Using Business Process Modelling to Improve Student Recruitment in UK Higher Education

Oluwatoyin Fakorede[1], Philip Davies[1] and David Newell[1]

[1] Department of Computing and Informatics
Faculty of Science and Technology, Bournemouth University
United Kingdom
{Ofakorede, Daviesp, Dnewell}@bournemouth.ac.uk

Abstract. We consider how the student recruitment process might be improved to optimize performance with particular reference to the clearing process. A Design Science Research (DSR) methodology was used which entails learning through artefact production and data was collected from interviews, observation and document analysis. The logic of the clearing process was modelled using a process-oriented modelling technique. An 'As Is' clearing process model was created to analyze the process, and a 'To Be' clearing process model developed. The improved model has been verified by domain experts and promises to enhance the clearing process in terms of cost saving and resource utilization.

Keywords: UK higher education; process modeling; recruitment process; business process improvement; BPMN; clearing

1 Introduction

Around 700,000 prospective students seek admission through the Universities and Colleges Admissions Service (UCAS) to over 380 higher education institutions (HEI) in the UK each year [1]. There is fierce competition amongst universities to recruit and retain students with almost 50% of universities' income being sourced from tuition fees [2]. Clearing is an extension of the higher education (HE) application process run by UCAS which can be used by applicants who do not have a place at a university or a higher education institution [3]. Clearing allows applicants to find courses that still have places available. According to UCAS, around one in eight people accepted onto a full-time university course arrived through clearing [4].

The clearing process is divided into early clearing, which runs from the beginning of July to mid-August, and main clearing which starts from mid-August when the A-levels results are released. This work focusses on main clearing from the university perspective [5]. From an economic view point, the idea of 'student as customer' has developed since the increase in tuition fees which has meant it is harder to fill places from clearing and consequently important to optimize and effectively manage the application experience. In this paper we use business process modelling to identify non-value-adding activities in the clearing process. The clearing process improvement is

iteratively achieved through the analysis of the process models. The use of a structured technique to support the improvement of a process from the 'As Is' to the 'To Be' state is a complex and difficult one which requires significant consideration of process improvement methodologies [6, 7] and lies outside the scope of the present work. This paper's originality lies in the application of process modelling to identify issues in the recruitment process in the UK HEI which so far no one has investigated. The paper is structured as follows: Section 2 describes choosing a business process modelling technique. Section 3 explains the use of BPMN-based process improvement models. Section 4 describes the methodology while data gathering sources are revealed in section 5. Section 6 presents the implementation of the DSR methodology using BPMN and section 7 presents conclusions and future work.

2 Choosing a business process modelling technique

Aguilar-Saven [8] has classified business process modelling techniques in two dimensions. The first dimension is based on four levels of functionality; level 1 - Descriptive for learning, level 2 - Decision support for process development/design, level 3 - Decision support for process execution and level 4 - IT enactment. The second dimension is based on whether the model is active (allows interaction between the model and the user) or passive (does not allow interaction).

Another author, Vergidis et al. [9] proposed three classifications of business process modelling techniques as follows (Figure 1):

1. Diagrammatic models: This entails the use of diagrams to represent a business process model e.g. Flowcharts, Role Activity Diagrams, IDEF. These techniques can be used to give fast and informal representation of a business process, but they lack the semantic capacity to depict a more complex construct [9].
2. Formal or Mathematical Models: These models have been accurately defined and analyzed to glean quantitative information from them. Petri-nets (see Figure 1) are business modelling techniques that can be visually represented using standard notations but with formal or mathematical underpinning [10]. The disadvantage of mathematical models is that they can be tedious to create and maintain [11].
3. Business Process Languages: These bridge the gap between the diagrammatical models and formal models. Where diagrammatical models lack semantics to capture complex constructs and formal models are too complex, business process languages based on XML reduce the complexity of formal models without losing consistency and capacity for analysis e.g. BPEL. Figure 1 shows business process languages that can be expressed diagrammatically e.g. YAWL, JBPM etc.

Several business process graphical notations can be used to model different aspects of processes in the business process lifecycle depending on the objective of the phase such as requirements analysis, mapping business requirements to IT Services, data flow between processes, modelling interaction between the model and the user, business process improvement, process simulation etc. These graphical notations can be grouped into three categories [12]:

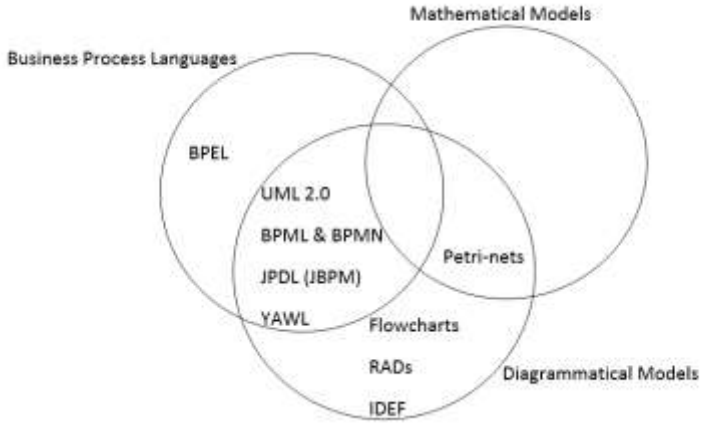

Fig. 1. Classification of business process modelling techniques according to Vergidis et al. [9].

1. Data-oriented Notations: The objective is to capture the flow of data e.g. Data Flow Diagrams. As this study is not about how data is stored or transformed in a process, DFDs will not be suitable to model the clearing process.
2. Role-oriented Notations: The objective is to capture the specific roles in an organization and their interaction with others. Role Activity Diagrams (RADs) capture humanistic processes and their interactions. As this study is not about human factors, it will not be suitable to model the clearing process [13].
3. Process-oriented Notations: The objective is to capture the flow of operational activities in or across business processes. Examples of this include Business Process Modeling Notation (BPMN), Unified Modeling Language Activity Diagrams (UML AD). Since the clearing process is best viewed from an operational perspective the process-oriented notation is most suitable to model the process.

BPMN is chosen over UML AD because the Object Management Group (OMG) BPMN version 2.0 includes a mapping of BPMN to a business process execution language called WSBPEL [14]. This makes business process models created in BPMN to be executable. On the other hand, UML AD does not include any specification of mapping UML AD to any business process execution language [15].

3 Use of BPMN-based process improvement models

As discussed above, a single process can be captured using multiple process models, from different perspectives, at different levels of abstraction using different modelling languages [16]. However, BPMN-based process improvement has not received much

attention. Business process improvement approaches in HEIs are scarce as indicated by Daurte and Martins [17]. Their work focused on the gathering of practices and knowledge and the communication between stakeholders to improve business processes. They presented an extension to the Business Process Maturity Model (BPMM) for HEI which includes five maturity levels that capture the degrees of organization transformations. Their improvement was aimed at the transition of institutions from maturity level 2 to 3 and validated by experiment at the University of Algarve [17].

Process improvement in HEI was carried out by Gamil [13] who focused on process improvements from a human resource perspective; showing roles, activities and interactions within an organization. This informed the use of Role Activity Diagrams (RAD) to model the student journey processes using RADs-RichPicture model to identify improvements in role-oriented services and therefore adopted a Role-oriented notation to capture the processes.

Another related work by Al-Medlej [18] investigated the factors that influence the decision-making process in Saudi Arabia HEI and explored ways to manage these factors in order to exert a positive influence on the process and proposed a new approach towards a more efficient decision-making process.

There are other non-HEI related BPMN-based process improvement models. For example, Khabbazi et. al [19] in their work engaged the use of BPMN 2.0 to capture and analyze the "As Is" complex inbound logistics of an industrial system. The logistic process entails all activities with respect to the inbound movement of the resources and information including the ordering, procurement, auction and purchasing processes. A "To Be" inbound logistics business process model was proposed to specify the structure and the behavior of the system.

Silvia et. al [20] presented the improvement of a government public service via the analysis of the Key Performance Indicator (KPI) and Critical Success Factor (CSF), while the process model was designed using BPMN. The Service Engineering Framework (SEF) research methodology was used which entails three phases: 1) Identification Phase (the performance of the existing business process using CSF and KPI analysis) 2) Design Phase (the current and proposed processes modelled using BPMN with Bizagi modeler software) and C) Design Validation was performed using the time analysis level of Bizagi modeler software [21]. The result of the business process improvement showed that the speed of various services provided had increased by a minimum of 58.1%.

Mpardis and Kotsilieris [22] created a process model that captures the procedures involved in approving a loan request using BPMN with Intalio|Designer. The process model was mapped to a BPEL 2.0 process server for execution. BPEL outputs were analyzed by Matlab based on some specific KPIs. The benefits of their approach could lead to reduction in cycle time and in-crease in output per employee.

There is lack of research work that analyses the admission process of UK HEI using the BPMN technique.

4 Methodology

The Design Science Research (DSR) methodology is used here in preference to the SEF methodology because the CSF and KPI analysis is not required. Design Science provides a set of synthetic and analytical techniques for carrying out research in Information Systems [23, 24]. This set of techniques formulates new knowledge or theory through the design of novel or innovative artefacts, followed by an analysis (which includes reflection and abstraction) of the performance of the artefacts to understand and improve the behavior of the information system.

DSR has four main process stages, where each stage has a specific output. The stages we apply here are:

1. **Awareness of Problem:** The problem needs to be identified, for example from an area of challenge in an organization. The problem is made manifest by creating the 'As Is' clearing process model using BPMN 2.0. In this case the problem was identified through involvement in the clearing process in the chosen university which led to the identification of clearing recruitment challenges. One problem identified was that applicants may select university "A" on UCAS Track without a prior offer from university A. On the other hand, upload of offer (made by universities) confirmations to UCAS happen only when the university is selected by the applicant. An applicant who already has an offer from university "A" may instead select University "B". Since staff are required to follow up on the applicants with offers, this activity could be a waste of time and resources. The output of this phase is a proposal for improved design.
2. **Suggestion:** The proposal from stage 1 is transformed into a tentative design. In this case the tentative design is the same as the proposal. The suggestion stage is part of the solution design. The cognitive process involved is **Abduction** because the suggestion offered to solve the identified problems are abducted from the existing process of knowledge base in the problem area [23; 25].
3. **Development:** This is the concluding part of the solution design. The artefacts can be constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices) and instantiations (implemented and prototypes systems) [23; 24]. In this case, the tentative design was developed into the 'To Be' clearing process model. Five progressive versions of the model were developed through an iterative process until a final validated version (see figure 2) which is an accurate representation of the UK HE clearing process. The cognitive process involved is **Deduction** because it involves a move from the general to the specific.
4. **Evaluation:** This phase entails the evaluation of the artefact based on performance measurements such as time saving and resource utilization. This was achieved through simulations used to compare various scenarios and domain experts. The cognitive process involved at this stage is called Deduction because knowledge deduced from the analysis of contradictions or deviations from expectations.

5 Data Gathering and Verification

The clearing process is regulated by UCAS and is the same for all UK HEs. The choice of HE was determined by access to data sources. The quality of data gathered was verified using verification strategies [26]. Verification of data is the process of establishing the validity and reliability of data. The relevant verification strategies used were appropriate sampling and concurrent data analysis. We gathered data from three independent sources; Interviews, Document Study and Observation.

1. **Interviews**: Interview was chosen to ensure that relevant questions are answered, and responses can be more in-depth. Both structured and semi-structured approaches were adopted to allow flexibility and adaptation and to elicit more in-depth and personalized responses. To guarantee the reliability of the interview data, we selected an appropriate sample [26] consisting of participants who have significant roles and adequate knowledge of the clearing process. Nine interviews were conducted involving seven members of staff involving; a senior management team member, academic staff, admissions staff, administrative staff, a business intelligence team member, IT services and one member of staff from UCAS. The interviews varied between 20 to 120 minutes duration and were recorded and transcribed for analysis. Both personal data and materials gathered were treated as confidential. The interviews covered areas such as; the student recruitment process; the clearing process from a UCAS perspective, HE perspective and student perspective; admission target setting; how admission estimates are generated, benefits of improving the process and verification of process models. The interview transcripts were coded into broad themes according to the research objectives.
2. **Document study:** Document study was chosen to gain background and context information, help generate interview questions, develop understanding, and discover insights relevant to UK HEI admissions. The Schwartz principles [27] of fair admissions and several reports on HE admissions relevant to the research objectives were downloaded from Ucas.com [3] and studied. Minutes of meetings and administrative reports for the same UK university were also examined using thematic analysis [28]. The codes used in the interview transcripts were applied to the content of the documents generating an integrated data gathered by different methods. The data obtained from document study was iteratively analyzed concurrently [26] with the data obtained from interviews to ensure uniformity.
3. **Observation:** Participant observation [29] was engaged to understand how the clearing process works. This was achieved through personal involvement [30]. As data verification process entails checking, confirming and being certain [26], the data obtained from observation was cross-checked with the data obtained from the above two sources to establish the quality of the data [31].

6 Implementing the DSR Methodology using BPMN

DSR Stage 1 Awareness of Problem

The information obtained from the interviews, document study and observation were translated into 'As Is' process models. The clearing process was modelled using BPMN (Figure 2) which represents the 'As Is' collaborative clearing process between UCAS, Applicant and University. An initial validation process was conducted to seek expert opinion on the process model to verify that it is an accurate, and acceptable description of the current clearing process. All the activities, interactions and explicitness of the elements were checked and validated through discussion with staff members whose roles and activities are represented in the model. Feedback and comments were received which informed the iterative creation of the 'As Is' clearing process.

The process begins when the UCAS system is updated with university vacancies available for applicants to view. The details of the applicants who do not hold any offers are entered into clearing on the UCAS TRACK system. The applicant is notified to pay clearing fees. Once the fees are paid, they can check vacancies available in various universities, identify the course they would like to study and contact the course provider by making a phone call. The triage team at the university receives the call, discusses entry requirements with the applicant and confirms whether spaces are available on the desired course. If places remain the call is transferred to the relevant department. Each department would have three to four academics available to talk to the applicant. If the applicant is given an offer at this stage, an admission letter is then emailed to the applicant. The applicant then has 24 hours to apply to the university via UCAS TRACK.

All applications made on UCAS TRACK are uploaded to the university every two hours during clearing. The university downloads data from UCAS and processes the offers. Once the offer is processed, the confirmation is uploaded to UCAS. UCAS updates the student records and sends a confirmation letter to the applicant. The university then sends an enrolment invitation to the applicant. If the university discovers the applicant has not applied through UCAS TRACK, the applicant will be contacted, reminded, and given a further 24 hours to apply. All phone calls, enquiries, offers, declines and refusals are collated and stored in a student records management system.

DSR Stage 2 Suggestion

Examining the current clearing process reveals the following issues:

1) Offers are made by the university before applicants can apply to the university on UCAS TRACK. These offers are verbal confirmations and may come from many universities at the same time. There is no way for UCAS to monitor these offers because they are not registered with UCAS until the applicant goes to TRACK, selects the university. The university only receives the application when UCAS uploads the data to the university. The university will then confirm with UCAS that an offer has been made to the applicant. As a result, time and resources utilized to speak to the applicant could end up being wasted as the applicant may choose to accept an offer from another University.

2) If the student does not apply within 24 hours, the clearing staff have to chase up the applicant expending more time and resources on an applicant that may have accepted an offer from another University.

3) UCAS TRACK is rendered ineffective in allowing UCAS to ensure that applicants do not have more than one offer.

The above-mentioned issues were confirmed as suggested in [25] by admissions domain experts with several years of experience in student's admissions.

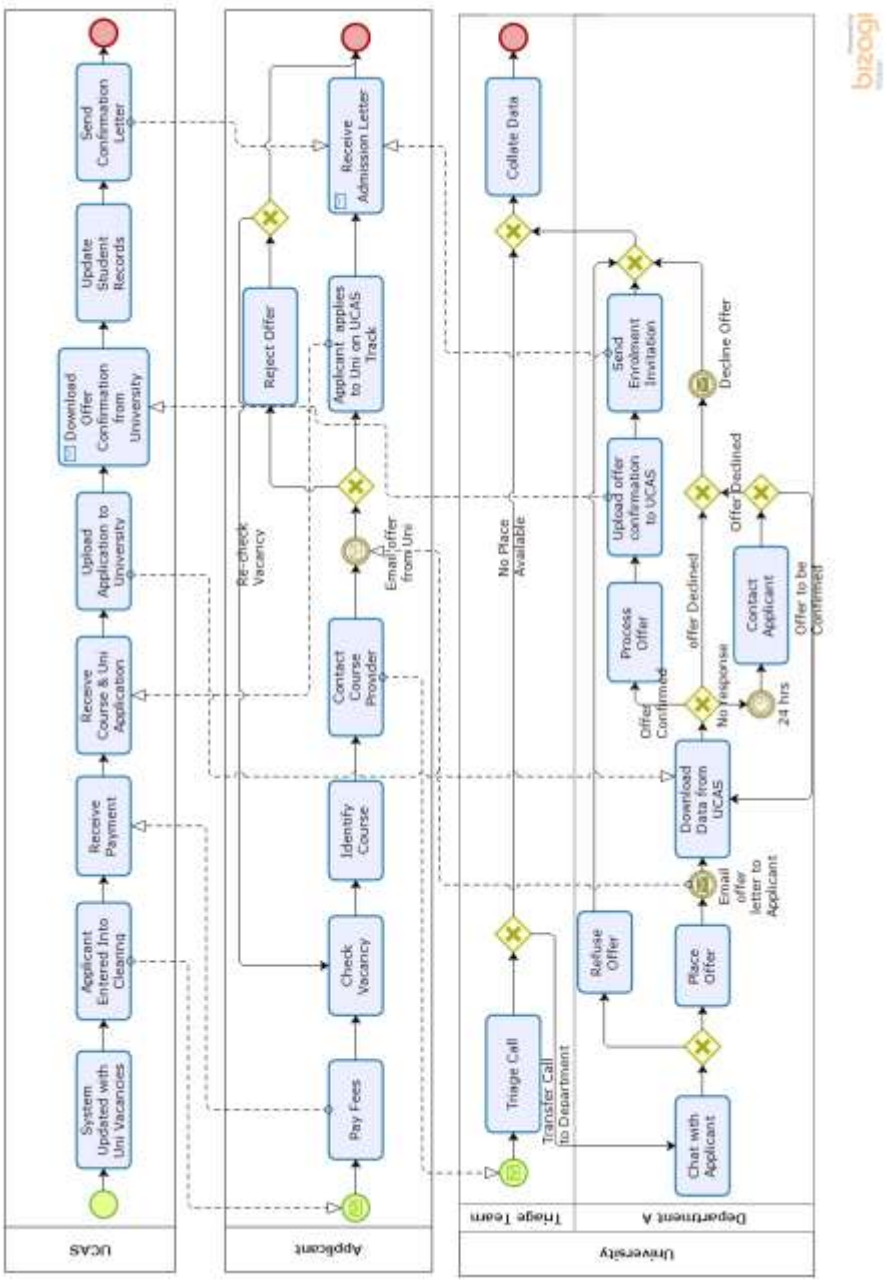

Fig. 2. 'As Is' Collaborative Clearing Process between UCAS, Applicant and University

DSR Stage 3 Development
To address these issues, a 'To Be' clearing process model was created to improve the process as shown in Figure 3. Starting from when the applicant is given an offer, an admission letter is emailed to the student by the university. The university also uploads all offers to UCAS. When the student gets the admission letter, they can go to UCAS to confirm or reject the offer and formally apply to the University. Meanwhile, UCAS would have a tracking activity which runs parallel to the offer decision notification from the applicant. The confirmations and rejections are available to the university for download. Once downloaded by the University, the offer confirmations can be processed and the invitation for enrolment is sent to the applicant.

DSR Stage 4 Evaluation
The first step in the evaluation phase is to validate the improved process model that it is an accurate, and acceptable description of the clearing process. All the activities, interactions and explicitness of the elements were checked and validated through discussion with staff members whose roles and activities are represented in the model.

Feedback and comments were received which informed the iterative creation of the 'To Be' clearing process. The benefit of this improved process is that it is simple, more efficient and less time wasting. Business process (BP) simulation [30] was employed to confirm that the model is error-free and to evaluate the performance of the clearing process models (both As-Is and To-Be) using Bizagi process modeler's [21] time analysis and resource analysis levels. The benefit for applicants is that they will finish with all the offers they have received in their TRACK account and they select the university of their choice, and the university receives the information. The benefit for the university is that it would save time, cost and resources expended in chasing applicants. The model only represents one department, it is expected that the proposed model would yield even cumulative benefits when applied to all faculties within the University.

7 Conclusion and future work

We have demonstrated that process modelling can be useful in identifying unnecessary or non-value activities in the clearing process model of a UK HEI facilitating the creation of an improved process model to allow for goal optimization such as time saving, resource utilization etc. The choice of a suitable modelling technique enabled the process model to accurately capture the business logic in the clearing process, thereby enabling the analysis of the process operations. After running simulations on both current and the proposed models using BP simulation with Bizagi tool, the outcome was that the proposed clearing process model was more efficient and saved time. Other benefits are allowing UCAS to effectively manage and track offers made by universities, students would be able to see all verbal offers made by Universities in their TRACK account, and universities would not need to waste time and resources to

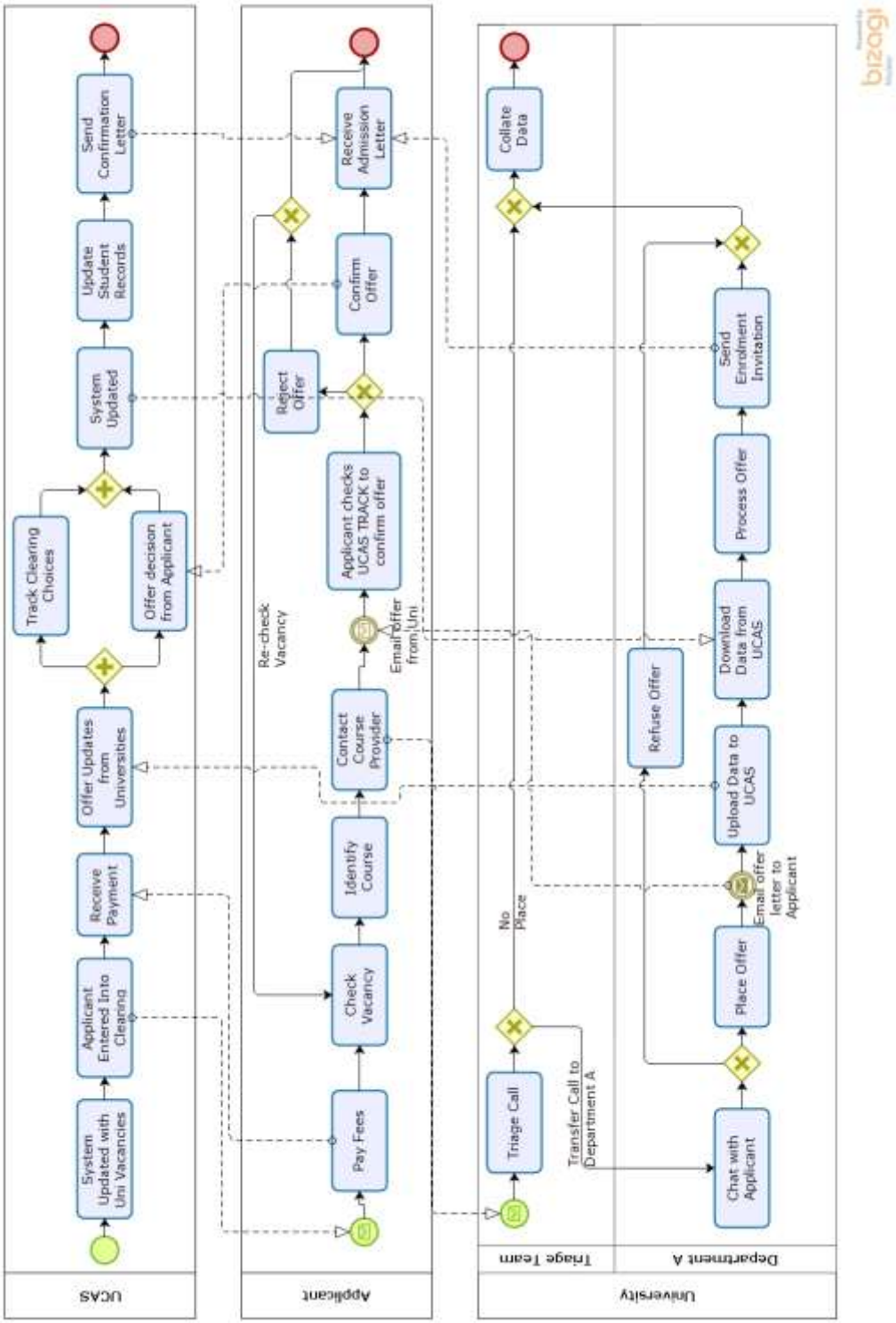

Fig. 3. 'To be' Clearing Process between UCAS, Applicant and University

chase up applicants who have decided to accept an offer from another university. Further work is needed to understand how the process models (current and proposed) will behave under certain resource constraints when simulated. As the modelling technique (BPMN) supports simulation, a what-if-analysis will be performed on the improved process to determine how the process model would behave under various scenarios [32]. Furthermore, future work will investigate the development of business process heuristics that would support the actual act of process improvement.

References

1. Attenda. "Delivering a highly successful Confirmation and Clearing process" 2013. Accessed on 16th May 2016. Available from: http://www.attenda.com/wp-content/uploads/2014/01/UCAS-Case-Study.pdf.
2. Universities UK, "Patterns and Trends in UK Higher Education 2017". Accessed on the 24th January 2018; Available from : http://www.universitiesuk.ac.uk/facts-and-stats/data-and-analysis/Documents/patterns-and-trends-2017.pdf.
3. UCAS.com., (2017). Accessed on the 19th November 2017; Available from: https://www.ucas.com/corporate/about-us/our-services.
4. UCAS (2016) Top ten reasons why clearing is an important route into higher education. Accessed on the 11th April 2018; Available from: https://www.ucas.com/corporate/news-and-key-documents/news/top-ten-reasons-why-clearing-important-route-higher-education.
5. UCAS (2015). Admissions Guide and Decision Processing Manual.
6. Gregor Zellner, "A Structured Evaluation of Business process Improvement Approaches". Business Process Management Journal. Vol. 17, No 2, 2011 pp. 203-237. Doi:10.1108/14637151111122329.
7. O. A. Rashid, M. N. Ahmad, "Business Process Improvement Methodologies: An Overview." Journal of Information Systems Research and Innovation 2014.
8. R. S. Aguilar-Saven, "Business Process Modelling: Review and Framework." International Journal of Production Economics, vol. 90, 2004, pp. 129-149, doi:10.1016/S0925-5273(03)00102-6.
9. K. Vergidis, A. Tiwari, and B. Majeed, "Business Process Analysis and Optimization: Beyond Engineering" IEEE Transactions on Systems, Man and Cybernetics, Part C (Applications and Reviews), vol. 38, Dec. 2007, pp. 69 – 82, doi: 10.1109/TSMCC.2007.905812.
10. W.M.P. Van der Aalst, A.H.M. ter Hofstede, M. Weske, "Business Process Management: A Survey" Conference on Business Process Management 2003.
11. M. Koubarakis and D. Plexousakis, "A Formal Framework for Business Process Modelling and Design." Information Systems. Vol 27, No 5, 2002 pp. 299-319.
12. M, Tay, "Notations for Business Process (Part 1) – RAD, EPC and BPMN," Accessed on the 22nd November 2017. Available from: http://blog.maxconsilium.com/2013/09/process-notation-p1.html.
13. N. Gamil, "Process Improvement in Higher Education Institutions," Faculty of Science and Technology, Bournemouth University, 2015.
14. OMG, Business Process Model and Notation Specification version 2.0. 2011. Accessed on 18th October 2017; Available from: http://www.omg.org/spec/BPMN/2.0/About-BPMN/.
15. OMG, The Unified Modeling Language Specification version 2.5. 2015. Accessed on 18th October 2017; Available from: http://www.omg.org/spec/UML/About-UML/

16. M. Weidlich and J. Mendling, “Perceived consistency between process models” Information Systems, vol 37, No 2, 2012 pp. 80-98.
17. D. Daurte and P. V. Martins, “Higher Education Business Process Improvement Achieving BPMM Level 3” 9th International Conference on the Quality of Information and Communications Technology, Portugal 2014. P. 319. Accessed on the 22nd of January 2018; Available from: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6984089&tag=1
18. H. I. Al-Medlej, “Decision Making Process in Higher Education Institutions – The Case of Saudi Arabia,” Middlesex University, 1997.
19. M. R. Khabbazi, M.K. Hasan, R. Sulaiman, A. Shapi’I, “Business Process Modeling for Domain Inbound Logistics System: Analytic Perspective with BPMN 2.0,” Journal of Basic and Applied Scientific Research, Vol. 3, No 9, 2013 pp. 569-578. Accessed on 20th January 2018, Available from: http://www.diva-portal.org/smash/get/diva2:828124/FULLTEXT01.pdf.
20. Silvia, Suhardi and P. Yustianto, “Business Process Improvement of District Government Innovation Service. Case Study Cimahi Tengah District of Cimahi,” 2016 International Conference on Information Technology Systems and Innovation (ICITSI), Bandung – Bali, 2016.
21. Bizagi. Available from: https://www.bizagi.com/en/products/bpm-suite/modeler.
22. G. Mpardis and T. Kotsilieris, “Bank Loan Process Modelling Using BPMN” Developments in E-Systems Engineering. 2010. doi: 10.1109/DeSE.2010.45.
23. V. Vaishnavi and B. Kuechler, “Design Science Research in Information Systems” 2004. Accessed on the 1st May 2017, Available from : http://www.desrist.org/design-research-in-information-systems/.
24. A.R. Hevner, S.T. March, J. Park, S. Ram, “Design Science in Information Systems Research”. MIS Quarterly Vol 28, No 1, 2004 pp. 75-105.
25. P. Offermann, O. Levina, M. Schonherr, U. Bub, “Outline of a Design Science Research Process”. Accessed on the 12th of April 2018. Available from: https://wise.vub.ac.be/sites/default/files/thesis_info/outline_of_design_science_research_process.pdf.
26. J. M. Morse, M. Barret, M. Mayan, K. Olson, J. Spiers, “Verification Strategies for Establishing Reliability and Validity in Qualitative Research.” International Journal of Qualitative Methods. Vol 1, No 2, 2002 pp. 13-22. Doi:10.1177/160940690200100202.
27. Higher Education Steering Group. Fair Admissions to Higher Education: Recommendations for Good Practice. Accessed on the 20th of September 2017. Available from: https://www.spa.ac.uk/sites/default/files/Admissions-review-Schwartz-2004.pdf.
28. G. A. Bowen, “Document Analysis as a Qualitative Research method”, Qualitative research journal, Vol 9, Issue 2, 2009 pp.27-40.
29. C. Mill, “Comparison of Research Methods.” (2015). Accessed on the 13th June 2017; Available from: https://themille17.org/wp-content/uploads/2015/07/Comparison-of-Research-Methods.pdf.
30. Personal attendance at clearing event at a UK University, 14 August 2017.
31. M. Lambert. “A Beginners Guide to Doing Your Education Research Project.” SAGE Publications London 2012.
32. M.Aguilar, T. Rautert, A. Pater, “Business process Simulation: a fundamental step supporting process centered management” Winter simulation, ACM, Phoenix, Arizona, 1999, pp. 1383-1392.