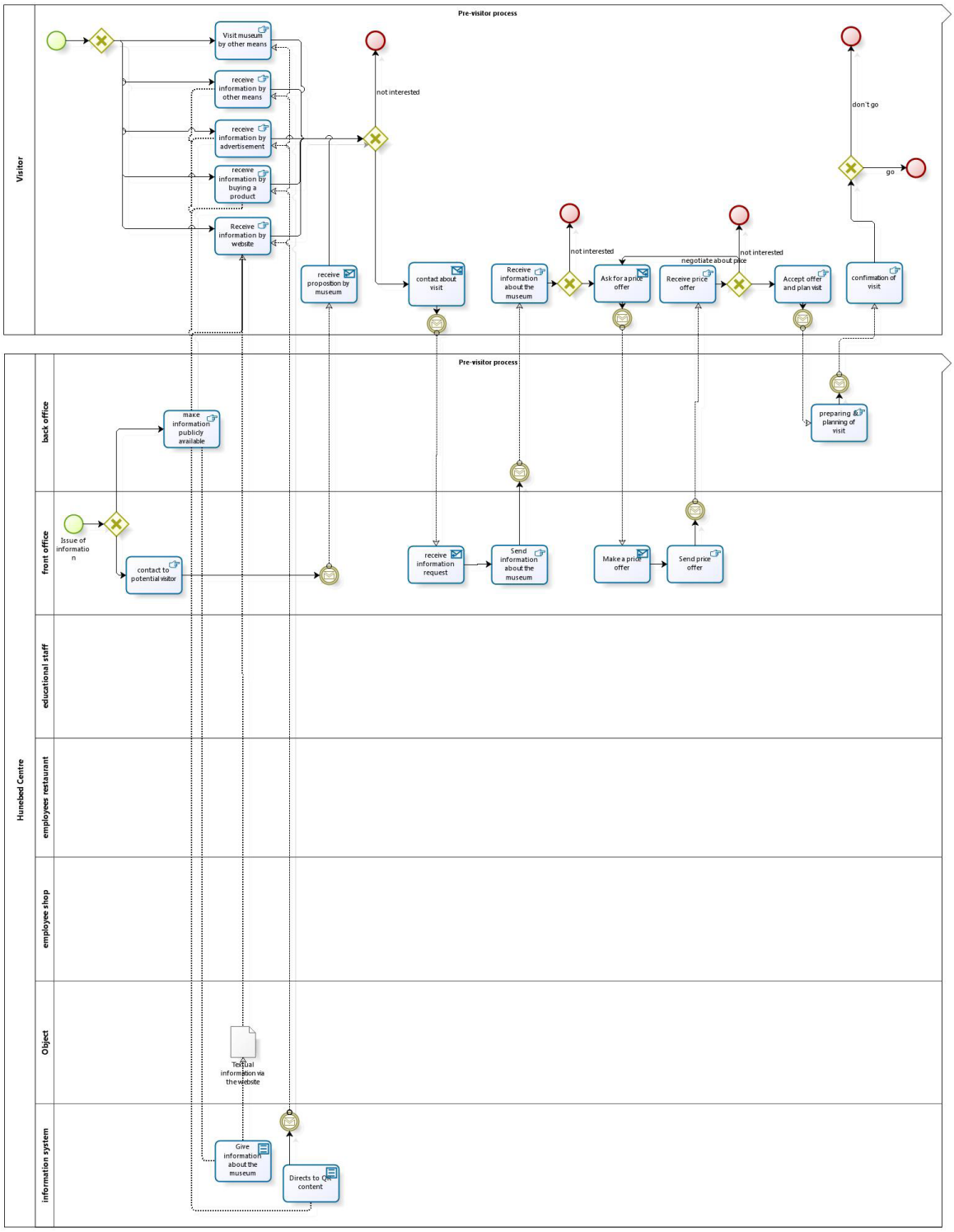
Appendix F – Sub process group outdoor visit



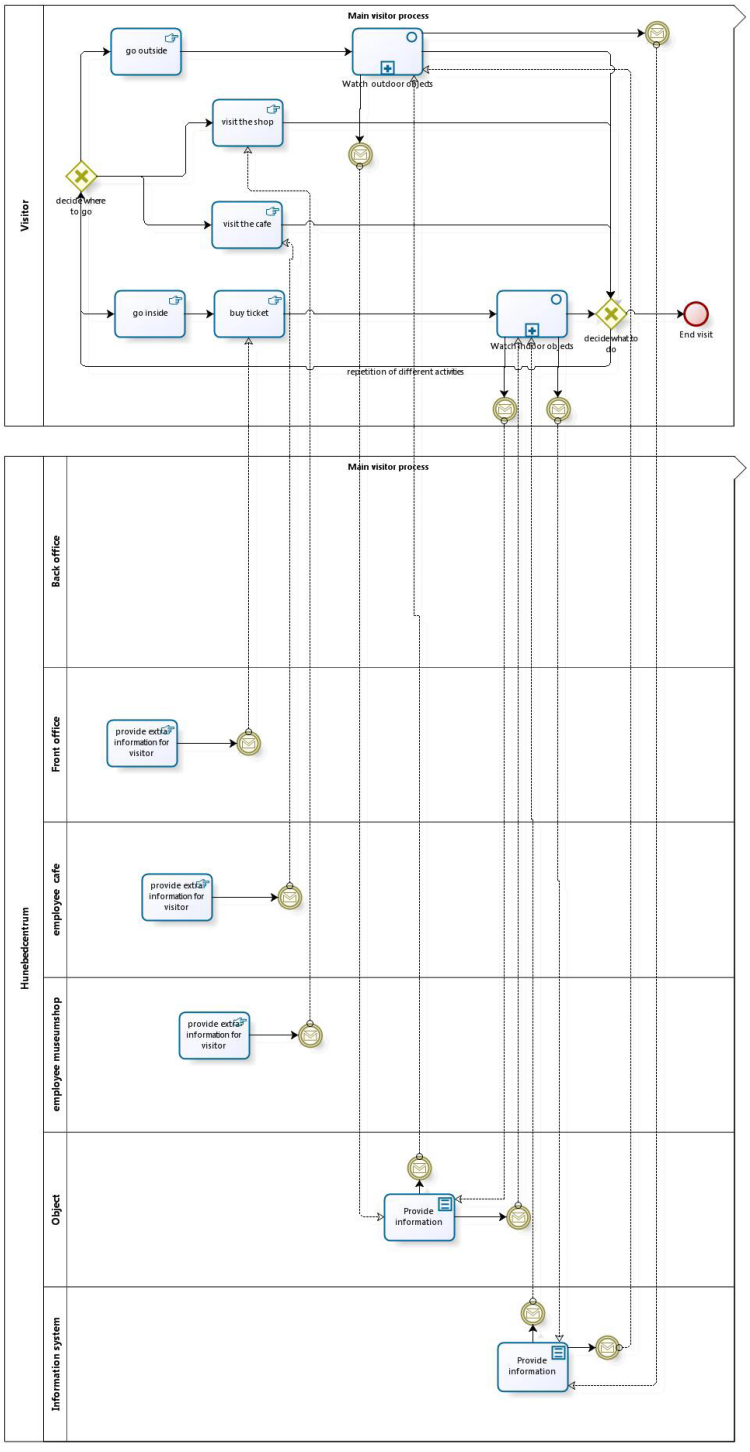
Appendix G – Redesigned individual pre-visitor process


Pre-visitor process
Visitor
Visit museum by 'accident'
receive information by other means
receive information via advertising
receive information by buying products
receive information from website
Go to museum
Pre-visitor process
Hunebedcentrum
Back office
make information publicly available
Front office
employee restaurant
employee museumshop
Object
Information system
website gives information
Directs to OK content

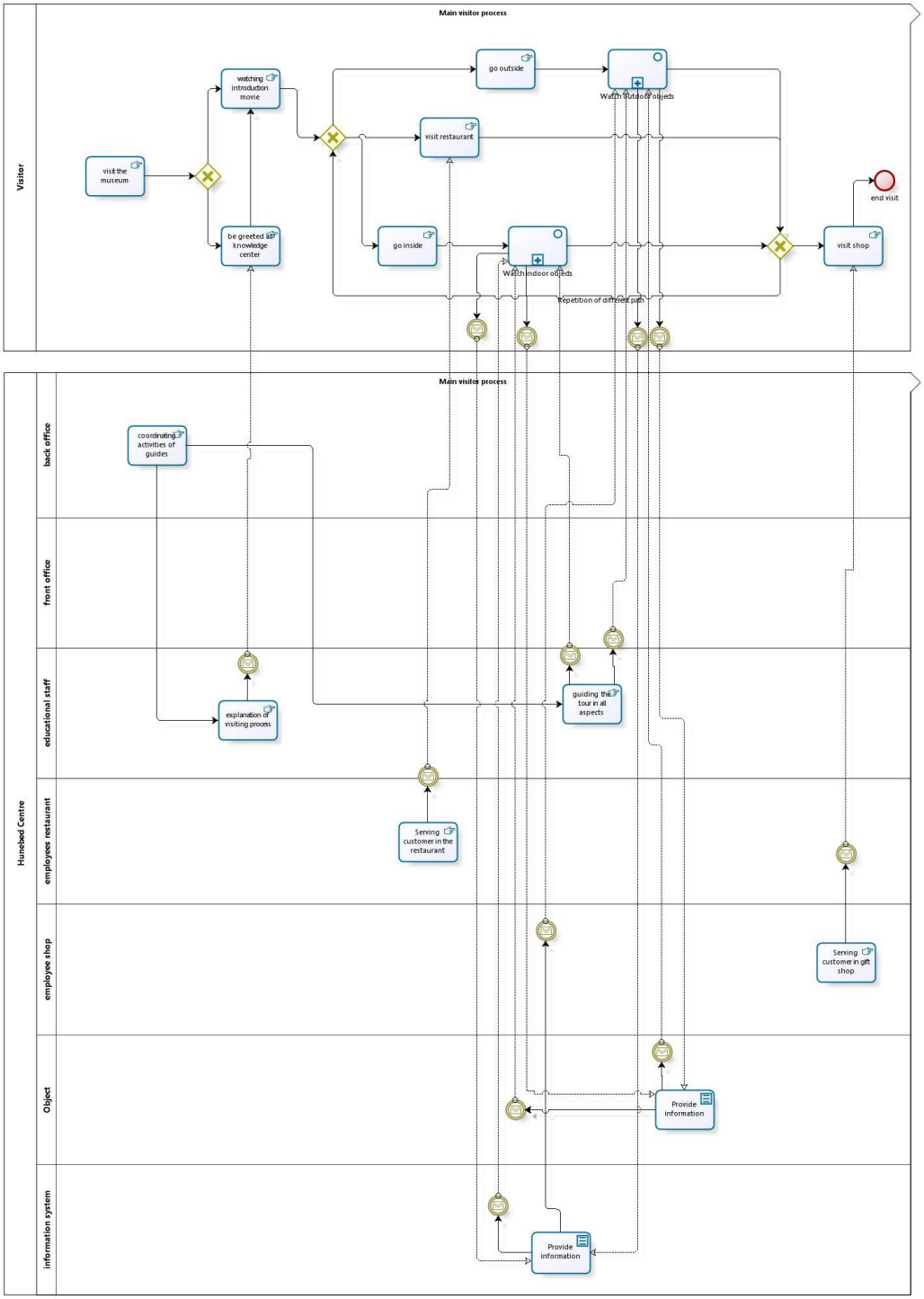
Appendix H – Redesigned group pre-visitor process



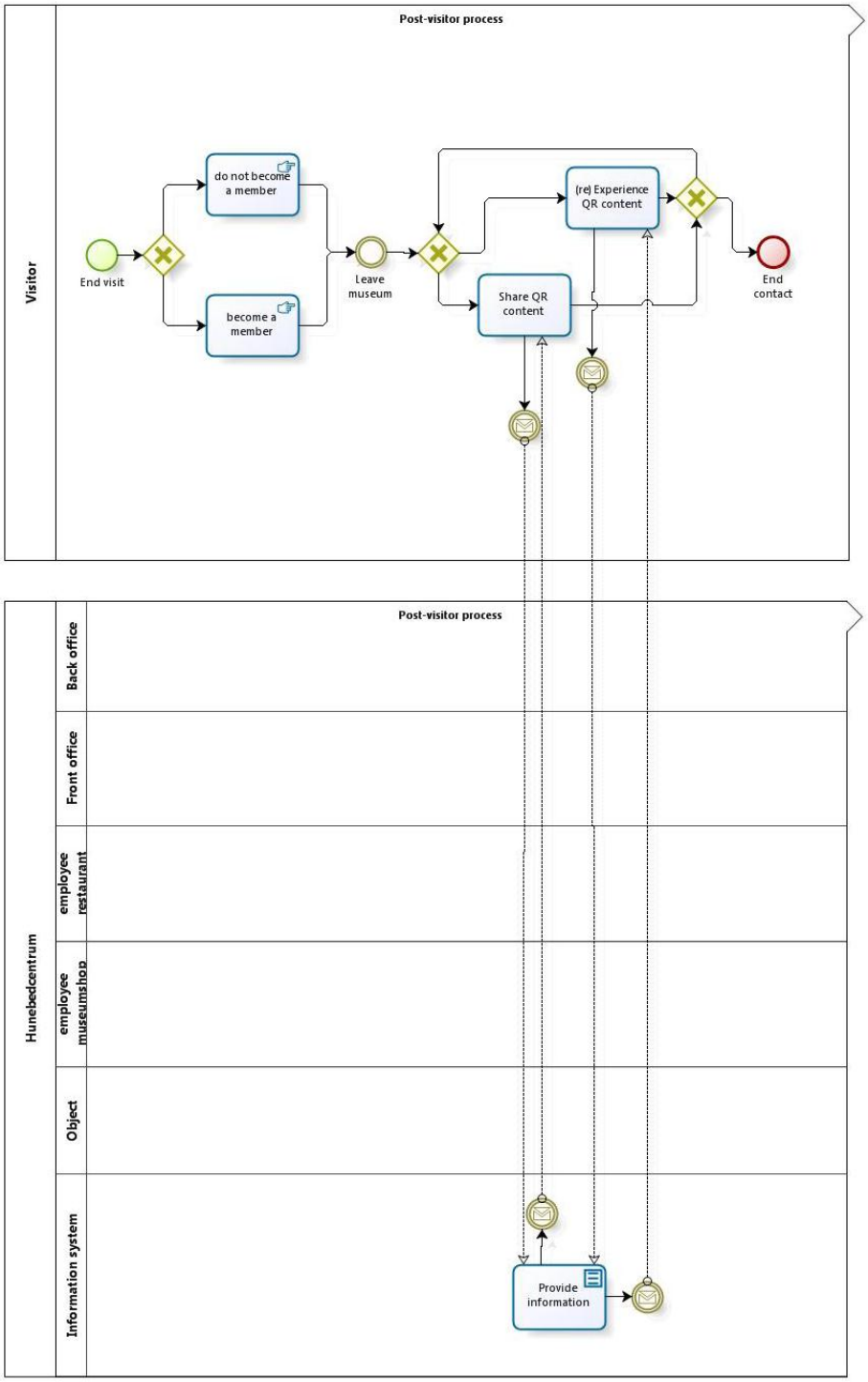
Appendix I – Redesigned individual main visitor process



Appendix J – Redesigned group main visitor process



Appendix K – Redesigned individual post-visitor process



Appendix L – Redesigned group post-visitor process