

Design and development of an online postgraduate research students' progression monitoring tool - ProGRess

Djamel Benaouda^{1*}, Julia Taylor², Fiona Knight³, Almasa Mulalić⁴

¹ Information Technology, Bournemouth University, England, UK

^{2,3} Doctoral College, Bournemouth University, England, UK

⁴ Faculty of Education, International University of Sarajevo, Bosnia and Herzegovina

*Corresponding author E-mail: dbenaouda@bournemouth.ac.uk

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Abstract

Digital content and publishing provide easy and efficient access to standardized and up-to-date information. It also eliminates content replication, ensures accuracy, and provides information security. Due to the rapid increase of affordable digital tools and applications, most educational institutions have already been using virtual learning environments to support their staff, lecturers, and students. This paper proposes a novel, secure, user-friendly, web-based monitoring system, called ProGRess, which tracks the engagement and progression of postgraduate research students (PGRs). ProGRess is an online application designed and developed in-house using agile development methodology for the Doctoral College (DC) at Bournemouth University (BU) and is used to monitor PGR progression. This paper aims to assess how ProGRess helps manage and track the interactions for milestone completion between PGRs, supervisors, assessors, examiners, and postgraduate research administrators (PGRAs). Additionally, the paper explores the software and its multi-tier client-server architecture, including its front-end user interface, backend application, data services, and software security.

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Keywords: Postgraduate research (PGR), ProGRess software, Agile development methodology, Authentication process, Software development architecture

1. Introduction

Since the Internet was initially developed as a means of communication, academics have been aware of its massive potential as an online learning and support tool. Yet it has become even more popular since the emergence of the World Wide Web [1]. Similarly, tools like Learning Management Systems, Research Platforms, Collaboration Tools, and Digital Libraries have greatly improved teaching & learning processes, and daily administrative operations. Educators and institutions increasingly leverage these technologies to improve the quality of instruction, support student engagement, and facilitate efficient administrative operations. Web-based tools offer a range of benefits to postgraduate researchers (PGRs) that track their engagement and progress [2], including enhanced accessibility, real-time communication, collaborative learning environments, and personalized educational experiences [3], [4]. These web tools also foster innovative pedagogical approaches,

such as flipped classrooms and blended learning [5], [6]. As institutions continue to adopt and refine these tools, it is crucial to evaluate their effectiveness in enhancing educational outcomes and to understand broader implications for the future of teaching and learning.

Many universities have recently been using PhD Manager (Haplo/now called Cayuse) [7], SITS Research Component [8], and SkillsForge [9]. For example, the University of London (City) uses SITS' standard admissions, student screens, and awards screens for their research degree students, as well as PhD Manager to keep records of meetings and progress for supervisors and their students. Bournemouth University (BU) has been using the Converis/ResearchPAD system [10] to monitor and manage Postgraduate Research students' (PGRs') progression. However, due to technological advancement, BU's executive management decided to upgrade its research management system by replacing the outdated ResearchPAD system. BU's Digital Solutions team has taken up this complex and challenging project, which was successfully completed and rolled out live on August 31st, 2022, whose secure URL address is <https://progress.bournemouth.ac.uk>.

This paper examines the development of ProGRess as a secure, fast, efficient, user-friendly, and comprehensive, Web-based, online postgraduate research progression monitoring system, advancing our understanding of ProGRess implementation as a postgraduate research workflow, by administrators, PGRs, supervisors, and examiners. Additionally, the paper illustrates the software and its client-server architecture, including its front-end user interfaces, backend application or business logic, data services such as the database, and software security.

2. Background and motivation

BU is very actively involved in undertaking research and delivers postgraduate research degrees across all its faculties, managing its PGRs through its Doctoral College. PGRs are regarded as being somewhere between students and staff [11] due to their individual and independent research work. This can lead to social and intellectual isolation compared to more communal, structured, and integrated learning spaces of the classroom for other students [12], [13]. Hence, PGRs require some additional support for well-being, mental health, and the academic research process. Indeed, the Doctoral College provides support to all PGRs both academically and by enhancing the PGR's experience. PGRs used to track their progression and engagement activities in a variety of ways of communication, such as face-to-face/online meetings, emails, phone calls, chats, etc. Unfortunately, some of these PGR-Supervisor-Administration engagement activities were not properly stored, which inhibited efficient communication between supervisors, PGRs, and administrators. The PGR's supervisory team and their corresponding administrators also had difficulties in tracking the PGR's progression. In addition, it was vital for BU to be able to monitor the appropriate engagement of those PGRs who are studying in the UK on a visa. So, a Management Information System was required to manage BU PGRs' progression during their research degree from enrolment/registration to award. In 2012/13, there was some discussion about acquiring a system to support not only PGRs enrolled in research degree programmes but also PGR Administrators (PGRAs) and Faculty Supervisors.

BU purchased an off-the-shelf, third-party software license for ResearchPAD with a PostgreSQL backend database, the online management system as part of BU's Student Journey Programme (SJP). ResearchPAD offered clear administration, tracked progression against the expected date, and set targets, as well as other functions. SJP was about giving PGRs the best experience and value for money. BU was running version 5.5 of ResearchPAD, which was first implemented in 2014. The supplier, Clarivate Analytics [14], had offered limited support for this version since July 2017. In December 2018, Clarivate indicated that support for version 5.5 had been suspended, and they urged BU to upgrade to version 6. The upgrade path and associated work were reviewed, and although Clarivate appeared confident in its ability to perform the upgrade, it was confirmed to be a complex exercise. Also, if ResearchPAD became unavailable due to a critical failure that IT could not fix, knowing that ResearchPAD was running with no supplier support available, a significant risk was foreseen, including the interruption of PGR progression and poor PGR experience. So, with the concerns associated with

an upgrade, combined with other significant ongoing business and technical concerns about the fitness for the purpose of Converis/ResearchPAD, led the Doctoral College and the IT Department to consider the development of a replacement with an alternative software solution, which would become ProGRess. In the early stage of discussions, the Doctoral College ruled out using either Brightspace, the current BU's Virtual Learning Environment [15], an Excel spreadsheet, SITS research component, or Skills Forge-based system as the new ResearchPAD replacement software solution. In fact, it was considered that the new system's requirements were too complex to be realized and managed within a spreadsheet-based replacement solution.

The goal was to develop user-friendly, secure, and centralized software, PGR Progression Manager, called ProGRess, using a fresh set of requirements that were fit for purpose. With ProGRess, PGRAs from the Doctoral College could oversee the academic excellence of PGRs at BU and ensure that their research degree journey was delivered consistently and fully supported, regardless of their subject area of research. ProGRess can subsequently enhance research productivity, communication, accountability, and the effectiveness of the relationship between the PGR, supervisory team, and their institutional administration. It provides the required audit trail of appropriate engagement by PGRs studying on a visa, and it also provides clarity for setting structured mentorship objectives with real-time and up-to-date progression tracking.

3. ProGRess application

ProGRess has been developed for the Doctoral College at BU to monitor PGRs' progression and engagement. It is available to all PGRs, Supervisors, PGR Administrators (PGRAs), Faculty Nominees (FNs), Academic Quality (AQ), Deputy Deans (DDs), Examiners, Assessors, and Administrators. ProGRess' users can record and monitor research degree progression, track progression against expected dates, and report on activity at PGR, Supervisory, Faculty, or University level. In other words, ProGRess helps manage the interaction for academic milestone completion between PGRs, Supervisors, and PGRAs.

ProGRess is a bespoke online, Web-based application that is designed and developed in-house using agile development methodology, as shown in Figure 1, upon X number of Y-week agile sprints. Each agile sprint, which contains a few priorities, top functionalities, or features selected from the requirements log list, goes through a normal software development life cycle (SDLC) process. A short release is thereby delivered into the test environment server to the client, including stakeholders and the test team for feedback and testing, respectively. The iterative development process continues until a minimum viable product (MVP) is created or when all functionalities have been completed. The development team required three developers, two backend and one frontend software engineer, one testing engineer, one Project Manager, and one Business Analyst for the duration of the project, which was initially estimated to be around 15 two-week sprints.

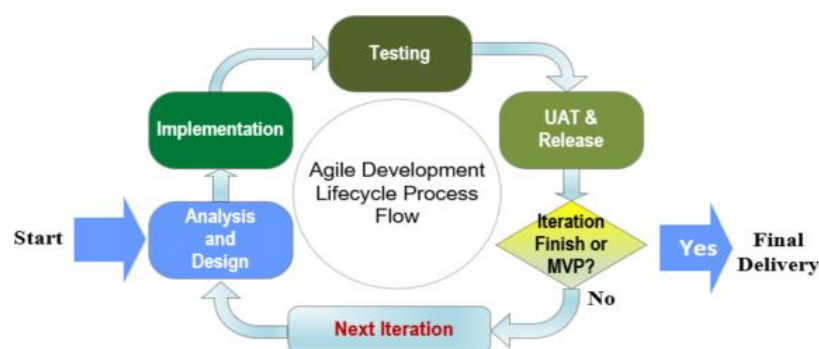


Figure 1. Agile development methodology (Source: Author)

4. System requirements, analysis, design, implementation, and testing

There is not a single process for software development, but numerous factors lead to different processes. These factors include software development, the scale, and so forth. Figure 2 shows the high-level view of the development process.

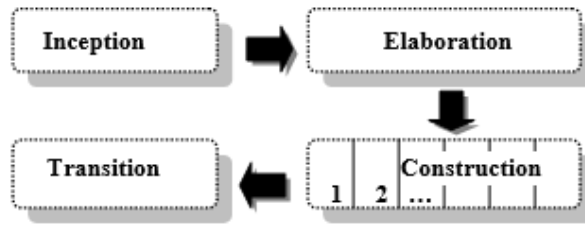


Figure 2. Development process outline (Source: Author)

The development process engages an iterative workflow and incremental delivery of working software in short-time box releases instead of having one big release at the end of the project. The construction phase consists of many or few iterations, depending on the project scope, in which each iteration builds production-quality software, tested and integrated, that satisfies a subset of the requirements of the project. The delivery may be external or purely internal. Each iteration contains all the usual software development life-cycle phases of analysis, design, implementation, and testing. In principle, we can start at the beginning: pick some functionalities with high priority and build them, pick some others, and so forth. However, it is worthwhile to spend some time creating a plan for it, which is done in the elaboration phase [16].

The first two phases are inception and elaboration. During inception, we establish the business rationale for the project and decide on the scope of the project. This should be a few days’ work to consider, if it is worth doing a few months’ worth of deeper investigation during elaboration. This is where we get the commitment from the project sponsor or stakeholders to go ahead. In elaboration, we have the go-ahead to start a project. At this stage, we only have a vague idea of the requirements, and we therefore need to get a better understanding of the problem. So, we collect more detailed requirements, do high-level analysis and design to establish baseline architecture, and create the plan for the construction phase. The starting point in gathering the requirements of the system is UML [17], [18] use cases. Use cases drive the whole development process.

A use case is a typical interaction that a user has with the system to achieve some objective. Use cases provide the basis of communication between the sponsor or stakeholders, the project manager, and developers in planning the project. One of the most important things to do in the elaboration phase is to identify all the key and most important use cases for the system we are building. For instance, Figure 3 shows a UML use case diagram for a PGR in our system, among other system users, as shown in Figure 4. Even with this kind of iterative process, there is some work that must be left to the end, in the transition phase. This can include beta testing, performance tuning, user training, and user guides.

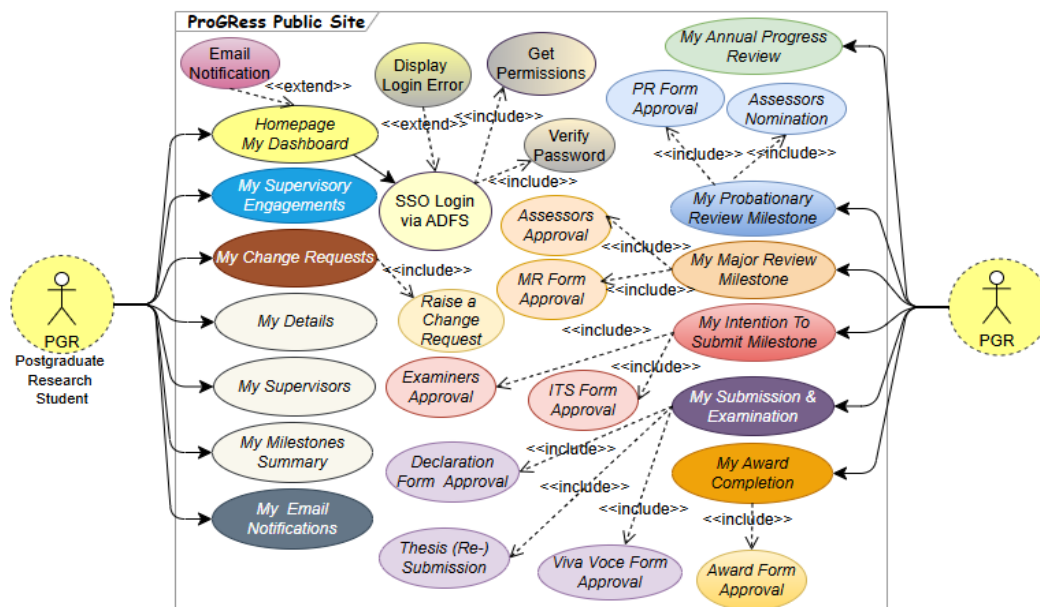


Figure 3. ProGress System: UML Use case diagram for a PGR actor (Source: Author)

Projects vary in how many ceremonies they have. High-ceremony projects have a lot of formal paper deliverables, formal meetings, and formal sign-offs. Low-ceremony projects might have an inception phase that consists of an hour’s discussion with the project’s sponsor or stakeholders, and a plan on a spreadsheet or Word document. We have shown iterations in the construction phase, but not in the other phases. In fact, we can have iterations in all phases, and it is often a good idea to do so in a large phase, such as construction.

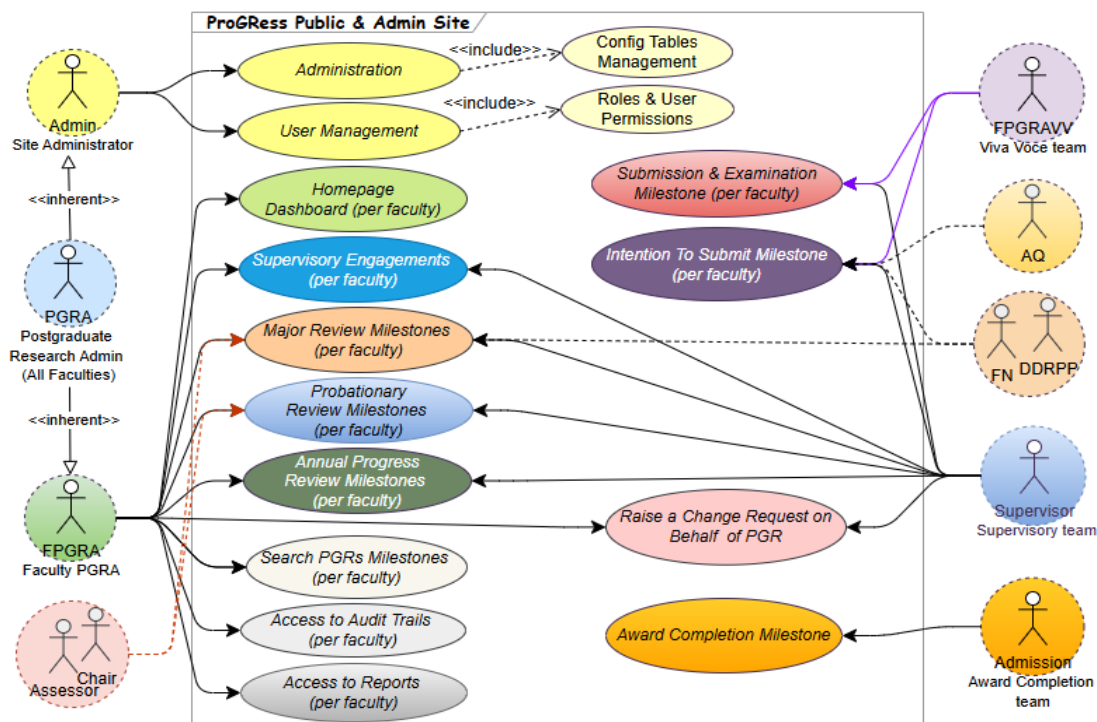


Figure 4. ProGRESS System: UML Use case diagram for an administrator actor (Source: Author)

As shown in Figure 5, the ProGRESS system comprises three subsystems, namely a) ProGRESS.Admin to migrate ResearchPAD data to ProGRESS database, b) ProGRESS.Public, the public-facing website that contains workflow-based Web forms that manage and track the interaction for milestone completion between PGR, Supervisors, and PGRAs, and c) ProGRESS.Service, the executable program, ProGRESS.Service.exe, that runs in the background of the Windows Operating System, which performs backend scheduled tasks, just to mention a few: SITS integration (e.g., calculate/recalculate when a change is made to a PGR’s enrolment date, study programme, study mode, or when an interruption or extension is applied on SITS), Archiving inactive email notifications, Send auto email reminders to PGRAs when an international PGR, who is studying in the UK on a visa’s registration expires within a month, Send auto email reminders for examination panel renewal to the first or lead supervisors when one or more examiners have been approved within 11 months, provided the PGR’s Viva Voce examination had not taken place within this period.

The ProGRESS system’s users/actors (roles) are PGR, Supervisor, Examiner, Independent Assessor, Independent Chair, PGR Administrator (PGRA), Faculty Nominee (FN), Academic Quality (AQ), and Deputy Deans’ Research and Professional Practice (DDRPP). The Student Record Database Integration task auto-populates the ProGRESS database nightly via SQL Server Integration Services (SSIS), which extracts from the SITS database and populates (i.e., inserts or updates) three ProGRESS database tables: a) PGR details, b) Associated Supervisors, c) Associated Study Plans. In turn, ProGRESS’ backend services auto run nightly and monitor those database tables updates to a) calculate/recalculate (when a change is made to a PGR’s enrolment date, study programme, study mode, or when an interruption or extension is applied on SITS from Tribal) milestones dates for each PGR based on their enrolment date, study programme (e.g., MRes, MPhil, PhD, DProf), and study mode (Full-Time, Part-Time), b) inserts these PGRs & Supervisors as user accounts. Finally, ProGRESS works very well with cross devices and major browsers, just to mention a few such as Google Chrome, Apple Safari, Microsoft Edge, Microsoft IE, Mozilla Firefox, and Opera.

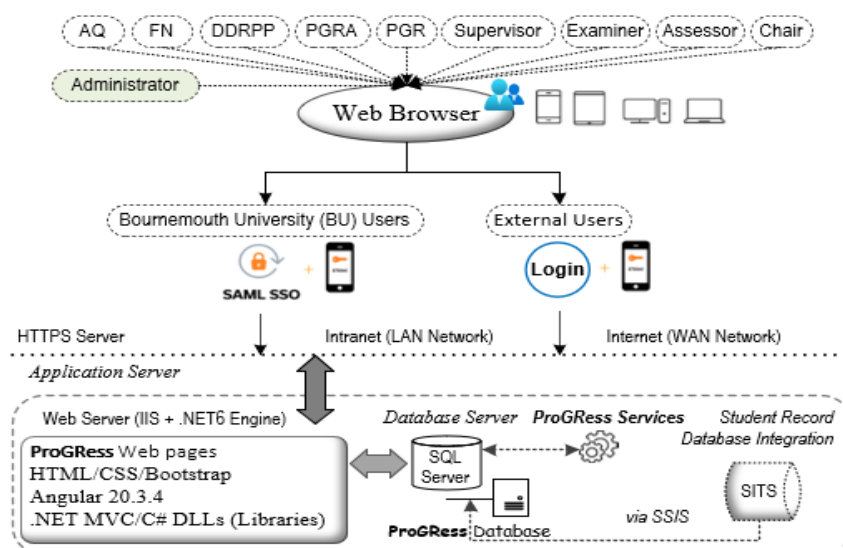


Figure 5. Web-Based ProGRESS System Architecture (Source: Author)

Some high-level requirements for ProGRESS, the software replacement solution, are as follows:

Doctoral College needs to:

- Oversee and control the progression process of PGRs enrolled at BU.
- Partner with Supervisors, Deputy Deans, & PGRAs to manage the progression of PGRs.
- Track and report on PGRs' progress from Probationary Review, Major Review, Annual Progress Review, Final Thesis (Intention to Submit, Declarations, Submission & Examination) to Award Completion (i.e., academic milestones for each study plan).
- Provide an audit trail of PGR's academic engagement.

ProGRESS's ResearchPAD replacement solution mainly needs to:

- Migrate data from ResearchPAD (i.e., PostgreSQL database).
- Integrate with the student information (record) system to populate student record, supervisor, and milestone information.
- Maintain a record of each PGR, their study plan(s), and the milestones (Probationary Review, Major Review, Annual Progress Review, Final Thesis, Award Completion) associated with each study plan.
- Enable the configuration of pre-defined workflow steps for each milestone.
- Enable email notifications and reminders to be sent when milestones are due or overdue.
- Provide reporting functionality that serves operational, strategic, and institutional needs.

4.1. PGR research degree journey

1. The PGR registers (during enrolment) in SITS (BU's Student Record System). SITS then automatically populates (or updates when changes are made) the PGRs' details, associated study plan, and their corresponding Supervisory members into ProGRESS database via SQL Server Integration Services (SSIS) such as student name, student number, start date, end date, faculty, department, study programme (e.g., PhD), study mode (e.g., Full-time), associated Supervisory team members (lead and secondary), thesis title, etc.
2. Three main ProGRESS services are run automatically daily to monitor some database tables fed by SITS:
 - a. Creating study plans and their study milestones (Probationary Review, Major Review, Final Thesis, and Award completion) database records for each enrolled PGR. Also, calculating the study milestones due dates based on their enrolment date, study programme, and study mode. These due dates are calculated using the enrolment date as well as a pre-defined look-up data "time period allowed" (configured by the PGRA) for each milestone type based on the PGR's study programme and study mode. For example, if a PGR student is enrolled on full-time (study mode)-PhD (study programme), their respective milestones

- due dates are set to enrolment [start date + x months] where x is 3 (for Probationary Review), 14 (for Major Review), 36 (for Final Thesis), and 48 (for Award Completion).
- b. Creating a user account in ProGRess database for each PGR and inserting it into the study plan. The PGR will subsequently receive a welcome letter email.
 - c. Creating a user account in the database for each Supervisory member (first and secondary Supervisors) associated with the PGR. Each Supervisor (i.e., only internal ones) will subsequently receive a welcome letter email. However, the external users will receive an email to change their password, which is hashed using a SHA-256 algorithm in the ProGRess database.
3. The active PGR is now ready to log in via Single Sign-On (SSO) [19], as explained in Figure 6, save as a draft, and submit their due milestones for approval, logging their engagements, for example, minute meetings, and track their progression and engagements with their supervisors online. However, the external users will log in to ProGRess via a normal secure login form.
 4. There are manual & automatic email notification reminders that PGRs, Supervisors, Assessors, Examiners, PGRAs receive to act upon certain tasks that are due to be actioned based on a workflow approval process.
 5. PGRAs can view on the dashboard the milestones or engagements with their supervisors that are outstanding and overdue, so they can send email reminders to the PGR and their selected Supervisory members. PGRAs are also able to view the reminder history.

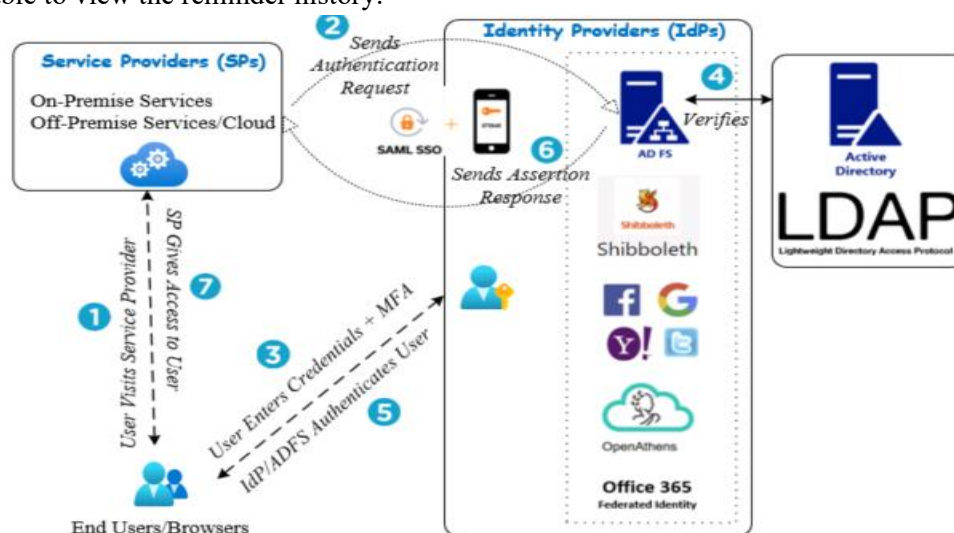


Figure 6. Single Sign-On (SSO) authentication process (Source: Author)

As shown in Figure 6, authentication is the process of verifying WHO the user is. Without Single Sign-On (SSO), the user needs to log in to each application for access, whereas with SSO, the user logs in to one application with one set of credentials and can access multiple applications. So, SSO reduces the number of potential attacks, improves the System's usability, and makes authentication faster and cheaper to maintain. Two-Factor Authentication (2FA) with SSO using SAML v2.0 allows end-users to access multiple applications (i.e., Service Providers) by logging in to one of them with one set of credentials. The Microsoft Active Directory Federation Services (ADFS) is the Identity Provider (IdP) used at Bournemouth University to authenticate staff, students, and lecturers. The ProGRess system was implemented in a three-tier client-server architecture that consists of three distinct layers, namely:

- a) A presentation (front-end user interface layer),
- b) An application (backend business logic layer), and
- c) Data services (database layer).

The software's security aspect is essential and based on multiple levels:

- a) Communication networks via firewall,
- b) Database via a separate port on the network protected with a service account,
- c) Application's Secure Socket Layer (SSL) ensuring end-to-end encryption between devices over the Internet, as well as subsequent checks in the business logic layer,

- d) Two-Factor Authentication (2FA) via SSO (BU users)/Login (external users) & code verification, and
- e) Authorization using the Role-Based Access Control (RBAC) method.

The Web Technology used:

- a) Frontend (HTML, CSS styles, Bootstrap for multi-device responsive design, Angular v.20.3.4),
- b) Backend (.NET6 & Object-Oriented Programming C#) hosted on Windows Server 2022 with Web Server's IIS v.10 (Internet Information Services), and
- c) Data Services (ProGRess database: Microsoft SQL Server 2019 with 124 relational database tables).

Figure 7, below, shows the overall ProGRess Website system structure: From authentication, authorization, etc. Figures 13 and 14 (shown in Appendix A) show the ProGRess login and landing page, where users can log in, and where two options are presented. On the one hand, if the user is affiliated with BU with a valid institutional email address, the user signs in via SSO. If the user has already logged in to one of the systems using their set of BU's credentials + 2FA (use either text message code verification or Microsoft Authenticator app), SSO will redirect and give them access to their homepage (i.e., Dashboard, Milestones that are due, overdue, or completed).

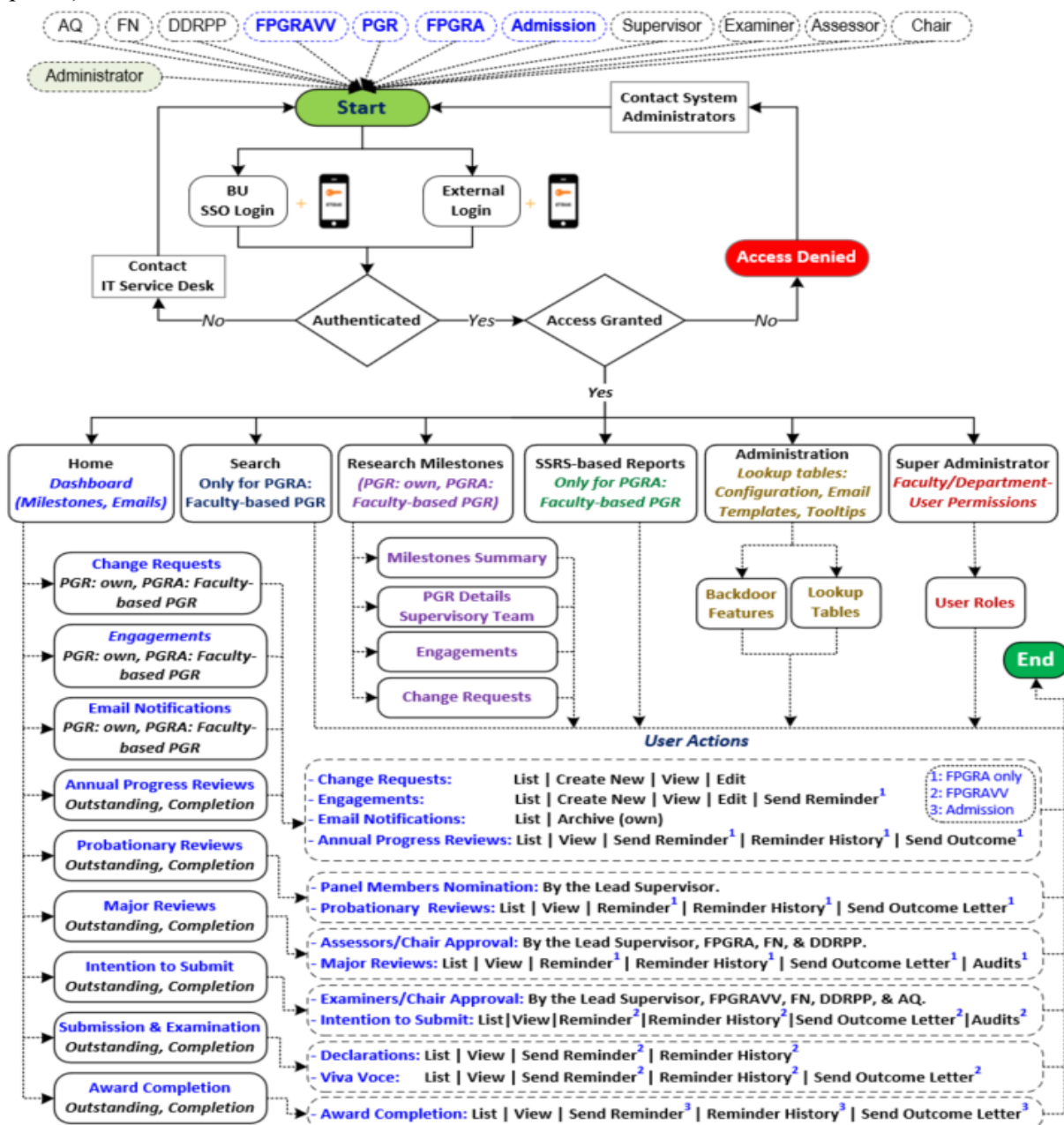


Figure 7. Workflow ProGRess system diagram (Source: Author)

Figures 8, 9, 10, 11, and 12 show the ProGress system’s selected Approval Processes diagrams, such as Probationary Review Form, Intention to Submit and Examiner Nomination, Submission and Declaration (including Thesis (Re-) Submission), and Viva Voce Examination.

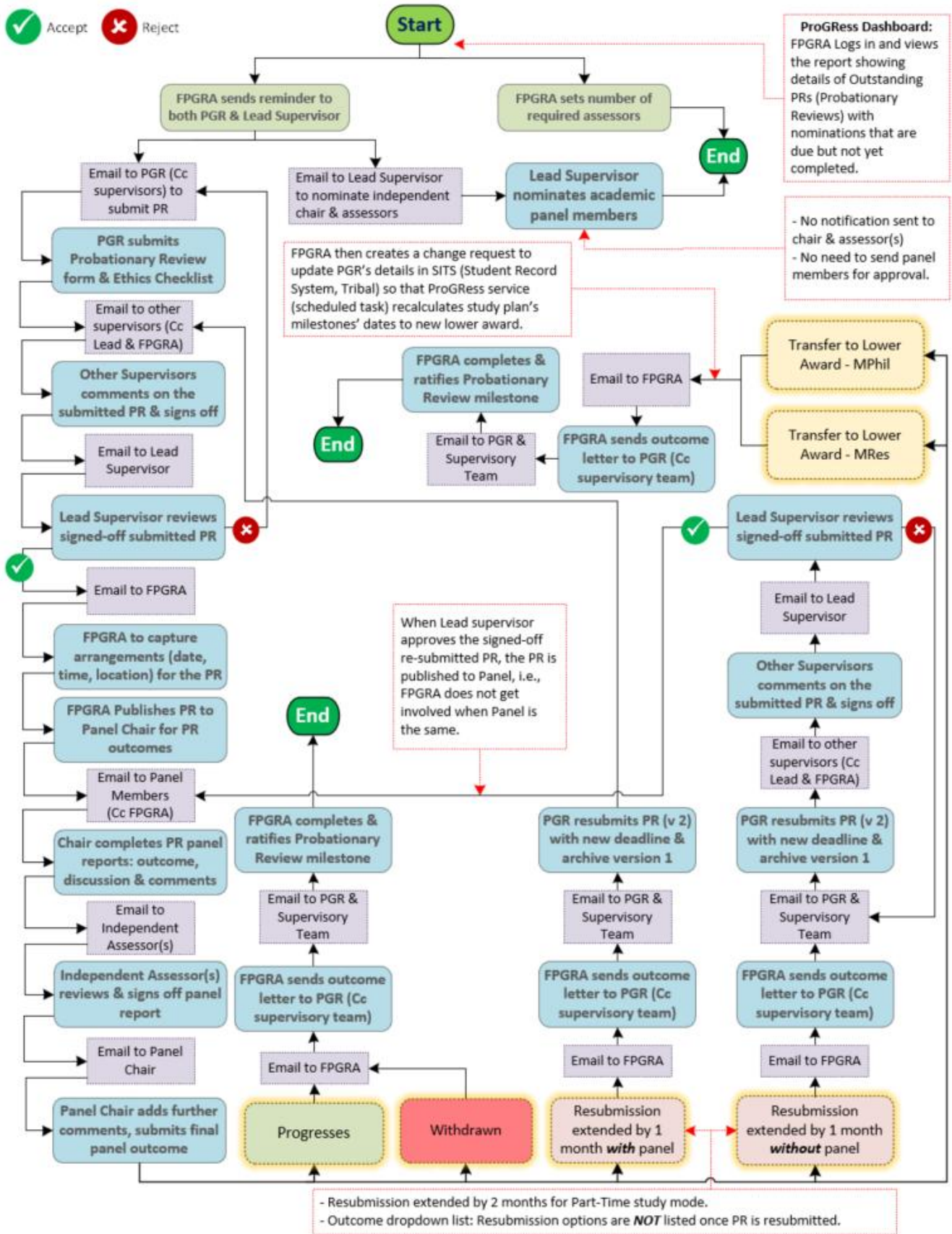


Figure 8. Probationary review form workflow approval process (Source: Author)

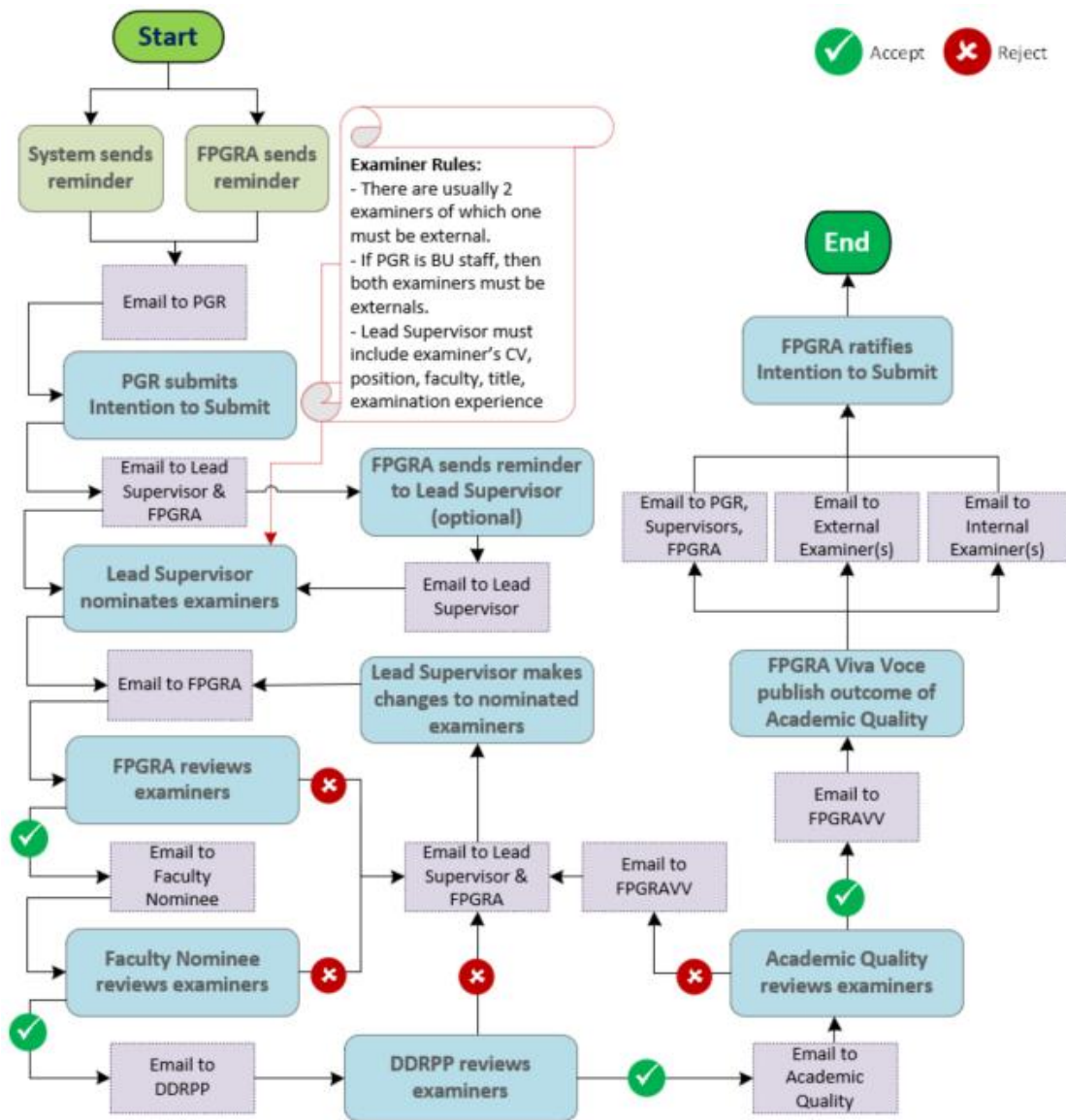


Figure 9. Intention to submit and examiner nomination & workflow approval (Source: Author)

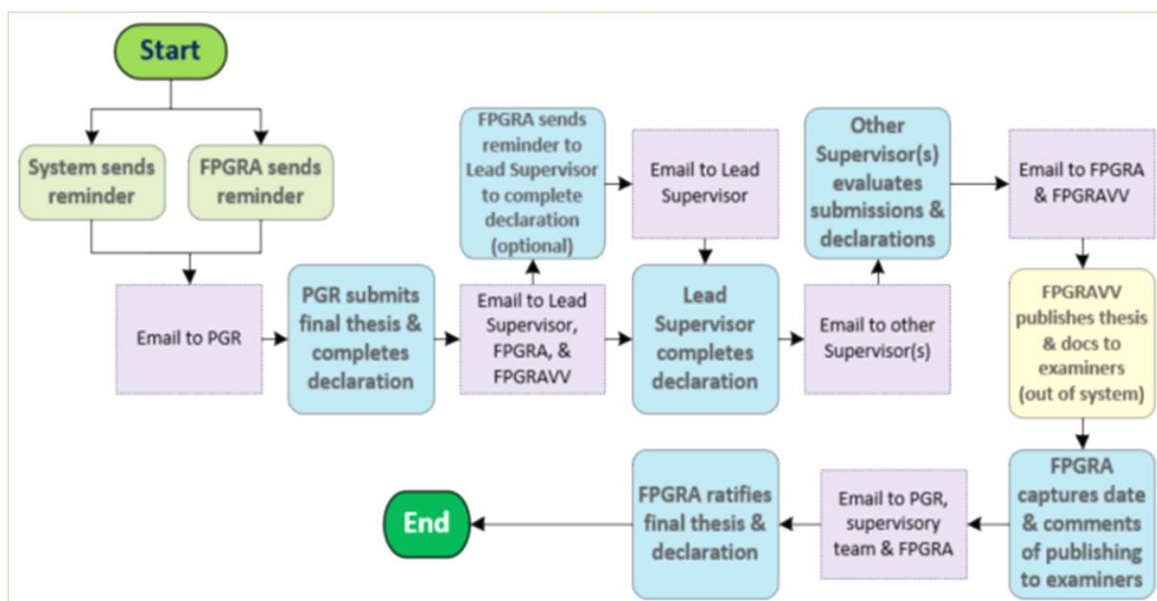


Figure 10. Final thesis submission and declaration workflow approval process (Source: Author)

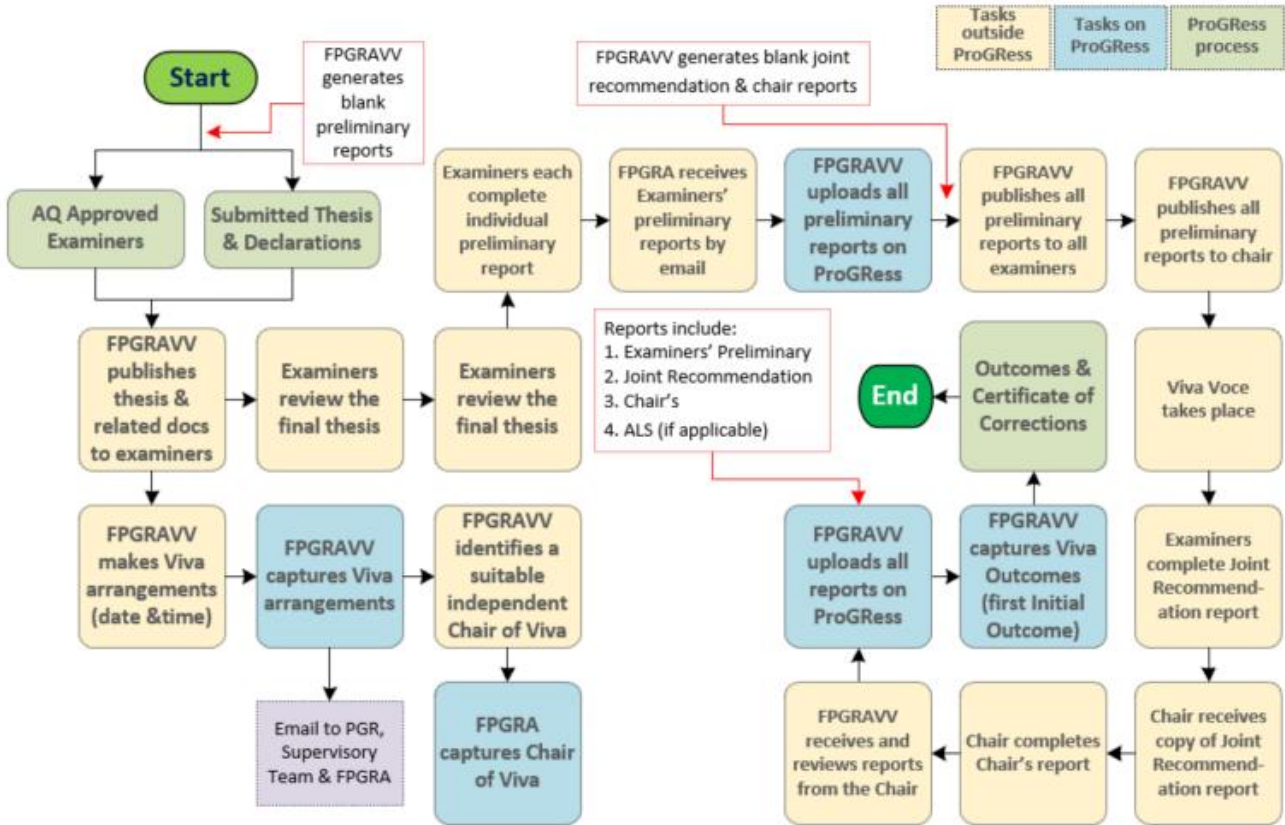


Figure 11. Viva Voce workflow approval process (Source: Author)

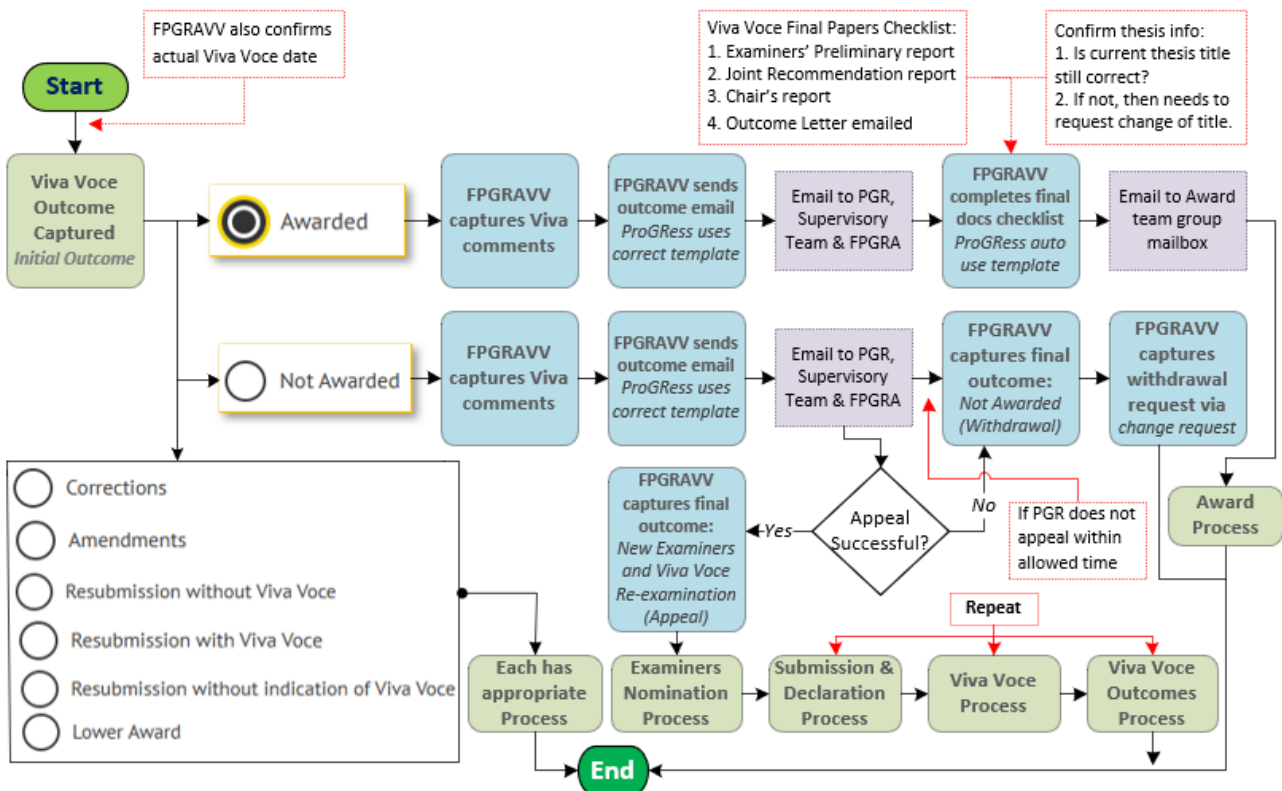


Figure 12. Outcomes and certificate of corrections workflow process (Source: Author)

Table 1 shows the ProGress system's usage statistics of 901 active PGRs taken in November 2025, and 1463 who have completed their degrees since 1998. PGRA usage has dropped significantly to 0.29% due to the implementation of ProGress.

Table 1. ProGRess system's user roles and usage statistics recorded in November 2025 (Source: Author)

User Roles	%
BU Postgraduate Researchers (PGRs) include MRes, MPhil, PhD, EdD, EngD	28.66
BU PGR Administrators (PGRAs)	0.29
BU Supervisors, Independent Assessors, and Independent Examiners	28.72
BU Faculty Nominees (FNs), Academic Quality (AQs), and Deputy Deans Research and Professional Practice (DDRPPs)	5.41
External Users – Supervisors, Independent Assessors, and Independent Examiners	36.93
	100%

5. Conclusions

The ProGRess system is based on Microsoft Web technologies, which include a variety of frameworks (.NET/C#, Angular), tools (IDE's Visual Studio 2022, SourceTree, SSRS), and cloud resources (DevOps, Azure) for building and deploying Web-based systems. It is accessible by authorized PGRs, Supervisory members, Faculty-based PGRAs (Viva Voce, Award teams), Examiner, Independent Assessor, Independent Chair, Faculty Nominee, Academic Quality, and Deputy Deans, Research & Professional Practice.

The system's access control security has been improved using two-factor authentication (login + code verification). In fact, Microsoft has recommended using App Authenticator rather than SMS based code verification. External users can either receive code verification by email or via the App Authenticator.

Doctoral College staff, academics, Supervisors, Assessors, Examiners, and PGRs have user-tested the ProGRess system extensively, and we have received very positive feedback from them through a series of testing activities including Show & Tell sessions, and thorough User Acceptance Testing (UAT) Testing by business owners as well as by the project's dedicated testing team members throughout the development process. The ProGRess system has been LIVE and publicly accessible (Internet facing) since August 31st, 2022, whose a secure URL link is <https://progress.bournemouth.ac.uk>.

The Advance HE Postgraduate Research Experience Survey (PRES) [20] is the leading survey of the Postgraduate Researchers (PGRs) in the UK. ProGRess has indeed contributed a great deal to BU's PRES scoring in 2024 compared to the previous years. In fact, the following question, amongst 60 other questions within the survey, was where BU scored above the sector benchmark. 84% of PGRs agreed that assessment procedures were clear to them, which was 8% above the benchmark (76%).

Feedback from all stakeholder groups has been very positive, discussing how the "workflow follows a logical process" and that the system allows PGRs to receive feedback quickly from their supervisory team. Further comments mention that ProGRess has enabled the administrative process to become "quick, easy and intuitive" and that the reporting ability "will really improve the way we report and the accuracy of our data". Furthermore, in a recent internal review, the auditors were highly impressed with the accessibility of the system, the clarity of the data, and the clearly documented audit trail of actions and responses.

6. Future work

The Doctoral College has had a service level agreement (SLA) since September 2022 with IT Services (i.e., Business Analysts, Developers, and Software Testers) to perform major enhancements twice a year in addition to daily support and bug fixing (currently not very much related to coding but rather related to data).

Some of the tasks/actions being done outside the ProGRess system, for example, as shown in Figure 11 (*Viva Voce* Approval Process), can be implemented within ProGRess, as well as getting external users, such as independent assessors, involved within ProGRess.

We might transform the ProGRess system into a Software as a Service (SaaS) product, subscription-based model, whereby universities typically pay a recurring fee for access to the software, rather than a one-time purchase. Consequently, BU could generate additional sources of income by commercializing this product to the academic community as such.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

Djamel Benaouda co-developed the ProGRess software, wrote the whole paper, and created all the diagrams, including figures and tables of this paper. Julia Taylor & Fiona Knight (as the project stakeholders), and Almasa Mulalić served as mentors, and provided conceptual guidance, suggestions, critical comments, and proofreading.

Ethical approval statement

Research ethics approval was obtained from the Ethical approval team at BU (Ref. Ethics ID number is 67695).

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APPENDIX A. ProGress' login and landing pages

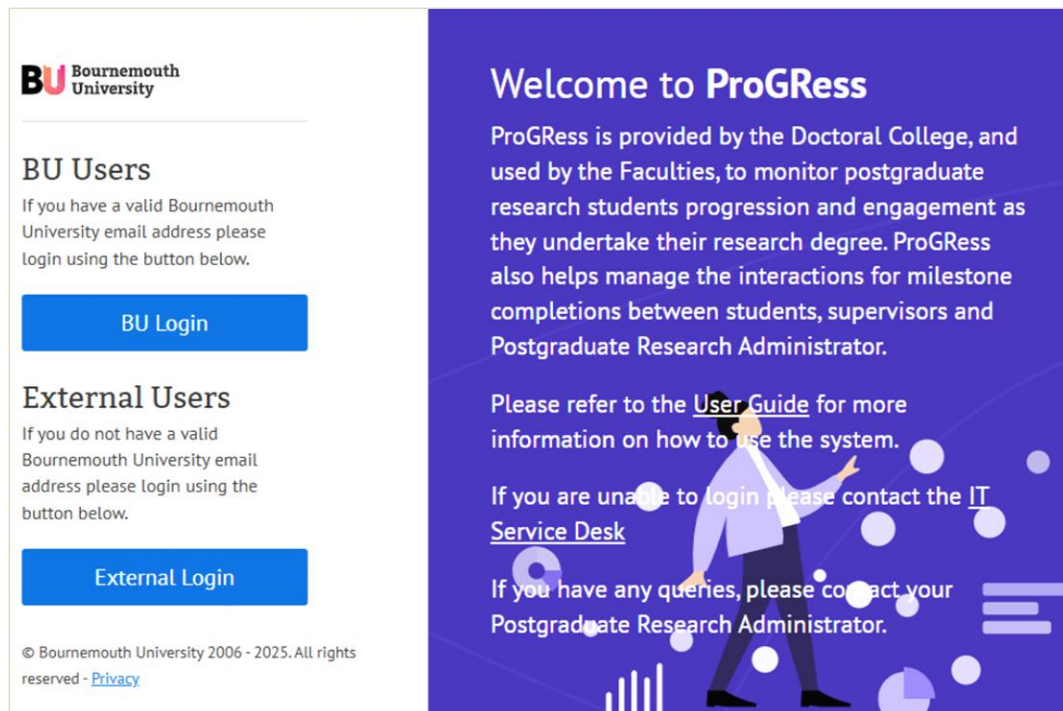


Figure 13. ProGress' login page. For users either from BU or registered externally (*Source: Author*).

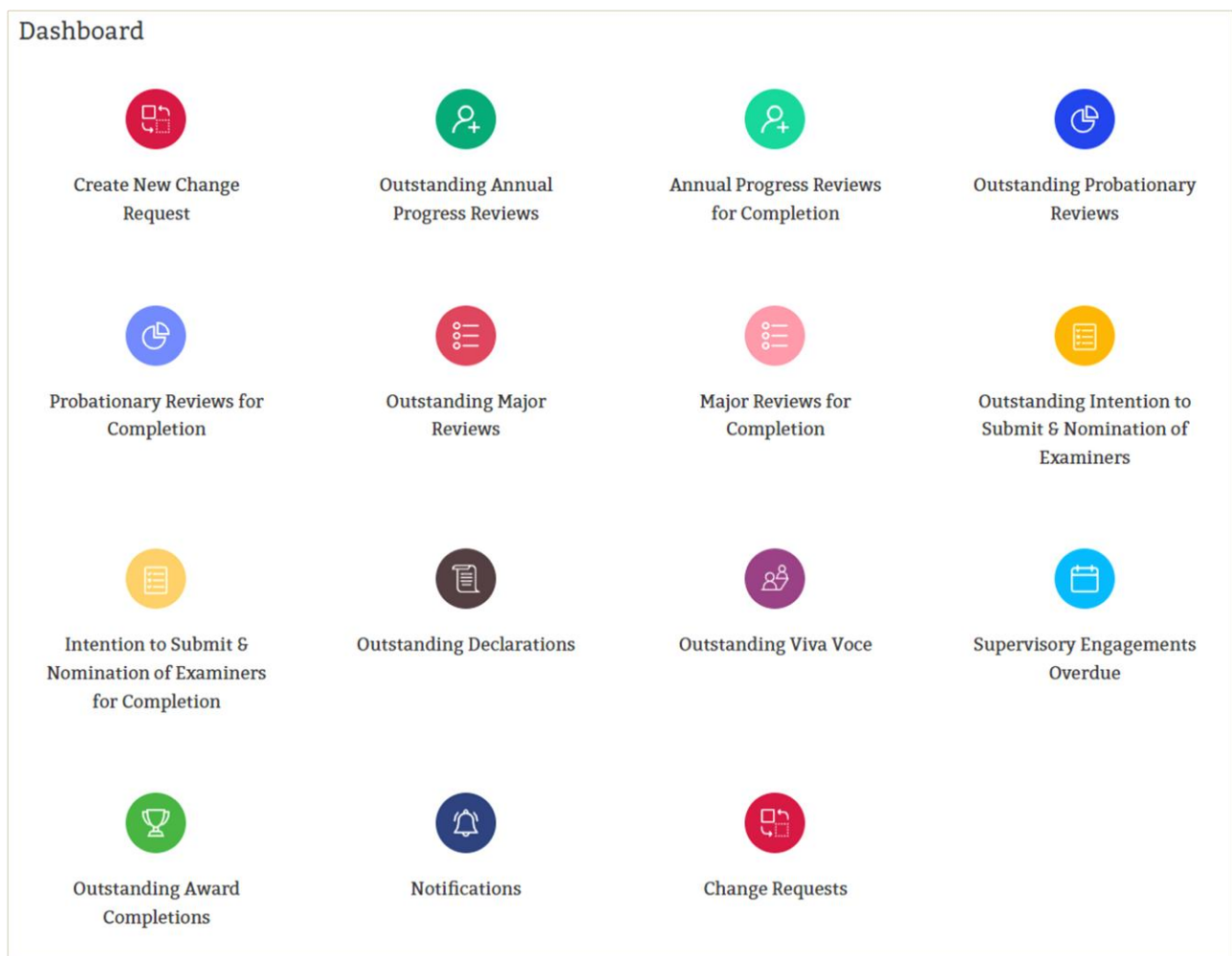


Figure 14. ProGress' landing page after a successful login – The Dashboard for PGR page (*Source: Author*)

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