

Configuration Manual

MSc Research Project MSc FinTech

Alexander Hyland Student ID: X18166342

School of Computing National College of Ireland

Supervisor:

Victor Del Rosal





MSc Project Submission Sheet

School of Computing

Student Name:	
Student ID:	
Programme:	Year:
Module:	
Lecturer: Submission	
Due Date:	
Project Title:	
_	

Word Count: Page Count:

I hereby certify that the information contained in this (my submission) is information pertaining to research I conducted for this project. All information other than my own contribution will be fully referenced and listed in the relevant bibliography section at the rear of the project.

<u>ALL</u> internet material must be referenced in the bibliography section. Students are required to use the Referencing Standard specified in the report template. To use other author's written or electronic work is illegal (plagiarism) and may result in disciplinary action.

Signature:	

Date:

PLEASE READ THE FOLLOWING INSTRUCTIONS AND CHECKLIST

Attach a completed copy of this sheet to each project (including multiple copies)	
Attach a Moodle submission receipt of the online project submission, to each project (including multiple copies).	
You must ensure that you retain a HARD COPY of the project, both for your own reference and in case a project is lost or mislaid. It is not sufficient to keep a copy on computer.	

Assignments that are submitted to the Programme Coordinator Office must be placed into the assignment box located outside the office.

Office Use Only	
Signature:	
Date:	
Penalty Applied (if applicable):	

Configuration Manual

Alexander Hyland Student ID: X18166342

Contents

Hard	ware & Software	2
1	Hardware	2
2	Software	2
1.2.1	Laptop	2
1.2.2	R studio	2
1.2.3	SoGoSurvey	2
Data		3
1	Collection	3
2	Analysis	6
2.2.1	Analysis using the average variable presented in survey results	6
2.2.2	Analysis using the minimum and maximum variables presented in survey results	8
2.2.3	Simmer package used to create discrete-event simulation	10
	Hardy 1 2 1.2.1 1.2.2 1.2.3 Data 1 2 2.2.1 2.2.2 2.2.3	Hardware & Software 1 Hardware 2 Software 2 Software 1.2.1 Laptop 1.2.2 R studio 1.2.3 SoGoSurvey Data

1 Hardware & Software

1.1 Hardware

View basic information about your computer

Windows edition		
Windows 10 Home		
© 2018 Microsoft Corpo	vration. All rights reserved.	Windows IU
System		
Manufacturer:	Microsoft Corporation	
Processor:	Intel(R) Core(TM) i5-8250U CPU @ 1.60GHz 1.80 GHz	Surface
Installed memory (RAM):	: 8.00 GB	Surface
System type:	64-bit Operating System, x64-based processor	
Pen and Touch:	Pen and Touch Support with 10 Touch Points	

1.2 Software

1.2.1 Laptop

OS Name	Microsoft Windows 10 Home
Version	10.0.17134 Build 17134

1.2.2 R studio



RStudio

Version 1.2.1335 © 2009-2019 RStudio, Inc.

Build 1379 (f1ac3452)

Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) QtWebEngine/5.12.1 Chrome/69.0.3497.128 Safari/537.36

1.2.3 SoGoSurvey

SoGoSurvey was the survey platform use for the gathering of information from this research. Survey monkey was originally used. However, survey money would only allow a certain amount of question and respondents before having to upgrade to a premium account. SoGoSurvey offer student accounts for 1 year. In order to active the student account you but post on a social media account and then send a copy of your student card to their email address. Once you follow the requirements, they set out they issue you an account.

≽ 🖍 Surveys ▾ 🛛 🚍			
Welcome Back, Alexander! Check in on the status of your most recent survey below or start something new! Questions? You'll find resources and inspiration ready and waiting in our Help Center.	Create Survey	Survey Bank	
Recent Surveys Conveyancing Process In Ireland Est. completion time : 3 mins Last Access: 8/7/2019 12:29	Total Responses 7		다 Watch and Learn
	View all Surveys		
Status V Survey Title Q	Start Date End Date	Total Invites	Total Responses
Conveyancing Process In Ireland	7/11/2019 7/10/2029	0	7

2 Data

2.1 Collection

The collection process was in line with the research methodology. A first draft of the process was made. Then using the appropriate literature and input from qualified solicitors', iterations of the process where made. The process was narrowed down to 20 steps. These steps where then compounded to create sections of a conveyancing process that would be easier to quantify in a survey situation. The survey can be seen below.



- This survey assumes a 5 day working week of Monday to Friday.
 Please respond to this survey in the context of your own personnel experience with the conveyancing process.
 Some questions may be specific to the vendors process while others to the purchasers process, please answer accordingly.

* Re

* The purpose of this survey is to evaluate the current time line of the conveyancing process within Ireland. These results will then be compared to what a technology, theoretically, could provide. This research is part of a thesis project for an MSc in FinTech at the National College of Ireland (NCI)

By taking part you agree to processing this information in accordance to the NCI's 3 ethics principles (as summarised below):

- You have the right to withdraw from the research study at an time.
 There will be no withdraw from the research study at an time.
 There will be no withdraw of information in order to deceive the participant, during the course of the survey.
 The right to dignity and protection from harm is adhered to.
 Potential benefits from the obtaining of information outweigh potential risks.
 Potential participants are doing so by their own free will.
 No vulnerable populations are being involved in the research.
 Compliance with ethical management and use of data.

While some information regarding the participant email address maybe sent in conjunction with the completion of the survey, there will be no processing of such information and it will be deleted once essential data is removed. Apart from the last question participants are required to enter answers in a numerical day format e.g. 12,3.

Yes, I consent to participating in this survey.

No, I do not consent to participating in this survey.

Figure 1 Consent Page

	National College બ Ireland
This survey assumes a 5 day working week o Please respond to this survey in the context Some questions may be specific to the vend	k of Monday to Friday. xt of your own personnel experience with the conveyancing process. ndors process while others to the purchasers process, please answer accordingly.
* Required Information	
* How many days does it take for the structural and plan	lanning survey to be received once requested?
Average amount of days?	
Minimum amount of days?	
In practice, what is the longest delay you have encountered?	d?
* How many days does it take to for the vendors solicitor	tor to investigate the Title, prepare the contract, prepare the requisition and then send to the purchasers solicitor?
Average amount of days?	
Minimum amount of days?	
In practice, what is the longest delay you have encountered?	d?
# How many days does take for the purchasers solicitor t	or to investigate the Title and raise pre-contract queries?
Average amount of days?	
Minimum amount of days?	
In practice, what is the longest delay you have encountered?	d?
# How many days does it take for a contract to be signed	ed, exchanged and a deposit to be paid post a sale being agreed?
Average amount of days?	
Minimum amount of days?	
In practice, what is the longest delay you have encountered?	d?
* Once the Acceptance of Loan Offer, Solicitors Undertal	taking and the Cheque requisition form has been sent, how many days does it take for the loan to be drawn down?
Average amount of days?	
Minimum amount of days?	
In practice, what is the longest delay you have encountered?	d?

Figure 2 Questions 1 – 5

Average amount of days?			
Minimum amount of days?			
In practice, what is the longest delay you have end	countered?		
* How many days does it take between contra	cts being exchanged and closing	<u>]</u> ?	
Average amount of days?			
Minimum amount of days?			
In practice, what is the longest delay you have end	countered?		
* Where documents require a signature, how r	many days does it take for a clier	nt(s) to sign said documents?	
Average amount of days?			
Minimum amount of days?			
In practice, what is the longest delay you have end	countered?		
In the vendor to purchaser exchange, how m Average amount of days?	hany days does it take to transfer	lunds?	
In the vendor to purchaser exchange, how m Average amount of days?	hany days does it take to transfer	lunas?	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have end	countered?	iunus?	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have encomposited and the second	countered?	lunds?	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co	countered?	101105? 3:	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have ence What percentage of documentation in the co Registered Post	countered?	101105 <i>?</i> 3:	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have end What percentage of documentation in the co Registered Post Courier	countered?	1unds? 3:	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX	countered?	iunds?	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX Email or Fax	countered?	ands?	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX Email or Fax Other	countered?	iunds?	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX Email or Fax Other Total	countered?	1unds?	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX Email or Fax Other Total	countered?	2 2	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX Email or Fax Other Total	onveyancing process are sent via	101105? 2:	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX Email or Fax Other Total	onveyancing process are sent via	101105? 2:	
In the vendor to purchaser exchange, how m Average amount of days? Minimum amount of days? In practice, what is the longest delay you have enc What percentage of documentation in the co Registered Post Courier Standard post or DX Email or Fax Other Total	any days does it take to transfer	turus?	Submit

Figure 3 Questions 6 – 10

The data was exported as a CSV file to an excel spreadsheet.

Α	В	С	D	E	F	G	н	1	J	K	L	М
Sr.No.	Response	Participat	1.The	2.How ma	ny days do	es it take fo	3.How ma	ny days do	es it take to	4.How ma	ny days do	es take for
				Average a	Minimum	In practice	Average a	Minimum	In practice	Average a	Minimum	In practice
1	. 1	Complete	Yes, I cons	7	4	14	8	2	60	8	2	30
2	2	Complete	Yes, I cons	2	1	21	14	5	60	21	5	60
3	3	Complete	Yes, I cons	60	30	60	10	4	21	10	4	90
4	. 4	Complete	Yes, I cons	5	2	30	2	1	45	1	1	50
5	5	Complete	Yes, I cons	20	7		2	1		14	2	
6	6	Complete	Yes, I cons	14	7	30	14	7	60	5	1	30
7	7	Complete	Yes, I cons	5	1	14	14	1	60	7	1	60
)												
-												

Figure 4 CSV of survey results

2.2 Analysis

```
2.2.1 Analysis using the average variable presented in survey results
```

```
🖅 🛛 🔄 Source on Save 🛛 🔍 🧨 🔹 📗
       # import data set from survey results
      survey <- read.csv("SoGoSurvey_Conveyancing Process In Irelan_2_ test.csv", na.strings = "")</pre>
      # change data types
      survey$Sr.No.<-NULL
survey$ParticipationStatus<-NULL
survey$X1.The.purpose.of.this.survey.is.to.evaluate.the.current.time.line.of.the.conveyancing.process.within.Ireland..TH
11
12
13 # remove avg,max,min row + remove survey answer row humber 5 as has na variables
14 survey<-survey[-c(1),]
15 survey<-survey[-c(5),]</pre>
16
17
18
19
20
21
      #gather columns package
install.packages(c("tidyr", "devtools"))
library(tidyr)
     #seperate questions to to allow for intividual step analysis using only average columns
22
     question1<- subset(survey, select = c(2)) # bring only average column for Q1
colnames(question1) <- c("Q1") # change column name
question1$Q1 <- as.integer(question1$Q1) # change structure from factor to integer .... repeat for 9 questions</pre>
23
24
25
26
27
28
29
30
31
        \begin{array}{l} \mbox{question2<- subset(survey, select = c(5))} \\ \mbox{colnames(question2) <- c("Q2")} \\ \mbox{question2SQ2 <- as.integer(question2SQ2)} \end{array} 
32
32
33 question3<- subset(survey, select = c(8))
34 colnames(question3) <- c("Q3")
35 question3$Q3 <- as.integer(question3$Q3)</pre>
35
36
37
38
39
40
41
     question4<- subset(survey, select = c(11))
colnames(question4) <- c("Q4")
question4$Q4 <- as.integer(question4$Q4)</pre>
42
43
       \begin{array}{l} \mbox{question5<- subset(survey, select = c(14))} \\ \mbox{colnames(question5) <- c("Q5")} \\ \mbox{question5\&Q5 <- as.integer(question5\&Q5)} \end{array} 
44
45
46
```

Figure 5 R code - average i

```
47
48
                          question6<- subset(survey, select = c(17))
colnames(question6) <- c("Q6")
question6$Q6 <- as.integer(question6$Q6)</pre>
      49
     50
51
     52
                             question7<- subset(survey, select = c(20))
colnames(question7) <- c("Q7")
question7$Q7 <- as.integer(question7$Q7)</pre>
   53
54
55
56
57
58
59
60
61
                              \begin{array}{l} \mbox{question8<- subset(survey, select = c(23))} \\ \mbox{colnames(question8) <- c("Q8")} \\ \mbox{question8SQ8 <- as.integer(question8SQ8)} \end{array} 
     62
63
64
65
                              \begin{array}{l} \mbox{question9<- subset(survey, select = c(26))} \\ \mbox{colnames(question9) <- c("Q9")} \\ \mbox{question9$Q9 <- as.integer(question9$Q9)} \end{array} 
     66
     67
     68 guestion10 <- subset(survey, select = c(29:34))</pre>
vectorize <- subset(survey, select = C(29:34))

# changing factors to integers wouldn't work so recreted matric by hand + removed other as had zero response
gestion10 <- rbind(c(10,10,70,10), c(8,40,50,2), c(2,58,40,0), c(5,5,80,10), c(30,30,30,10), c(15,5,30,50))
colnames(question10)<- c("%reg_post", "%Courier", "%SP/DX", "%Email/Fax") # change column names
question10 <- as.data.frame(question10)

# establish a percentage chance of a form of communication occuring
question10_breakdown[1] <- sum(question105'%reg_post')
question10_breakdown[2] <- sum(question105'%reg_post')
question10_breakdown[3] <- sum(question105'%Courier')
question10_breakdown[4] <- sum(question105'%Email/Fax')
duestion10_breakdown[4] <- sum(question105'%Email/Fax')
duestio
                               # creating a vector with chars that have the same probailty as survey resulls
      84
85

        85
        010 <- rep("n/a",600)</td>

        7
        010 <- replace(010,1:70,"RP")</td>

        88
        010 <- replace(010,71:218,"C")</td>

        90
        010 <- replace(010,219:168,"SP")</td>

        90
        010 <- replace(010,519:600,"E")</td>

        71
        010 <- replace(010,519:600,"E")</td>
```

Figure 6 R code - average ii

```
91
92
       #Discrete event simulation of current process
  93
  94
        process_simulation_current <- rep(0,57003)</pre>
  95
  96
        set.seed(1)
  97 - for (i in 1:57003)
         process_time <- 0.0
transfer <- 0.0
  98
  99
100
           process_time <- process_time + rnorm(1, mean(question1$Q1), sd(question1$Q1))
process_time <- process_time + rnorm(1, mean(question2$Q2), sd(question2$Q2))
process_time <- process_time + rnorm(1, mean(question3$Q3), sd(question3$Q3))</pre>
101
102
103
           process_time <- process_time + rnorm(1, mean(question4$Q4), sd(question4$Q4))
process_time <- process_time + rnorm(1, mean(question5$Q5), sd(question5$Q5))</pre>
104
105
           process_time <- process_time + rnorm(1, mean(question6%Q6), sd(question6%Q6))
process_time <- process_time + rnorm(1, mean(question7%Q7), sd(question7%Q7))</pre>
106
107
           process_time <- process_time + rnorm(1, mean(question8$Q8), sd(question8$Q8))
process_time <- process_time + rnorm(1, mean(question9$Q9), sd(question9$Q9))</pre>
108
109
110
111 -
          for(j in 1:12){
112
113
                transfer_method <- sample(Q10,1)</pre>
114
              if (transfer_method == "RP") {
  transfer <- transfer + 2</pre>
115 -
116
117
             3
118 -
                else if ( transfer_method == "C"){
119
                 transfer <- transfer + 1
120
                else if ( transfer_method == "SP"){
121 -
                   transfer <- transfer + 2
122
123
124 -
               else if ( transfer_method == "E"){
   transfer <- transfer + .0007</pre>
125
               }
126
127
          process_time <- process_time + transfer
process_simulation_current[i] <- process_time</pre>
128
129
130
        3
131 str(process_simulation_current)
132
         m1<- mean(process_simulation_current)</pre>
133
        m1
```

Figure 7 R code - average iii

134

```
135
        # Discrete event simulation of proposed blockchian
136
137
               process_simulation_new <- rep(0,57003)</pre>
138
139
               set.seed(1)
140 -
             for (i in 1:57003) {
141
                 process_time <- 0.0
142
                   transfer <- 0.0
143
144
                   process_time <- process_time + rnorm(1, mean(question1$Q1), sd(question1$Q1))</pre>
                   process_time <- process_time + rnorm(1, mean(question1$Q2), sd(question1$Q2))
process_time <- process_time + rnorm(1, mean(question3$Q3), sd(question3$Q3))
process_time <- process_time + rnorm(1, mean(question4$Q4), sd(question4$Q4))
process_time <- process_time + rnorm(1, mean(question5$Q5), sd(question5$Q5))
process_time <- process_time + rnorm(1, mean(question5$Q5), sd(question5$Q5))</pre>
145
146
147
148
149
                   process_time <- process_time + rnorm(1, mean(question7$Q7), sd(question7$Q7))
process_time <- process_time + rnorm(1, mean(question8$Q8), sd(question8$Q8))
process_time <- process_time + rnorm(1, mean(question9$Q9), sd(question9$Q9))</pre>
150
151
152
153
154 -
                   for(i in 1:12){
155
                           transfer <- transfer + 0.000005
                   3
156
157
158
                   process_time <- process_time + transfer</pre>
159
                   process_simulation_new[i] <- process_time</pre>
160
               3
161
162
           m2 <- mean(process_simulation_new)</pre>
163
           m2
164
         plot(process_simulation_new)
165
```

Figure 8 R code - average iv

2.2.2 Analysis using the minimum and maximum variables presented in survey results

```
2
            ⊭ import data set from survey results
             survey <- read.csv("SoGoSurvey_Conveyancing Process In Irelan_2_ test.csv", na.strings="")</pre>
             View(survey)
                                            ised columns
           surveySSr.No.<-NULL
surveySParticipationStatus<-NULL
surveySX1.The.purpose.of.this.survey.is.to.evaluate.the.current.time.line.of.the.conveyancing.process.withi
    10
   11
12
13
14
15
16
17
18
           # remove avg,max,min column + remove survey answer number 5 as has na variables
            survey<-survey[-c(1),]
survey<-survey[-c(5),]</pre>
   19
            #gather columns package
install.packages(c("tidyr", "devtools"))
library(tidyr)
   20
21
22
   24 #seperate questions to to arrow not internal
25
26
26 question1<- subset(survey, select = c(3,4))
27 question1</pre>squestion1squestion1squestion1squestion1squestion1squestion1squestion1squestion1squestion1squestion1squestion1squestion1squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion2squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion3squestion4
```

Figure 9 R code - min/max i

```
question5<- subset(survey, select = c(15,16))
question5 <- gather(question5, "question_5","answer_q5",1:2)
question5%question_5 <-NULL
question5%answer_q5 <- as.integer(question5%answer_q5)</pre>
 50
 51
 52
 54
 55
56
57
58
         question6<- subset(survey, select = c(18,19))
question6 <- gather(question6, "question_6","answer_q6",1:2)
question6$question6 <-NULL
question6$answer_q6 <- as.integer(question6$answer_q6)</pre>
 59
 60
 61
         question7<- subset(survey, select = c(21,22))
question7 <- gather(question7, "question_7","answer_q7",1:2)
question7S[question_7 <-NULL
question7[question_7 = 0]<-1 # replace a zero with 1 as zero means within a day
question7Sanswer_q7 <- as.integer(question7Sanswer_q7)</pre>
 62
63
64
65
66
67
68
          question8<- subset(survey, select = c(24,25))
question8 <- gather(question8, "question_8","answer_q8",1:2)
question8$question_8 <-NULL
question8$answer_q8 <- as.integer(question8$answer_q8)</pre>
69
70
71
 72
 73
74
75
76
77
78
79
         question9<- subset(survey, select = c(27,28))
question9 <- gather(question9, "question_9","answer_q9",1:2)
question9$question_9 <-NULL
question9$answer_q9 <- as.integer(question9$answer_q9)</pre>
 80
81
         question10 <- subset(survey, select = c(29:34))</pre>
 8
 83
          # changing factors to integers wouldt work so recreted matric by hand + removed other as had zero respones
84
         question10 <- rbind(c(10,10,70,10), c(8,40,50,2), c(2,58,40,0), c(5,5,80,10), c(30,30,30,10), c(15,5,30,50))
colnames(question10)<-c("%reg_post", "%Courier", "%SP/DX", "%Email/Fax")  # change column names
question10 <- as.data.frame(question10)</pre>
85
 86
87
 88
           # establish a percentage chance of a form of communication occuring
89
         # establish a percentage chance or a form or communicat
question10_breakdown <= c(1,1,1)
question10_breakdown[1] <= sum(question10$`%reg_post`)
question10_breakdown[2] <= sum(question10$`%Courier`)
question10_breakdown[4] <= sum(question10$`%Email/Fax`)</pre>
 90
 91
 92
 93
 94
```

Figure 10 code - min/max ii

```
96
97 # creating a vector with chars that have the same probailty as survey resulls
98
99 Q10 <- rep("n/a",600)
100 Q10 <- replace(Q10,1:70,"RP")
101 Q10 <- replace(Q10,71:218,"C")
102 Q10 <- replace(Q10,71:218,"SP")
103 Q10 <- replace(Q10,519:600,"E")
104
```

Figure 11 code - min/max iii

```
106
107
            #Discrete event simulation for current process
 108
 109 process_simulation_current <- rep(0,57003)</pre>
 110

      111
      set.seed(1)

      112 - for (i in 1:57003) {

      113
      process_time <- 0.0</td>

      114
      transfer <- 0.0</td>

 114
115
                process_time <- process_time + runif(1, min(question1$answer_q1), max(question1$answer_q1))
process_time <- process_time + runif(1, min(question2$answer_q2), max(question2$answer_q2))
process_time <- process_time + runif(1, min(question3$answer_q3), max(question3$answer_q3))
process_time <- process_time + runif(1, min(question5$answer_q4), max(question4$answer_q4))
process_time <- process_time + runif(1, min(question6$answer_q5), max(question6$answer_q6), max(question6$answer_q6),
process_time <- process_time + runif(1, min(question6$answer_q6), max(question6$answer_q6))
process_time <- process_time + runif(1, min(question6$answer_q7), max(question6$answer_q7))
process_time <- process_time + runif(1, min(question6$answer_q8), max(question8$answer_q8))
process_time <- process_time + runif(1, min(question8$answer_q8), max(question8$answer_q8))
process_time <- process_time + runif(1, min(question9$answer_q9), max(question9$answer_q9))</pre>
 116
 117
 118
 119
 120
 121
 122
 123
 124
 125
 126 - for(j in 1:12){
 127
                      transfer_method <- sample(Q10,1)</pre>
 128
 129
                   if (transfer_method == "RP") {
    transfer <- transfer + 2</pre>
  130 -
 131
                   else if ( transfer_method == "C"){
 132
133 -
 134
                              transfer <- transfer + 1
  135
                     selve if ( transfer_method == "SP"){
 136 -
 137
138
                             transfer <- transfer + 2
                     {
    else if ( transfer_method == "E"){
        transfer <- transfer + .0007
    }
</pre>
 139 -
 140
 141
            process_time <- process_time + transfer
process_simulation_current[i] <- process_time
}</pre>
 142
 143
 144
 145
 146
 147 plot(process_simulation_current)
148 m1 <- mean(process_simulation_current)</pre>
 149
150
            m1
```

Figure 12 code - min/max iv

```
151
           #Discrete event simulation for current process
 152
153
154
           process_simulation_new <- rep(0,57003)</pre>
155
156 set.seed(1)
157 - for (i in 1:57003) {
              process_time <- 0.0
158
               transfer <- 0.0
159
160
161
              process_time <- process_time + runif(1, min(question1$answer_q1), max(question1$answer_q1))
process_time <- process_time + runif(1, min(question2$answer_q2), max(question2$answer_q2))
process_time <- process_time + runif(1, min(question3$answer_q3), max(question3$answer_q3))</pre>
162
163
              process_time <- process_time + runif(1, min(questions%answer_q3), max(questions%answer_q4))
process_time <- process_time + runif(1, min(questions%answer_q4), max(questions%answer_q4))
process_time <- process_time + runif(1, min(questions%answer_q6), max(questions%answer_q6))
process_time <- process_time + runif(1, min(questions%answer_q6), max(questions%answer_q6))
process_time <- process_time + runif(1, min(questions%answer_q8), max(questions%answer_q6))
process_time <- process_time + runif(1, min(questions%answer_q8), max(questions%answer_q8))
process_time <- process_time + runif(1, min(questions%answer_q8), max(questions%answer_q8))
process_time <- process_time + runif(1, min(questions%answer_q9), max(questions%answer_q9))</pre>
164
165
166
167
 168
169
170
171 -
               for(j in 1:12){
172
 173
                         transfer <- transfer + .000005
174
175
               process_time <- process_time + transfer
176
              process_simulation_new[i] <- process_time</pre>
177
           3
178
179
           min(question9$answer_q9)
180
181 range(process_simulation_new)
182
           m2 <- mean(process_simulation_new)</pre>
183
           m2
184
```

Figure 13 code - min/max v

2.2.3 Simmer package used to create discrete-event simulation

```
166 # attempt to use a Discrete event simulation package.
       # worked with no errors, no undertsnading if the results where correct.
167
168
          # not enough understanding of package.
169
       install.packages("simmer")
170
       library(simmer)
library(parallel)
171
172
173
174
       set.seed(1)
175
       env <- simmer("conveyancing")</pre>
176
       env
177
178
       sale<- trajectory("sale process") %>%
         # imput steps of conveyancing process
seize("step1", 1) %>%
timeout(function() rnorm(1, mean(question1$Q1), sd(question1$Q1)))%>%
179
180
181
182
         release("step1", 1) %>%
183
            # step 2
          seize("step2", 1) %>%
184
185
          timeout(function() rnorm(1, mean=mean(question2$Q2), sd = sd(question2$Q2)))%>%
         release("step2", 1) %>%
186
            # step 3
187
188
          seize("step3", 1) %>%
         timeout(function() rnorm(1, mean(question3$Q3), sd(question3$Q3)))%>%
release("step3", 1) %>%
189
190
191
            # step 4
         seize("step4", 1) %>%
timeout(function() rnorm(1, mean(question4$Q4), sd(question4$Q4)))%>%
192
193
194
         release("step4", 1) %>%
195
            # step 5
          seize("step5", 1) %>%
196
         timeout(function() rnorm(1, mean(question5$Q5), sd(question5$Q5)))%>%
release("step5", 1) %>%
197
198
199
            # step 6
         seize("step6", 1) %>%
timeout(function() rnorm(1, mean(question6%Q6), sd(question6%Q6)))%>%
release("step6", 1) %>%
200
201
202
203
            # step 7
          seize("step7", 1) %>%
timeout(function() rnorm(1, mean(question7$Q7), sd(question7$Q7)))%>%
204
205
206
         release("step7", 1) %>%
          # step 8
seize("step8", 1) %>%
207
208
         timeout(function() rnorm(1, mean(question8$Q8), sd(question8$Q8)))%>%
release("step8", 1) %>%
209
210
```

Figure 14 R code - Simmer i

```
# step 9
211
               r step "
seize("step9", 1) %>%
timeout(function() rnorm(1, mean(question9$Q9), sd(question9$Q9)))%>%
release("step9", 1)
212
213
214
215
216 - envs<- mclapply(1:57003, function(i){</pre>
              envs<- mclapply(1:57003, function(i){
  simmer("conveyancing") %>%
  add_resource("step1",1) %>%
  add_resource("step2",1) %>%
  add_resource("step3",1) %>%
  add_resource("step4",1) %>%
  add_resource("step5",1) %>%
  add_resource("step6",1) %>%
  add_resource("step6",1) %>%
  add_resource("step8",1) %>%
  add_resource("step8",1) %>%
  add_resource("step9",1) %>%
  add_resource("step9",1) %>%
  add_generator("sale", sale, function() rnorm(1,1,1)) %>%
  run(365) %>%
217
218
219
220
221
222
223
224
225
226
227
228
                     run(365) %>%
229
                     wrap()
230
           })
231
install.packages("simmer.plot")
library(simmer.plot)
234
          process <- get_mon_arrivals(envs)
plot(process, metric = "flow_time")</pre>
235
236
237
            plot(resources)
238
           plot(sale)
239
240
```

Figure 15 R code - Simmer ii