Mouse food hopper dividers for a refined feeding method

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Abstract

The University of Oxford's Biomedical Services (BMS) where this project was carried out, is a facility within the science area which opened in 2008, for the purpose of rehousing animals, from older facilities, After the move the University exceeded the Home Office regulations for animal care and also set a gold standard for animal care.

One of the main financial goals of the University is to provide appropriate resources to maintain outstanding learning, teaching and research within their departments. To meet with these financial objectives, well scoped budgeting alongside regular reviews of resource allocations is vital. After a recent review into the amount and cost of mouse diet used in BMS, concerns regarding wasted diet and the actual needs of animals have been raised. Following the review, refined animal care and improved resource allocation became the two driving forces behind the project idea.

This project aimed to establish whether a different method of presenting diet *'ad-libitum'* to laboratory mice, could lower the negative consequences of excess food, such as decreased quality, palatability and increased cost. The main aim of this project was to refine the way laboratory mice are fed which could have a positive impact not only on unnecessary diet waste but also Animal Welfare. In this project the current practice, which was providing a fully topped up food hopper to each cage on a weekly basis, was going to be compared with a more refined method by using a food hopper divider to provide less food to each cage which still meets the actual needs of the mice.

Keywords: mice, budgeting, reduce food waste

Introduction

The University of Oxford is an historic educational research university located in Oxford, UK. There is no exact date of foundation, however it is the oldest university in the English-speaking world due to the fact that teaching has existed in Oxford from 1096. The university does not have a main campus. Instead it is divided into colleges, student accommodation, departments and other facilities which are all located throughout the city centre. During the 20th and 21st centuries the humanistic core has been extended with new research capacity in the natural and applied sciences, including medicine and has become one of the world leading centres for biomedical research.[1]

Biomedical Services (BMS), where this project was carried out, is a facility within the science area which opened in 2008, for the purpose of rehousing animals from older facilities, used in many important research studies such as: heart diseases, Alzheimer's, muscular dystrophy, cancer, Parkinson's, stroke and diabetes. After the move the University exceeded the Home Office regulations for animal care and also set a gold standard for animal care.[2] As Oxford is committed to high standards of Animal Welfare the BMS also provides a number of different functions such as;

- Training and education – with personal licence training and PPL Holder courses.
- Veterinary Services – an entire team with veterinary surgeons for providing specialist care and advice.
- Home Office Administration Unit for all information regarding Ethical Review or further information on the Animals (Scientific Procedure) Act 1986.[3]

One of the main financial goals of the University is to provide appropriate resources to maintain outstanding

learning, teaching and research within their departments. To meet with these financial objectives, well scoped budgeting alongside regular reviews of resource allocations are vital. After a recent review into the amount and cost of mouse diet used in BMS, wasted diet and the actual needs of animals have been raised. Following the review, refined animal care and improved resource allocation became the two driving forces behind the project idea.

This project aimed to establish whether a different method of presenting diet *ad libitum* to laboratory mice, could lower the negative consequences of excess food, such as decreased quality, palatability and increased cost. The main aim of this project was to refine the way laboratory mice are fed which could have a positive impact not only on unnecessary diet waste but also Animal Welfare. In this project the current practice, which was providing a fully topped up food hopper to each cage on a weekly basis, was going to be compared with a more refined method by using a food hopper divider to provide less food to each cage which still meets the actual needs of the mice. I managed the project from start to finish with the support of other members of staff, such as management, animal technicians and a secondary leader.

Synopsis

Based on the 'Handbook of Laboratory Animal Management and Welfare' by Sarah Wolfensohn and Maggie Lloyd,[4] the daily food intake of average male mice is approximately 5g. However this fact is not fully considered when it comes to the feeding regime. A pelleted rodent diet is manufactured with high quality and important nutrients to provide good animal welfare and healthy mice to be used in research. However, these ingredients can spoil, harden or become deficient in specific nutrients over time. The common shelf life of the diet is 6-9 months following the storage recommendation; 'its original packaging or in a container that prevents continuous exposure to light and minimal exposure to air'.[5] As the microenvironment within the Individually Ventilated Cages (IVC) is strictly controlled, to meet with the requirements of the animals, the dietary quality control only could be applied by reducing the size of the food hopper for quicker diet turnover. Turning over diet at a quicker rate is also essential as in mice, malocclusion of both the incisors and the rooted molars has been linked to trauma to developing teeth caused by cage lids, improper handling, fighting or too-hard food.[6]

The issue of unnecessarily wasted rodent diet and the negative effects of excess food on Animal Welfare has been raised previously in our facility. The original idea was simply to compare two racks of Green Line IVC cages (Tecniplast) using two different feeding regimes. Group 1 had been provided with a full sized hopper, Group 2 had the adjusted half hopper size to control the amount of diet provided. As a result, the project failed to show any differences between the two groups. The failure had many reasons; such as the strain, number of animals, number of cages, sex and the age of animals had not been controlled. Therefore the project did not outline clear goals and SMART objectives.

This project intended to compare x40 C57BL/6 male mice in 10 cages at 8 weeks of age, using two different hopper size (x20 mice fed with full, x20 mice fed with half hopper) with x40 B6SJLCD45.1 male mice in 10 cages at 8 weeks of age using two different hopper sizes (x20 mice fed with full, x20 mice fed with half hopper).

Project goals and SMART objectives

The aims of using a smaller hopper size in IVC cages were:

1. Promoting Animal Welfare through providing refined amount of diet (less diet / fresh diet).
2. Cut back on costs of consumables (only spend the necessary amount on diet).
3. Reduced diet waste (lessen the impact on waste disposal / landfill).

Clear objectives are vital in the process of project scoping and planning. These objectives help to identify the project itself and all the smaller components that are essential for a successful implementation and evaluation. For this reason, these objectives have to be approached in a SMART way.

SMART is an acronym which has been described by George T. Doran in 1981.[7] The acronym stands for Specific, Measurable, Achievable, Realistic and Time-bound (SMART).

- **Specific:** Previously listed project goals are clearly stated including specific details of involved animals, cage numbers, strains, age and sex. It highlighted what is going to be included in this project and what is not.
- **Measurable:** Different hopper sizes are physically measurable alongside with the food intake which is measured in grams on a weekly basis. The cost of diet within the two groups can be calculated. At the end of the project, the unused diet was also measurable.
- **Achievable:** As resources, budget, place and staff were available for this project, the objectives are achievable.
- **Realistic:** By reducing the amount of diet in the food hoppers, a more adequate, refined way of feeding can be achieved which promoted Animal Welfare. The project does not require specific training or invasive, difficult procedures to achieve its goals.
- **Time-bound:** The weekly measurements should be completed by the 8th of March when the 8 weeks of pilot study will end.

Organisational context

After clarifying the project objectives we had to identify the stakeholders. Stakeholders can be individuals or a group of people who have an interest and also have a certain level of influence for the project. As their level of interest and influence have a big impact on the progress of the project, it is vital to recognise that, different stakeholders have different perspectives which will require different approaches and communication strategies. Their level of interest and influence had to be identified in the scoping stage, however the communication style and frequency will be specified in the following planning stage within the project life cycle.

Stakeholders:

- **Animal facility manager** – High influence, high interest – key players, keep satisfied.
  The facility manager had a high influence due to the fact that his approval is vital due to the nature of this project. The extra x80 animals in x20 cages within the facility had to be allocated and approved. As the project involves food intake measurements on a weekly basis, which is a deviation from the normal daily routines, the manager also had a high interest in the process of implementation.
  Communication: Weekly, regular face to face meeting.

- **Finance department** – High influence, high interest – key players, manage closely.
  Finance department had a high influence as they are involved in funding the project and also had high interest in its success due to possible budget cuts on rodent diet.
  Communication: Initial face to face meeting followed by email updates on progress.

- **Supplier (NKP Isotec-hopper divider)** – Low influence, high interest – keep informed.
  The supplier is an external stakeholder with low influence in the project itself. However they were highly interested in the outcome due to the business opportunity.
  Communication: Email as required.

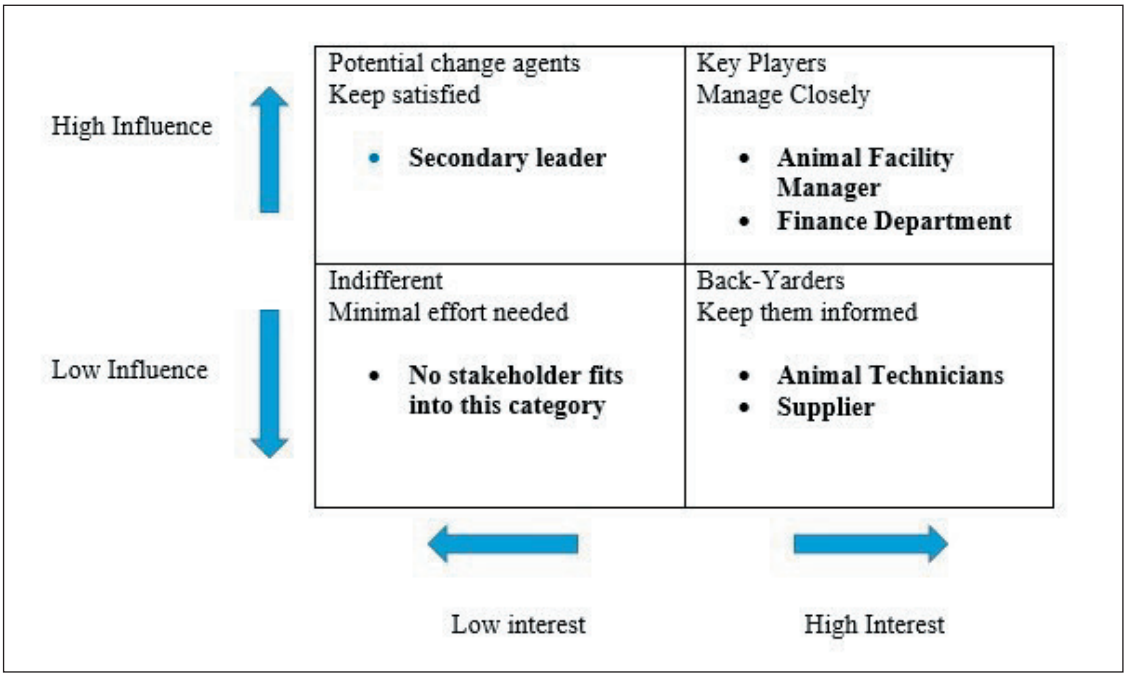
- **Animal Technician** – Low influence, high interest – back-yarders – keep them informed.
  Animal Technicians who are responsible for the day-to-day care of the mice involved in the study had low influence on the project itself, however regular communication with them was vital in the recognition of problems.
  Communication: Initial team meeting about the study and weekly face to face update on progress.

- Low influence, low interest – minimum effort.
  No stakeholder fitted into this category.

- **Secondary leader** – high influence, low interest – potential change agents.
  A secondary leader who has no interest in the project but can influence the outcome. A senior Animal Technician, to cover the weekly food intake measurements and monitor / report back about the project in the event of my absence.
  Communication: Initial meeting, weekly email update and phone call in the case of staff issue.

Stakeholder map

A visual representation of stakeholders on a map was a beneficial tool, clearly assessing their level of interest/ influence and also the communication levels they require.



Risk register

Risk ID	Date Identified	Risk	The risk is caused by	Effects of Risk	Mitigating Action In Place	Impact Level
1	15/12/2020	Invalid data collection due to variables.	Those factors changing in the project called variables and that could have an effect on the outcome. Invalid data collection can be the result of not recognising or not controlling possible variables in the project; such as: number, age, sex, strain, species of animals are not set and uniformed. Using different equipment or method for measuring food intake. Different housing conditions within the same project.	Data cannot be used. Failure of project.	Project is scoped correctly with sufficient time spent on information gathering. Fix variations that can be controlled are recognised and dealt with.	High
2	25/12/2020	Lack of communication with stakeholders.	This can be caused by a poorly planned project where the style and frequency of communication with stakeholders is not specified in the planning document.	Loss of interest. Loss of support.	Detailed communication plan created in the planning stage of the project life cycle and strictly followed.	Medium
3	15/12/2020	Error in data collection / in record keeping.	These errors can be caused by: Not specific / clear instructions such as: units used for measurements, the way of recording data. Lack of training.	Invalid result, failure of project.	Initial training, weighing sheet and support is provided to all the people who is involved.	High
4	01/11/2020	Staff issue.	Staffing issues can occur when the project team has not been scoped properly. Not enough staff. No staff cover in the case of sick days or holidays.	Delay. Project is not delivered within the agreed timescale.	Creating staff rota with extra cover.	Low

Overview budget of the main costs

Mouse food hopper divider project		
Overview budget of the main cost of project	**£**	**£**
CONSUMABLES		
Diet	25	
Water	48	
Sizzle nest	34	
Environmental enrichment – fun tunnel	87	
Sawdust – Bedding	8	
	202	
EQUIPMENT	**£**	**£**
Removable food hopper divider x 1000	2,850	
Weighing scale	100	
	2,950	
ESTIMATED TIME SPENT ON PROJECT		
My own time spent on project: 16 hours / 8 week		
Colleagues time spent on the project: 6.5 hours / 8 weeks		
Time spent on preparing consumables: 8 hours / 8 weeks		
	Total	3,152

Project planning document

Method Statement

Planning the project consisted of many different elements such as gathering ideas and options, highlighting key issues and recording the plan. Before creating the implementation plan which helps in breaking down the project into manageable chunks and maps out the main tasks, it was important to assess the following resources;

Human: Assess the people who are required in the project. How many, how long and at what skill level? Find and talk to professionals and bring them on board.

Technical: Assess the technical needs. Do we need external expertise in the subject?

Physical: Consider required equipment, space, specific instruments which had to be costed into the project.

Method and processes

Laying out the information we had and making initial decisions on what marketing methods were needed to 'sell' the concept of the project to others. What information needs reporting and how the information will be reported to end users? If possible bring on board other institutes who had already done similar projects.

Logistics

Assess what kind of materials we needed, how many, sources available in the required time to make sure the project is delivered in the time and way it should be delivered.

Budget

Assess the budget available. Did it cover the resources that are required? It is important to reduce the budget early in the scoping and planning stage and to try not to deviate.

Stakeholder engagement

As all stakeholders involved in the project had a certain level of impact on the final outcome, identifying the right amount of stakeholder engagement with personalised communication strategies was vital. Too much time spent on communicating with low interest/influence stakeholders is just as risky and can have as much as a negative effect on the progress of the project as not enough engagement with high interest and high influence stakeholders. During communication, giving and gaining information are equally important. For this reason, when preparing to engage with stakeholders the POURS model will be used to cover the five essentials of communication.

POURS

Plan what to tell and ask.

Outline objectives and seek feedback.

Use open questions.

Reflect and use closed questions for confirmation.

Summarise and agree on actions.

Following the steps within the POURS model gave us the opportunity to talk about the project and gain information from stakeholders in a clear and structured way and also minimised misunderstandings with reflection and a final summary on further actions.

The chosen medium that we were using for our communication with stakeholders also has a huge impact on the success or failure of the project. Using the wrong medium can lead to lost or misinterpreted information with further implications in the study progress.

The Shannon and Weaver's model was first introduced by Claude Shannon and Warren Weaver in the 1948 article called 'A Mathematical Theory of Communication' within the Bell System Technical Journal.[8]

Implementation plan

Task	The way in which the task will be done
Scoping	
Outline the goals of the project.	List project objectives that are designed to be SMART.
Identify stakeholders with their interest and influence.	Stakeholder map.
Complete a risk register.	Four main risks presented in an Excel file with the level of potential risk and mitigation action.
Overview of budget of the main cost of the project.	Excel spreadsheet.
Reserving animals.	Discussion with the facility manager and operational manager regarding sourcing surplus mice from own colonies.
Ordering necessary equipment.	Contact with supplier regarding cage hopper dividers.
Creating a Standard Operating Procedure for diet measurements with attached weighing sheets.	Detailed step by step instructions in a word document.
Creating staff rota.	Complete staff rota in Excel for the 8 weeks project period, with extra cover.

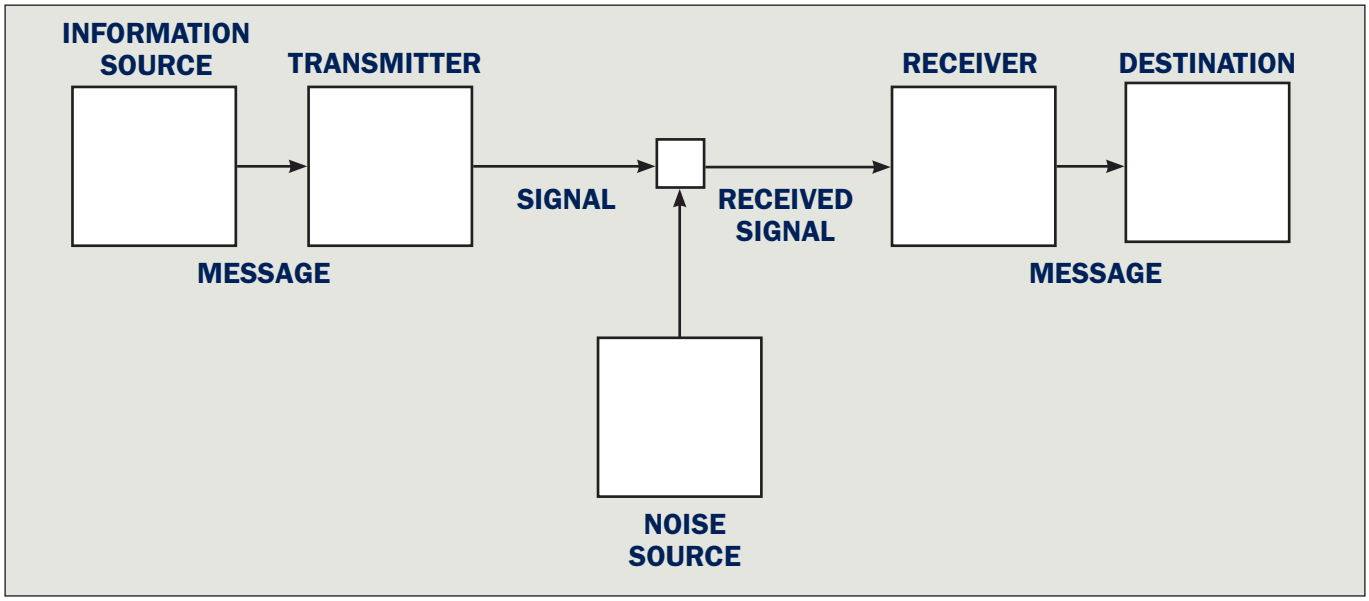


Figure 1. Schematic diagram of a general communications system.[9]

Applying the Shannon – Weaver communication model in preparation of stakeholder engagement, the following factors have to be considered (Figure 1).[9]

- **The information source** (sender) who has the information and has to choose a message, someone to send the message to and also the medium which is used for sending the message.
- **The transmitter** (encoder) who turns the information to signals which are in this case spoken or written words to communicate the message to someone.
- **The medium** (channel) of communication which carries the information from the sender and encoder through the receiver. It can be email, face to face, phone, etc.
- **The receiver** decodes the message from the signal.
- **Destination** where the message arrives.
- **Noise source** is any interference that occurs between sending and receiving the message. Internal noise means that the interruption happens during encoding (when the information has been sent incorrectly) or during decoding (where the information misunderstood by the receiver). Noise also can be external, where the interruption comes from an external source such as poor internet connection during online meeting.[10]
- **Feedback** is the last element of the Shannon and Weaver model which was added to the model in 1948 after Norbert Weiner had criticised the original linear approach which means the information only going in one way.[11]

  Feedback is an important part of communication as it occurs when the receiver is responding to the sender regarding the message.

To choose the right medium and minimise noise in the communication with stakeholders all of the elements in the Shannon and Weaver model were considered and used.

Communication plan

1. **Animal facility manager**
   As the animal facility manager had a high influence and high interest in the project, weekly face to face meetings were required at every stage of the project life cycle in order to keep this stakeholder satisfied.

2. **Finance department**
   The finance department were also identified as a high influence/high interest stakeholder with the needs of regular and detailed communication. The interaction started with an initial face to face meeting which was followed by email updates on progress.

3. **Supplier**
   The supplier of IVC food hopper dividers had a low influence/high interest in the project which meant communication was important however we only needed to keep them informed in a moderate way. After providing the dividers they will not have any influence on the project itself, however their interest in the outcome is high. Communication was essential at the start and the end of the project which was carried out by e-mails.

4. **Animal Technicians**
   The Animal Technicians who are going to spend a certain amount of time with the daily health checks of the animals were classified as 'Back-Yarders'. They have low influence on the project itself however they had high interest in Animal Welfare and therefore, in the success of the study. Communication through the initial team meeting where the project objectives were discussed, followed by monthly face to face meetings on progress.

Risk register

Risk ID	Date Identified	Risk	The risk is caused by	Effects of Risk
1	15/12/2020	Invalid data due to variables.	The factors changing in the project called variables and that could have an effect on the outcome. Invalid data collection can be the result of not recognising or not controlling possible variables in the project; such as: number, age, sex, strain, species of animals that are not set and uniformed. Using different equipment or method for measuring food intake. Different housing conditions within the same project.	Failure of project.
2	25/12/2020	Lack of communication with stakeholders.	This can be caused by a poorly planned project where the style and frequency of communication with stakeholders is not specified in the planning document.	Loss of interest. Loss of support.
3	15/12/2020	Error in data collection/in record keeping.	These errors can caused by: Not specific / clear instructions such as: units used for measurements, the way of recording data. Lack of training.	Invalid result. Failure of project.
4	01/12/2020	Staff issue.	Staffing issues can occur when the project team has not been scoped properly. Not enough staff. No staff cover in the case of sick days or holidays.	Delay. Project is not delivered within the agreed timescale.

Gantt chart

A Gantt chart is a horizontal representation of a project schedule which was developed by Henry L. Gantt originally for recording the progress of workers towards task standards. In 1917 he realised he should be scheduling based on time instead of quantities, so he created a bar chart that could represent how the work was scheduled, over time, from start to completion[12]. Gantt charts are frequently used in project management as it can be adopted to many control systems where the number of tasks can be associated to the time factor.[13]

Task	Start date	End date	November	December	January	February	March	April
Reserving animals	01/11/2020	01/11/2020						
Identify stakeholders	15/11/2020	20/11/2020						
Producing scoping document	01/01/2021	11/01/2021						
Producing budget overview	20/12/2020	25/12/2020						
Creating Risk register	26/12/2020	30/12/2020						
Creating planning document	10/01/2021	20/01/2021						
Setting up x 16 cages	28/12/2020	28/12/2020						
Setting up x 4 cages	11/01/2021	11/01/2021						
Data collection	28/12/2020	08/03/2021						
Engagement with Stakeholders	20/11/2020	25/03/2021						
Project implementation and evaluation	27/01/2021	15/04/2021						

Chart 1. Gantt chart of project activity

Mitigating Action In Place	Impact Level	Start Date	End Date	Results of mitigation action	Final Impact Level
Project is scoped correctly with sufficient time spent on information gathering. Fix variations that can be controlled, are recognised and dealt with.	High	01/01/2021	11/01/2021	Variables are minimised by using animals with same age, sex, strain, numbers, environmental enrichment. The project scoped correctly.	Medium
Detailed communication plan created in the planning stage of the project life cycle and strictly followed.	Medium	20/11/2020	25/03/2021	Stakeholder engagement document is followed throughout the project. All stakeholders are satisfied on their own interest level.	Low
Initial training, weighing sheet and support is provided to all the people who are involved.	High	25/12/2020	08/03/2021	All involved staff familiar with the aims, methods of the project. Staff are trained and competent in data collection.	Medium
Creating staff rota with extra cover.	Low	15/12/2020	08/03/2021	Continuity of the project is ensured with a staff rota, with two extra back up contact.	Low

Budget

Mouse food hopper divider project						
Cost on monthly bases from Scoping to Evaluation						
RESOURCES			£	£	£	
LOGISTICS	**CONSUMABLES**	**Quantities**	**Month 1**	**Month 2**		
	Diet – Irradiated Rodent Diet	2 bags x 12.5kg	25	25	50	
	Water included into weekly room supply based on 800 bottles	20 cages x 30p	24	24	48	
	Sizzle Nest – 25g/cage/week, 4kg/20cages/8weeks	1 bag x 10kg	34	0	34	
	Environmental enrichment – fun tunnel – 20 tunnels/2 weeks	1 box x 400	87	0	87	
	Sawdust – Eco-Pure lab animal bedding Aspen Chips 6 (Datesand) – 100gr/cage/2weeks, 2kg/20 cages/2weeks = 8kg	1 bag x 10kg	8	0	8	
					Total	227
			£	£	£	
PHYSICAL	**EQUIPMENT**	**Quantities**	**Month 1**	**Month 2**		
	Removable food hopper divider x 10	1 box x 1000	2,850	0	2,850	
	Weighing scale	1 x 100	100	0	100	
	SPACE					
	Estimated cost / room / month regardless of number of animals					
	Electricity		166	166	332	
	Gas/heating		56	56	112	
	Building maintainance		142	142	284	
	Waste disposal		5	5	10	
					Total	3,688
			£	£	£	
HUMAN	**TIME SPENT ON PROJECT**	**Quantities**	**Month 1**	**Month 2**		
	My own time spent on project: 2hours/20 cages/week	16 hours	240	240	480	
	Colleagues time spent on the project: 6.5 hours / 8 weeks	6.5 hours	63	63	126	
	Time spent on preparing consumables: 8 hours / 8 weeks	8 hours	77.4	77.4	155	
	Time spent with stakeholder engagement - meetings/emails/ reporting results	10 hours	96.75	96.75	194	
					Total	955
					Total	4,870
BUDGET	£6000 which covers the required resources with + £1,300 for unexpected expenses plus consumable delivery fees					

Ethics committee approval

Due to the fact that all the 80 mice had been sourced from surplus stock animals and used for a non-invasive project, ethics committee approval has not been required.

Delivery methodology

Task	The way in which the task will be done	The way in which the task has been done	Milestones / Contingency
Scoping / Planning	**Implementation plan**	**Implementation**	**Timing / Problems**
Outline the goals of the project.	List project objectives that are designed to be SMART.	Within the scoping document project background and main objectives have been detailed which are SMART.	In accordance with Gantt chart, the task has been delivered in time with no problem.
Identify stakeholders with their interest and influence.	Stakeholder map.	Stakeholders have been identified with their likely level of influence and interest in the project. The result is demonstrated on a stakeholder map.	The task has been delivered in time. During the implementation process the high interest / high influence finance department has been extended by the operational manager who became the main stakeholder contact, regarding budgeting the project.
Complete a risk register.	Four main risks presented in an Excel file with the level of potential risk and mitigation action.	Risk register has been completed in Excel format and attached to the scoping document. Main risks and their mitigation activities are listed to demonstrate how the project risks can be effectively reduced and managed.	Task completed in time with no issues.
Overview of budget of the main cost of the project.	Excel spreadsheet.	Overview of main costs have been listed in an Excel format.	Delivered in time. Following a face to face meeting with the new stakeholder within the finance department it has been realised that expenditures were less than that budgeted for the food hopper dividers.
Reserving animals.	Discussion with the facility manager and operational manager regarding sourcing surplus mice from own colonies.	Animals have been reserved in two steps due to the fact that the required age range had not been available in one batch.	The task has been completed as planned in the Gantt chart with no issues. Stakeholder engagement was positive and productive.
Ordering necessary equipment.	Contact with supplier regarding food hopper dividers.	Necessary equipment has been ordered.	No delay in the preparation or receiving orders. Food hopper dividers have been provided by BMS from a previous study. For this reason, the supplier of dividers as a low influence / high interest stakeholder now excluded from the project.
Creating a Standard Operating Procedure for diet measurements with attached weighing sheets.	Detailed step by step instructions in a word document.	SOP and weighing sheets are written up to support correct data collection.	After starting data collection, changes were made to the final form of weighing sheets. This meant a week's delay in completion.
Creating staff rota.	Complete an Excel staff rota for the 8 weeks project period, with extra cover.	Rota has been created to cover the 8 weeks project.	Delivered in time however, rota had to be extended with an extra 2 weeks, to cover measurements for the second batch of animals.

Project results

The project involved x80 male mice in total (x40 C57BL/6, x40 B6SJLCD45.1) aged between 8 and 16 weeks, sourced from the BMS in-house breeding stock. The mice, at weaning, were grouped into fours and housed in x20 GM500 Sealsafe Plus Green Line IVC cages (Tecniplast). Environmental conditions and enrichment were standardised across the x20 cages to minimise controllable variables. Room temperature was maintained between 20˚C and 24˚C, relative humidity between 45% and 65% with a 12-hour light-dark cycle. For housing, 1cm deep Datesand Eco-Pure Aspen Chips 6 Premium bedding (product code: Eco 4) and Sizzle Nest nesting material (Datesand) (product code: CS1A09) was used. The environmental enrichment was provided with 1x disposable Datesand mouse play tunnel (product code: CS3B01) per cage. Reverse Osmosis was used as the water purification process with the use of 2916 Teklad global 16% protein irradiated diet. The study was carried out on a comparison basis, where the amount of diet and its turnover rate was measured with the use of two different sized food hoppers, within two different mouse strains for further data collection.

To evaluate the project, the three, previously scoped, project goals are going to be re-assessed alongside with the project outcomes.

Project goals:

1. Promoting Animal Welfare through quicker diet turnover.
2. Cut back on costs of consumables and only spend the necessary amount on diet.
3. Cut back on diet waste and lessen the impact on waste disposal / landfills.

Project outcomes:

1. During the study various data were collected. However the focus was on the weekly diet turnover and residue left in the different sized hoppers. As Table 1 and 2, show below, there is a great difference between hopper sizes when it comes to diet excess. The actual food intake and the collected data demonstrates that the mice were supplied with the required amount of diet for each week in both groups, however with the use of full hoppers a large amount of dietary excess was also registered. After considering the number of mice per cage and their food intake, the excess diet level was calculated on a daily basis and expressed as 'extra day supply'. With the use of full hoppers we had an average 15 day supply above the weekly needs of the mice, which led to slow diet turnover, hardened food pellets, reduced quality and palatability.

2. The second goal of the project was to cut back on the costs of consumables. After collecting data through the 8 weeks period, Table 3 below demonstrates the differences between the groups.

   The results in Table 3 show that, there is no significant difference between the groups when it comes to cutting the costs of consumables. This is due to the fact that, regardless of hopper sizes, the weekly food intake and the amount of diet added to the cages was persistent throughout the study. The 1.9 kg diet difference comes from the initial cage set up, where the different sized food hoppers were filled up to their own maximum capacity.

3. The third goal of the project was to cut back on diet waste and lessen the impact on waste disposal /

Mouse strain: C57BL/6

Group 1. Full hopper – 20 mice in 5 cages					Group 2. Half hopper - 20 mice in 5 cages			
Topped up full hopper			Full hopper residue after 7 days		Topped up half hopper		Half hopper residue after 7 days	
								
Week	Average diet residue / group 1 (g)	Average diet residue / cage (g)	Average diet residue / mouse (g)	**Extra day supply**	Average diet residue / group 2 (g)	Average diet residue / cage (g)	Average diet residue / mouse (g)	**Extra day supply**
1.	1614	322	80	**16**	730	146	36	**7**
2.	1499	299	74	**14**	572	114	28	**5**
3.	1347	269	67	**13**	482	96	24	**4**
4.	1581	316	79	**15**	525	105	26	**5**
5.	1572	314	79	**15**	569	113	28	**5**
6.	1556	311	77	**15**	699	139	34	**6**
7.	1491	298	74	**14**	630	126	31	**6**
8.	1360	272	68	**13**	542	108	27	**5**

Table 1. Comparing average diet residue within C57BL/6 group.

Mouse strain: B6SJLCD45.1

Group 1. Full hopper – 20 mice in 5 cages					Group 2. Half hopper – 20 mice in 5 cages			
Topped up full hopper		Full hopper residue after 7 days			Topped up half hopper		Half hopper residue after 7 days	
								
Week	Average diet residue / group 1 (g)	Average diet residue / cage (g)	Average diet residue / mouse (g)	**Extra day supply**	Average diet residue / group 2 (g)	Average diet residue / cage (g)	Average diet residue / mouse (g)	**Extra day supply**
1.	1745	349	87	**17**	752	150	37	**7**
2.	1612	322	80	**16**	560	112	28	**5**
3.	1354	270	67	**13**	362	72	18	**3**
4.	1483	296	74	**14**	564	112	28	**5**
5.	1387	277	69	**13**	514	102	25	**5**
6.	1504	300	75	**15**	684	136	34	**6**
7.	1457	291	72	**14**	618	123	30	**6**
8.	1324	265	66	**13**	516	103	25	**5**

Table 2. Comparing average diet residue within B6SJLCD45.

Used diet \ 8 weeks (g)	
C57BL/6	
Full hopper	Half hopper
6349	5441
B6SJLCD45.1	
Full hopper	Half hopper
6431	5412
Total: 12780g = 12.7kg	**Total: 10853g = 10.8kg**

Table 3. Comparing the amount of diet used in the two different sized hoppers.

Week	**Discarded diet (g)**			
	Mouse strain: C57BL/6		**Mouse strain: B6SJLCD45.1**	
	Full hopper	**Half hopper**	**Full hopper**	**Half hopper**
1.	1614	730	1745	752
2.	1499	572	1612	560
3.	1347	482	1354	362
4.	1581	525	1483	564
5.	1572	569	1387	514
6.	1556	699	1504	684
7.	1491	630	1457	618
8.	1360	542	1324	516
Total	**12.0kg**	**4.7kg**	**11.8kg**	**4.5kg**

Table 4. Comparing the amount of diet disposed from the two different sized hoppers.

landfills. The relevant data has been evaluated in Table 4. The calculation has been based on the amount of diet left in the hoppers at the end of each week, assuming that the animals were to be culled and the diet discarded. As a result, we would have discarded 23.8 kg diet from the full hoppers and 9.2 kg diet from the half hoppers with a total difference of 14.6 kg. Significant differences between the two strains were not detected in any of the results.

Stakeholder engagement

Animal facility manager – High influence, high interest – key players, keep satisfied.

There was an initial face to face meeting with the facility manager, where the project idea was outlined and proposed to him. As the project involved animals, required space, equipment and time which was a deviation from the usual day to day routine, they played a vital part in the approval of this study. After highlighting the SMART project objectives and possible benefits the meeting was successful and their full support was given.

Communication was planned on a weekly face to face meeting which was more like short updates on the progress of the project. These interactions were important to raise and discuss possible issues and changes during the implementation period. As a result of the COVID-19 pandemic, reduced staff and new safety measurements changed the communication strategy to phone or email conversation when necessary.

Finance department – High influence, high interest – key players, manage closely.

During the implementation process the finance department was extended with the addition of the operational manager, as a new high influence/high interest stakeholder who played a vital role in the funding and adding her expertise to the project. Communication started as an initial face to face meeting discussing the overview budget of the main costs. This communication was moved over to email or phone discussion to comply with social distancing.

Supplier (NKP Isotec-hopper divider) – Low influence, high interest – keep informed.

The supplier, as an external low influence stakeholder, has been included into the scoping document, however the planned email communication regarding ordering the dividers has been excluded at the implementation stage. The reason for the stakeholder exclusion is that, this project had been carried out previously in a different format so the required IVC hopper dividers were still available within the BMS.

Animal Technician – Low influence, high interest – back-yarders – keep them informed.

Animal Technicians who are responsible for the day-to-day care of the mice involved in the study, required an initial team meeting to introduce the main aspect and goals of the project. During the 8 weeks period face-to-face meetings were planned on a weekly basis however this engagement was not necessary due to the close working regime we maintained during the project. Technicians were responsible for the daily health and diet level monitoring and I was carrying out the weekly cleaning and feeding tasks with data collection. This gave us the opportunity to engage and talk about the progress or any concerns. It is important to recognise that, initially Animal Technicians were identified as a low influence stakeholder, however due to their daily involvement in health monitoring and reporting, their role became very beneficial to the project.

Secondary leader – high influence, low interest – potential change agents.

The secondary leader, who had no interest but high influence on the project, was a senior Animal Technologist with the responsibility of being familiar with the project and covering the weekly food intake measurements in case of my absence. Initial engagement included a face-to-face project proposal with the explanation of project objectives and a discussion on his role as a stakeholder. Frequent communication has been scheduled in on the weekly basis via phone, ensuring the continuity of the project in my absence. The data collected by the secondary leader was sent to me via email and discussed over the phone.

Updated risk register after mitigation action

Risk ID	Date Identified	Risk	The risk is caused by	Effects of Risk
1	15/12/2020	Invalid data due to variables.	Those factors changing in the project called variables and that could have an effect on the outcome. Invalid data collection can be the result of not recognising or not controlling possible variables in the project; such as: number, age, sex, strain, species of animals that are not set and uniformed. Using different equipment or method for measuring food intake. Different housing conditions within the same project.	Failure of project.
2	25/12/2020	Lack of communication with stakeholders.	This can be caused by a poorly planned project where the style and frequency of communication with stakeholders are not specified in the planning document.	Loss of interest. Loss of support.
3	15/12/2020	Error in data collection/in record keeping.	These errors can caused by: Not specific/clear instructions such as: units used for measurements, the way of recording data. Lack of training.	Invalid result, failure of project.
4	01/12/2020	Staff issue.	Staffing issues can occur when the project team has not been scoped properly. Not enough staff. No staff cover in the case of sick days or holidays.	Delay. Project is not delivered within the agreed timescale.

Mitigating Action In Place	Impact Level	Start Date	End Date	Results of mitigation action	Final Impact Level
Project is scoped correctly with sufficient time spent on information gathering. Fix variations that can be controlled are recognised and dealt with.	High	01/01/2021	11/01/2021	Variables are minimised by using animals with same age, sex, strain, numbers, environmental enrichment. The project scoped correctly.	Low
Detailed communication plan created in the planning stage of the project life cycle and strictly followed.	Medium	20/11/2020	25/03/2021	Stakeholder engagement document is followed throughout the project. All stakeholders are satisfied on their own interest level.	Low
Initial training, weighing sheet and support is provided to all the people who are involved.	High	25/12/2020	08/03/2021	All involved staff familiar with the aims, methods of the project. Staff are trained and competent in data collection.	Medium
Creating staff rota with extra cover.	Low	15/12/2020	08/03/2021	Continuity of the project is ensured with a staff rota, with two extra back up contact.	Low

After the planned mitigation actions were carried out, the level of potential risks changed in the following way:

Risk 1. Invalid data collection due to variables.
The risk level originally had been identified as high, as the project involved many different variables. These variables had to be identified and controlled to minimise the risk. The previously set mitigation action was carried out without any difficulties and the level of risk reduced to low.

Risk 2. Lack of communication with stakeholders.
Original risk level was classified as medium as there was a possibility, after the initial communication happened, to only focus on the project delivery itself and not keep up with regular stakeholder engagement. As a mitigation action, a stakeholder engagement document was followed, however the communication channels had to be altered due to the need of social distancing. The project did not lose the interest or support of any stakeholders so the level of risk reduced to low.

Risk 3. Error in data collection / record keeping.
Risk 3 initially had a high-risk level which was predicted to be reduced to medium with staff training as the mitigation action. As the involved participants frequently had to be changed, this risk maintained its medium risk level throughout the project.

Risk 4. Staff issue.
In the risk register, staffing issue was only identified as a low-level risk in regards to sickness and holidays. Mitigation action was carried out with a staff rota without any problem; therefore the low risk level was maintained.

Due to unforeseen circumstances the project did face some staffing issues that had not been registered. This was related to new participants and detailed in the evaluation document under the 'challenges' headline.

Budget management

Budgetary management is a key part of any project for the purpose of tracking expenditures and incomes. In this project an overview budget was identified and included in the scoping document which gave us a general summary of the expected costs. This overview was developed further in the project planning document to demonstrate costs on a monthly basis from the stage of scoping to evaluation. During this process the following three main budgetary subsections were identified:

- consumables
- equipment /space
- human resources

All these subsections were monitored closely to ensure that the estimated budget and actual costs were still in balance. As the project was a short-term pilot study with relatively small expenditures, full funding was available and provided internally which put us in a fortunate situation. During implementation we did not face any unforeseen situation which would have caused additional cost or required any mitigation. £2850 was budgeted for the removable food hopper dividers and was saved due to the fact that previously

purchased dividers involved in a similar study were still available within the BMS. We also managed to promote value engineering with borrowing the initially budgeted weighing scale for food intake measurements. This also meant an extra £100 was not spent.

My own time spent on the project was underestimated, as a large amount was taken up on initial research and writing up the project results. However, this did not influence the human resources budget, as the 6hrs per month allocated study time provided by BMS had not initially been accounted for. The project was completed within budget which I believe was the result of thorough budgeting in the early stages of scoping and planning.

Project Evaluation

Methodology analysis

As evaluation is the last stage of the project life cycle it has an important role in determining the effectiveness of the project. For a successful evaluation, all steps outlined in the implementation methodology had to be revisited and analysed. Through this analysis vital information is gained about the final project such as; Was it a success or failure? What went well and what went not so well? What was missing and what needs to be changed next time or is it worth repeating at all?

Successful outcomes

In regards to successes, this project has three main positive outcomes:

1. The project was delivered on time, which was the result of a thorough scoping and planning document with an achievable Gantt chart. Clear goals were kept to the minimum on a realistic time and budget scale. Animal reservation, stakeholder identification and communication started at a very early stage which was necessary for early mitigation actions. Also the budget was set early to avoid the need of replanning.

2. Positive stakeholder engagement. I was fortunate enough to find stakeholders who were able to relate to the subject and so maintained their interest in the project. Their positive contribution and cooperation helped the project's smooth progress.

3. The final result also delivered two of the desired project outcomes, which was promoting Animal Welfare through a refined feeding regime and also minimising diet waste. Due to the low number of cages involved, the project did not generate the expected result regarding cutting the cost of consumables. However, as this null result contributed to the study and redirected the focus to the unnecessary excess of diet and waste, it can be evaluated as a positive project outcome.

Challenges

During the implementation process, some challenges also occurred. The previously planned stakeholder communication and their frequencies had to be modified due to COVID-19 restrictions. Some stakeholders were not available to attend, even for a socially distanced meeting. For this reason, these interactions were carried out via email or phone conversations. The pandemic also had an impact on the number of staff available and their daily routine, which meant the previously appointed people involved in the study had to be changed for a certain period. This required more communication with the new participants to provide the necessary information.

Conclusions

Overall the methodology analysis showed that most of the implementation has been delivered with a positive outcome. However some of the challenges could have been avoided with a more detailed implementation plan and risk register. One of the main threats which had not been considered at the scoping stage was the sourcing of extra mice for the case of health concerns. The project did not face any health issues, however any reduction within the experimental group without suitable replacement, would have caused a major impact on the study outcome. Day-to-day staffing issues which increased the need for more engagement with technicians and the secondary leader also should receive more attention as a risk factor.

Stakeholder feedback

Gaining feedback from stakeholders is an important part of stakeholder management as it has an effect on the project progress and outcome. Questionnaires are great tools to determine stakeholder satisfaction through different types of questions. The following questionnaires were created for key, high interest and influence stakeholders with the use of a rating scale (Figure 2) and open-ended questions (Figure 3) for maximum feedback.

Stakeholder feedback questionnaire:

Animal facility manager – High influence, high interest

	How do you rate the following questions?				
Questions	Very poor	Poor	OK	Good	Very good
How would you rate the handling of your views/ suggestions on the project?					
How would you rate the management of the project?					
How would you rate the engagement/communication during the project?					
How would you rate the project outcome and its impact on Animal Welfare?					

Figure 2. Rating scale stakeholder feedback questionnaire – animal facility manager.

Finance department – High influence, high interest

Questions	Comments / answers
How clear were the main objectives of this project?	
If you had any queries, were they dealt with sufficiently?	
How satisfied were you with the communication throughout the project?	
How satisfied are you with the outcome of this project?	

Figure 3. Open-ended stakeholder feedback questionnaire – finance department.

Budget analysis in excel format

Mouse food hopper divider project						
Cost on monthly bases from Scoping to Evaluation						
RESOURCES			£	£	£	
LOGISTICS	**CONSUMABLES**	**Quantities**	**Month 1**	**Month 2**		
	Diet – Irradiated Rodent Diet	2 bags x 12.5kg	25	25	50	
	Water included into weekly room supply based on 800 bottles	20 cages x 30p	24	24	48	
	Sizzle Nest – 25g/cage/week, 4kg/20cages/8weeks	1 bag x 10kg	34	0	34	
	Environmental enrichment – fun tunnel – 20 tunnels/2 weeks	1 box x 400	87	0	87	
	Sawdust – Eco-Pure 6 (Datesand) – 100gr/cage/2weeks, 2kg/20 cages/2weeks = 8kg	1 bag x 10kg	8	0	8	
					Total	227
			£	£	£	
PHYSICAL	**EQUIPMENT**	**Quantities**	**Month 1**	**Month 2**		
	Removable food hopper divider x 10	1 box x 1000	2,850	0	2,850	-2,850
	Weighing scale	1 x 100	100	0	100	-100
	SPACE					
	Estimated cost / room / month regardless of number of animals					
	Electricity		166	166	332	
	Gas/heating		56	56	112	
	Building maintainance		142	142	284	
	Waste disposal		5	5	10	
					Total	738
			£	£	£	
HUMAN	**TIME SPENT ON PROJECT**	**Quantities**	**Month 1**	**Month 2**		
	My own time spent on project: 2hours/20 cages/week	16 hours	240	240	480	
	Colleagues time spent on the project: 6.5 hours / 8 weeks	6.5 hours	63	63	126	
	Time spent on preparing consumables: 8 hours / 8 weeks	8 hours	77.4	77.4	155	
	Time spent with stakeholder engagement - meetings/emails/ reporting results	10 hours	96.75	96.75	194	
					Total	785
					Total	1,920
BUDGET	£6000 which covers the required resources with + £1,300 for unexpected expenses					

Reflection

Regardless of their size, every project has lessons to learn, which are discovered in the evaluation stage. These lessons are fundamental in continuous improvement and learning as the gained experience can be processed and used as a benefit in the future.

As David A. Kolb (1984) described his theory,[14] learning is a four stage process (Figure 4), which applied perfectly to this project. The learning cycle starts with perceiving information through experience then this information must be processed. Reflection is the most important understanding stage in learning because only well processed and evaluated information can be used effectively in the future. On the following stages of the learning cycle, our actions will be based on new knowledge, that leads us to new experiences and the cycle self-generates. David A. Kolb's quoted summary is "learning is the process whereby knowledge is created through the transformation of experience".[15]

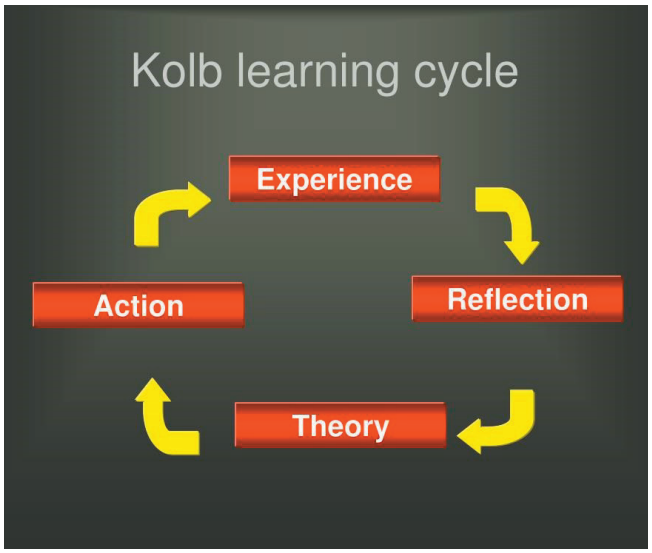


Figure 4. The four-stage learning cycle by David Kolb.[17]

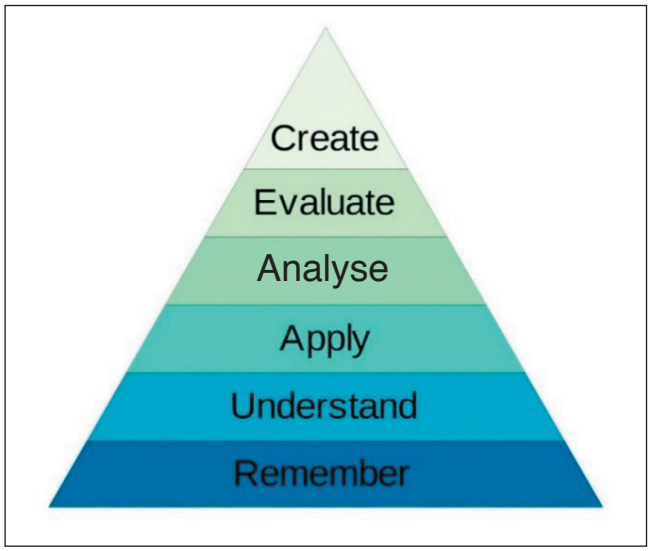


Figure 5. Bloom revised taxonomy pyramid.[18]

Of course Kolb is not the only one considering learning processes. Benjamin Bloom (1965) also had a theory called Taxonomy of Educational Objectives,[16] which can represent the importance of the evaluation stage within a project. Compared with Kolb's theory, it has six stages instead of four, which gives a more complex picture about learning (Figure 5). The main difference is shown in the top three stages which are analysis, evaluation and creation. These elements are used in higher education when the information is not only processed and applied but is also analysed and critiqued before creating something new.

Lessons learned from scoping and planning stage:
The main lessons learned during these stages were the importance of detailed scoping and planning documents. Spending a large amount of time on preparation gave me a stable project framework which was suitable for further development. These documents were completely missing from my previous experience on a similar study, which lead to a straightforward failure. As we have had some challenges during the project, I believe a more detailed risk register should have been created with suitable mitigation actions. As the project was based on two main elements; animals and staff, I realise I could have spent more time to consider risks around staffing issues and potential animal health concerns. The identification of, and setting communication strategies with stakeholders, also played a big part in the project. Bringing an extra stakeholder on board within the finance department did not cause any setback in the project delivery. However with earlier identification, her valuable contribution could have given me a more accurate budget from the beginning.

Lessons learned from implementation and evaluation stage:
Creating suitable weighing sheets and a rota took a bit longer than anticipated but did not have a negative effect on the final delivery. However it meant a slight deviation from the Gantt chart. I also realised that I had to spend more time on the project itself and include more communication with new participants. To mitigate this issue in the future I would allocate more tasks to the secondary leader, to give myself more time for stakeholder engagement. Also, an extra stakeholder would be involved, such as a statistician for data analysis and blinding purposes.

Referring to Kolb and Bloom;[14-16] the information gained through this project experience was processed and analysed which means future projects can be based on knowledgeable actions for improved outcomes. After evaluation of the project, I believe it could be an effective refinement opportunity and could be utilised as a foundation for further Animal Welfare improvements. Extending this study with the use of breeding cages,

different hopper sizes, age range or mice with different genetic backgrounds could be beneficial not only in BMS but also in the wider professional community.

Acknowledgement

The staff and management of the the BMS, University of Oxford for their assistance and co-operation with the project.

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Table References

Table 1. Comparing average diet residue within C57BL/6 group.

Table 2. Comparing average diet residue within B6SJLCD45.

Table 3. Comparing the amount of diet used in the two different sized hoppers.

Table 4. Comparing the amount of diet disposed from the two different sized hoppers.