Toward a More Sustainable and Environmentally-Friendly Design Future: Applying Remote User Feedback Methods to Business Case and Commercial Product Development

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Abstract

Design approaches have often been accused of failing to engage with users within the design process, with user engagement seen as a high-cost activity in terms of time, logistics, and financial investment. This has the potential to compromise commercial opportunity and to adversely affect products user experience. Here, a participatory design approach is applied, remotely, to an existing software product to identify the tangible benefits of adoption as reported by actual users. This acted as a valuable feed-back mechanism to help the developers understand how they could further improve their service offering and provided the opportunity to form a data-driven approach to business case development for those wishing to purchase the product. The highly transferable, sustainable, low cost, and high impact approach will enhance the user experience and commercial potential of products and services, while assisting those wishing to build stronger business cases for product manufacture and adoption. As such, it will be of interest to product manufacturers, designers, and researchers, alike.

Keywords: Socio-Technical System Design; Participatory Design; Product Design; Business Case Development; UX; User Participation; Sustainable Innovation, User Feedback

Abbreviations

UCD: User Centred Design; KPI: Key Performance Indicator

Introduction

Despite an increasing awareness of user-centred design (UCD), designers and user centred design practitioners in industry are typically constrained in terms of time and budget, which frequently prevent them from consulting with end-users while assessing the ease of use of the products they create [1]. Literature suggests that user input was often overlooked as a source of insight into the design process [2]. This may have been compounded by the perception of user involvement being an unnecessary and expensive luxury [3]. However, a lack of involvement in the design and evaluation stages of product development, and crucially post-release development, may cause issues that preclude users interacting with products and services intuitively and optimally.

Background to user centred design

User-Centred Design is a design philosophy that looks to overcome the issues above, placing the needs, wants, and desires of all users at the centre of an iterative design process, allowing their input to drive a product, system or service's development and seeking their contribution at every stage (Figure 1). To adequately inform the design and development process, it is important to capture information and feedback from all stakeholders involved.

Participatory design approaches attempt to better understand and involve real users, and are imperative and important in creating more appropriate, inclusive, and user-friendly products [5,6]. Crucially, this process should not cease when products are released but can and should be revisited regularly to ensure existing products remain relevant to the market. This places manufacturers and developers in an advantageous position; capable of refining their
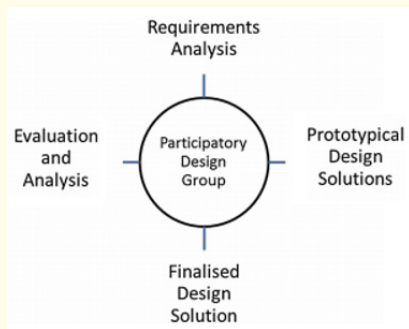
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Figure 1: Placing the participatory design group at the centre of the design process [4].

products and responding rapidly and effectively to new and emerging business needs. The following section will introduce the product domain and show how this approach was ultimately applied to business case development by understanding in greater depth the user experience of product adoption and use.

Facility management, booking systems, and business case development

As highlighted by Meder., *et al.* [7] core equipment and facilities are key to many areas of academic and industrial research, particularly in the life sciences, because they:

• Provide cost-effective access to state-of-the-art equipment and advanced skills.

• Permit the transfer and utilisation of technical knowledge and expertise.

• Connect institutions and foster collaborations and interdisciplinary research.

Universities and institutions use several different digital booking systems to monitor and manage the use of large items of equipment and facilities. The decision on which system to use is taken at a local level by individual laboratory managers within departments, and often by individual research groups within departments. This study focusses on a system that was released over 15 years ago which is one of the most popular and highly regarded booking systems with 21 instances across 13 internal departments of an institution. The challenge was to develop a business case for

a further instance in a 'super-department' across multiple sites whilst exploring the longer term roll-out of the technology. Therefore a more holistic and strategic approach was required.

The initial business case was written in early 2020 following discussions with key members of the institutions User Group that was created in 2018, and by liaising with the product's European sales manager. The business case included the following aspects:

• Introductory Preamble

• Direct Objectives

• System Introduction

• Benefits and Predicted Efficiency Gains

• Revenue Generation and Service Benefits

• Supporting Laboratory Social Distancing to facilitate access and use of Equipment

• Implementation and Costing

• Risk and Risk Mitigation.

Information is the understanding of data in context. Data begets information which in turn helps develop knowledge that aids informed decision making (Figure 2).
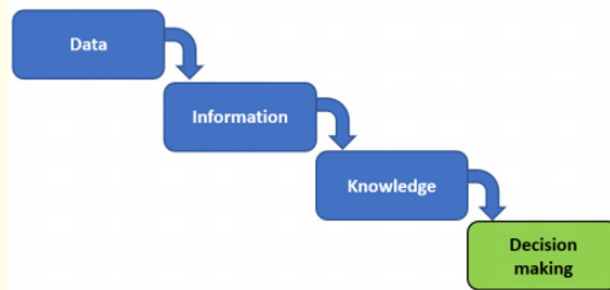

Figure 2: Waterfall model of data informing decision making [8].

Qualitative, narrative data is rich in content but can be unwieldy; "words are fatter than numbers and usually have multiple meanings. This makes them harder to move around with and work with... numbers are usually less ambiguous and can be processed more economically" [9]. Even though narrative data may be more difficult to work with, words are often more revealing than numbers when understanding the problem space and the individual

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perspectives, knowledge, and experiences of the assembled experts [10]. Combining a qualitative and quantitative data acquisition exercise in the first instance, captures the desired information and helps in the development of valuable knowledge for inclusion in subsequent business cases. The developers of the system are renowned for being very user-focused and responsive, however this was an aspect they were yet to explore, and it provided an opportunity for them to learn a significant amount about their product in the market and the actual experience of their users in the field.

Participatory design in context

Effective UCD requires the participation of a multidisciplinary team that captures the needs of end-users in the context of use [11,12]. Thus, participatory design is viewed as an approach to better understand the capabilities, experiences, needs, and desires of users in any given situation; factors that are imperative in creating more appropriate, usable, and useful end products [5]. It is an approach that can be applied in a myriad of contexts and scenarios as, fundamentally, it is a belief that all people have something to offer at every stage of the design process, and a conviction that they can be articulate, creative, and inspirational, in generating new ideas and developing current thinking [13]. This increases the relevance of the output and it is therefore fitting when trying to elicit knowledge in early design stages. It is equally relevant when revisiting and reevaluating existing products and services.

In this way, it is useful to revisit and look at the participatory design process holistically, to understand the stakeholder components within this participatory design group. In the model depicted, the user remains the central focus with all stakeholders being equally able to contribute to the discussion to aid the ultimate process of iterative design, development, implementation and evaluation (Figure 3). The model is based on Wilkinson and De Angeli's participatory design work [4] and reflects the fact that participatory and user centred design aims to develop technologies and solutions with the close involvement of all stakeholders and end-users throughout iterative cycles of requirements gathering, prototype development, implementation, and evaluation [14].

Involving stakeholders throughout the process can improve the applicability and acceptability of the finalised product or service solution, add value in terms of improved design output, and reduce
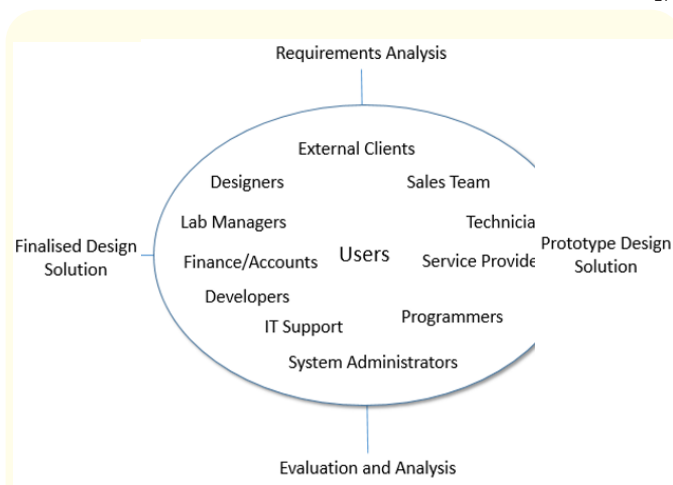

Figure 3: Participatory Design Stakeholder Map reflecting the scope and input of the wider design group involved in system development.

subsequent development costs [15]. This enhances the overall experience of service engagement and increases the uptake and adoption of the solutions developed [10]. As Mayer [16] highlights, creating an environment that is open to feedback and input from the widest possible group of contributors is critical to a successful outcome:

"The best ideas are born in collaboration with experts from different areas. Diversity helps you see completely different points of view about your project and see flaws or gaps you might have missed on your own. Feedback from multiple sources is also critical to professional growth and the successful execution of products".

There remains a need to recognise the resource constraints of conducting UCD within commercial spheres. Wilkinson, Walters, and Evans [16] describe the challenges faced when adopting UCD in commercial settings where manufacturers can be reluctant or unable to commit financial resource to a full UCD proposition, preferring to opt in and out of elements of a user-centred approach. These constraints are inherent in the manufacturing sector, and the approach detailed in this paper sympathetically focusses on a highly transferable, low-cost, high-impact, methodology by seeking input from existing users of the system to gain crucial understanding of the cost-savings, gains, and benefits of system adoption to be used in current and future business cases.

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Materials and Methods

In this study, alongside an early business case, testimonials and statements were collected from existing users of the system that might be considered domain experts, not unlike the lead-user approach described by Von Hippel [12] and Taffe [17]. The remaining objective was to capture and interrogate data relating to the tangible benefits realised through system adoption to enhance the business case.

Participatory design in context

A questionnaire was developed targeting both qualitative and quantitative aspects of system use and circulated to the existing user base of the booking system. It is important to highlight that this participatory design exercise was coordinated during the height of the first wave of the COVID19 pandemic in 2020. Whilst this may have been expected to obstruct and limit the research possible, the approach adopted was ideally suited to remote administration. The introductory prose and the targeted and open questions developed are presented in the appendix.

Appendix

The Questionnaire's introductory prose and the targeted and open questions developed are presented below.

We hope this email finds you and those closest to you safe & well. In our continuous effort to improve our service offering, we would like to ask you to take a moment to fill out this survey to provide insight into your experience with our system. We understand that your time is precious and we sincerely appreciate your participation. Your feedback is mission critical to help us better serve you and the community's emerging needs. Accordingly, we would like to ask you to please take a few minutes of your time to fill out the following survey.

The anonymised aggregate results of the survey will be made available to the whole community for all our shared benefits. As always, you can contact us with any questions, comments, or ideas. We thank you in advance for your attention.

On average, how much time do you feel staff save on administrative tasks using the system?

How much time do you save per month through automated billing?

Has the revenue of the instruments increased since adopting the system?

Do you believe that with using this system users are now more "aware" and therefore less inclined to overbook equipment or cancel bookings at the last minute?

Have you been able to use the data from the system for incidents and maintenance to discuss or negotiate your support contracts?

Did the productivity of the facility increase since installation, i.e. the ratio of usage versus the available time?

Has the satisfaction of your users increased with and since adopting the system?

Has the effectiveness of the facility staff increased thanks to the different workflows and processes the system offers?

Has it helped the facility staff to have the system's 'Projects and Services' feature available?

Do the reports generated by the system help you obtain funding or grant awards?

Have you integrated the system with your organisation's authentication system, and is this a benefit to you and the users?

Have you integrated the system with your organisation's financial system and is this a benefit to you?

Have you integrated the system with any other software?

We would welcome your input regarding integration with or implications for your University's Digital Transformation Strategy with particular focus upon efficiencies and cost recovery. A short statement identifying the relevant benefits and issues it would or does overcome would be welcome. If you can identify KPI's (Key Performance Indicators) and provide figures in terms of efficiencies generated, or real costs saved in your instance (that could be extrapolated from) that would be really helpful. e.g. If you were able to present data on how long things took, the number of processes involved, time taken, administrative costs etc., PRE and POST system adoption; such a direct comparison would be incredibly useful.

What Quality Insurance Certification do you have at the facility or the organisation?

Was the system used in the context of obtaining certification(s) and audits?

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What are the five best aspects of adopting the system as a Facility Management Solution?

What are the five most challenging aspects of adopting the system as a Core Facility Management Solution?

Research participants

The questionnaire was developed into a survey and circulated to each of the 740 existing users who are responsible for the local implementation and management of the system, typically employed by institutions in the capacity of laboratory and equipment managers. Collectively they represent over 200 institutional contracts across territories within Europe, the United States, Australia and Singapore.

Research procedure

The survey was circulated and held open for 3 months, at which point the survey closed with a total of 28 responses with two reminders being sent out during that time. The data captured was analysed by the product developer and the report assembled and disseminated to everyone involved.

Results

The key findings from the survey's targeted questions are presented in table 1 below.

The key responses from the survey's open questions are presented in table 2 below.

Targeted Question	Response
On average, how much time do you feel staff save on administrative tasks using the system?	• 47% see up to 30% in staff time saving • 32% see between 30-60% in staff time saving • 11% see more than 60% in staff time saving
How much time do you save per month through automated billing?	• 38% save between 1 and 2 days a month on administrative tasks with the automated billing • 14% save more than 3 days a month on administrative tasks with automated billing
Has the revenue of the instruments increased since adopting the system?	• 46% see an increase in the instrument's revenue • 7% see an increase between 30 to 50%
Do you believe that with using this system users are now more "aware" and therefore less inclined to overbook equipment or cancel bookings at the last minute?	• 46% are convinced that the system supports a proper use policy and reduces booking 'abuses' independently of implementing late penalty charges
Have you been able to use the data from the system for incidents and maintenance to discuss or negotiate your support contracts?	• 32% have already used the reports of downtime and maintenance to renegotiate their support contract • 43% would consider using these reports to negotiate
Did the productivity of the facility increase since installation, i.e. the ratio of usage versus the available time?	• 38% see in increase in the facility productivity • 15% see an increase of over 50% in facility productivity
Has the satisfaction of your users increased with and since adopting the system?	• 57% observe an improvement in user satisfaction through the use of the system
Has the effectiveness of the facility staff increased thanks to the different workflows and processes the system offers? Has it helped the facility staff to have the system's 'Projects and Services' feature available?	• 71% are convinced the effectiveness of the facility staff has improved with system adoption • 29% say it is directly attributable to the improvement of user management • 100% of participants believe this feature realises time savings, improves communication and transparency, helps define different workflows and life cycles, and also gives an impeccable audit and invoicing process

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Do the reports generated by the system help you obtain funding or grant awards?	• 25% of respondents have used the reports to obtain funding and found the system helped enormously producing the case
Have you integrated the system with your organisation's authentication system, and is this a benefit to you and the users?	• 71% have integrated the system with their organisation's authentication system to facilitate secure and easy login for the users
Have you integrated the system with your organisation's financial system and is this a benefit to you?	• 21% have already integrated the system with their organisation's financial system • 25% are working toward that integration
Have you integrated the system with any other software?	• 86% have not integrated the system with other software
What Quality Insurance Certification do you have at the facility or the organisation?	• 14% have ISO 9001 (2015) • 60% have none • 10% have no formal certification

Table 1: Key Findings from the Targeted Question Responses.

Open Question	Response
We would welcome your input regarding integration with or implications for your University's Digital Transformation Strategy with particular focus upon efficiencies and cost recovery. A short statement identifying the relevant benefits and issues it would or does overcome would be welcome.	• This system saves a lot of time (staff improve their efficiency) and prevents damage to the equipment (based on user documented user accountability and user rights). • We have found that the system fits with how, as an institute, we wish to permit openness and transparency with the users, group leaders and senior management • Benefits: accurate information on usage, additional income through tracking • The system makes calculating cost recovery easy • The system has increased the efficiency of our department massively in the context of the research environment, from User, Admin Staff, Operations, Finance, Customer Relations, Governance and other areas (eg COVID19 adjustments) • I am unsure if our university has a digital transformation strategy; the use of digital systems is currently very chaotic with every department and faculty doing their own thing • The need to use a booking system was clear from the beginning in order to enforce a level of booking hygiene and to partially cover maintenance costs. • Enhances strategic planning and forecasting • Standardized reporting makes it easier to benchmark core facility operations

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If you can identify KPI's (Key Performance Indicators) and provide figures in terms of efficiencies generated, or real costs saved in your instance (that could be extrapolated from) that would be really helpful. e.g. If you were able to present data on how long things took, the number of processes involved, time taken, administrative costs etc., PRE and POST system adoption; such a direct comparison would be incredibly useful.	- Invoice generation is a big benefit for us - We used to spend 2-3 days processing recharges, discounts and costs. Saving of administrative time has been a huge benefit to us. We've then been able to use admin staff time to assist in processing these charges - Exact usage statistics are good, and service & maintenance issues much easier to track - This system was instrumental in our facility achieving an institutional silver award for sustainability - The ordering, consolidation and recharging process took days. Now this can be done in hours. For auditing, this has saved hours in searching information and validating costs, and auditors accept the auto-generated reports provided - Difficult to compare as the usage of the facility grew during the time. Managing the instruments and bookings is only a small part of our job - The system has been particularly helpful for booking equipment and streamlining/ automating invoicing - Our KPI's are how much machine-time gets used, and how many papers come out of our facility. I find no difference between the time I used to spend doing an SQL query for our previous system, and the time I now spend converting the system output into whatever format management require.
Was the system used in the context of obtaining certification(s) and audits? Tell us how:	- Auditors always highlight this system as a strength - Allows us to complete our KPI's on equipment use, downtime monitoring, maintenance, training efficacy monitoring and project distributions - The system has, through no fault of its own, proved something of a hazard for financial audits because it is independent of the financial system, linked to it only via monthly uploads. This means that if we make an error, it's stored for posterity, and can't be tagged as an error, while it will be corrected by finance in their system, creating a discrepancy for auditors. - Not yet; there is a desire to use it for this going forward
What are the best aspects of adopting the system as a Facility Management Solution?	- Invoicing - billing automation, simplicity and transparency, quick and easy - Tracker - usage, and user management, statistics - Project management - Transparency and Audit of projects, Workflow management - Training Management - Organisation, Audit, User Rights management - Incident management - Statistics, reporting - usage, bookings, billing, maintenance, training - Flexibility - ease of deployment, SaaS, efficiency - Time saving - ease of use, unique portal, easy booking, off-site access to system - Documentation management - centralised, harmonised audited documentation - API integration - User management - centralised DB, full control of permissions, and audit trace - Managing multiple cores from one central system - uniformity, harmonisation, reporting - Scheduling management - booking, permissions, restrictions, audit

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What are the most challenging aspects of adopting the system as a Core Facility Management Solution?	• Change management - re-interpreting internal process, imposing change, centralising methodology, Culture change
	• Understanding all possible options and features of the system (underling complex features are underused or undiscovered)
	• Funding - Raising funds to pay for the system
	• Institutional support
	• Adjusting to how it enhances facility processes
	• Accepting it will not do all we want
	• Financial integration, internal process, integration in general
	• Complex Billing definition/authorisations/understanding
	• The need of a Champion for a successful Implementation (for multicore projects)
	• Registration of new Users (account user request) see an increase of over 50% in facility productivity

Table 2: Open Question Responses.

Discussion

The primary response to the pandemic often being to close or reduce access to laboratories may have been additionally responsible for the relatively low survey response rate. Whilst we cannot generalise from the data captured per-se, the survey with its open and targeted questions, allowed individual respondents to identify, evaluate and categorise the benefits of system use in terms that were meaningful to all stakeholders, and in so doing these became crucial pieces of data-cum-information, meaningful and relevant for inclusion in the local business case. Simultaneously, analysing the responses gave the developer an overwhelming understanding of pinch-points, conversational jump-in points, and informed opportunities to initiate dialogue regarding future development.

The targeted questions were posed to elicit information on the tangible benefits of system adoption for inclusion in the business case. The data indicates that administrative time savings have been realised with the introduction of the booking system with 47% of respondents seeing up to a 30% saving in staff time. The system's ability to automate certain processes, such as billing, resulted in 38% of respondents saving between 1 and 2 days a month. In terms of revenue, 46% see an increase, and booking abuses – where an item is booked but not used or used beyond an agreed period – are also reduced. The usage data (time the equipment spends in use, unused or inoperative) generated by the system has also been used to negotiate maintenance contracts with equipment suppliers, increasing the return on investment in the system and realising further cost savings to the organisation. Facility productivity has also increased with 38% seeing an increase in the facility productivity overall, and 15% seeing an increase of over 50%.

Improvements in user satisfaction have also been witnessed indicating that those using the system to book equipment also experience the benefits of its introduction. According to 71% of respondents, the effectiveness of the facility staff has improved, and a quarter have used the reports generated by the system to obtain further research funding, reflecting a further return on investment. Almost three-quarters of respondents have integrated the system with their organisation's authentication system to facilitate secure and easy login for users, 21% have integrated it with their institution's financial system and 25% are working toward doing so.

The open questions were posed to gain higher level, contextual, awareness of how the system fitted within and was received by the organisations. This scoping exercise included how the system was integrated into institutions' digital transformation strategies as this would be instrumental to the success of future business cases. The open questions also allowed the community to define the relevant Key Performance Indicators (KPI's), such as equipment use, downtime monitoring, maintenance, training efficacy monitoring

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and project distributions. Further efficiencies were highlighted with one participant reporting that the ordering, consolidation, and recharging process traditionally took days, and that following the introduction of the system, this was reduced to hours. Time spent validating costs and auditing was also reduced with the auditors satisfied to accept the auto-generated reports provided by the system, and this was viewed as being highly advantageous.

This approach to insight acquisition is also highly effective from a developer perspective. For example, more than 80% of respondents had not integrated the system with any other software. This provides a unique insight and opportunity to ask why? Is it complicated, is it desirable, is there a demand to do so, is it necessary, is there more the developer can do to facilitate integration?

The survey identified that 71% of respondents were convinced the effectiveness of the facility staff had improved with system adoption, with 29% reporting that this was directly attributable to the improvement of user management. 100% of participants believed the system's 'Projects and Services' feature realised time savings, improves communication and transparency, helps define different workflows and life cycles, and gives an impeccable audit and invoicing process. This, then, provides both a positive marketing opportunity and direct feature validation. The exercise also provides an opportunity to gain further contextual information, such as the level of quality assurance certification in place within institutions and research laboratories.

Asking users to reveal the best and worst aspects of engagement has a number of benefits. It clearly identifies where users are extremely happy and these can be used as promotional points in future marketing, it also identifies where design shortfalls exist, where further development investment is required and, crucially, would be welcomed.

"The system has, through no fault of its own, proved something of a hazard for financial audits because it is independent of the financial system, linked to it only via monthly uploads. This means that if we make an error, it's stored for posterity, and can't be tagged as an error, while it will be corrected by finance in their system, creating a discrepancy for auditors."

Whilst the example above may look like negative feedback, it highlights where increased dialogue would benefit both parties, as integrating the system with institutional finance systems is already in place particular institutions and is in development by others. Capturing this feedback highlights both a need and desire for the feature, and a need to engage the community collectively and raise greater awareness of the systems capabilities. Responding to these aspects will maintain and highlight a company's commitment to ongoing user engagement and their reputation for being user-focused and responsive.

Where does this fit within participatory design?

The framework below reflects how this exercise aligns with the participatory design process, and the results of its execution have clearly emphasised the importance of revisiting the user experience even after a product has been well established and universally accepted. Figure 4 shows how the initial development would have incorporated the participatory design approach (1) and highlights the procedural aspect of conducting user consultation post product establishment within the market (2) and how the data obtained can be analysed and fed into subsequent development.
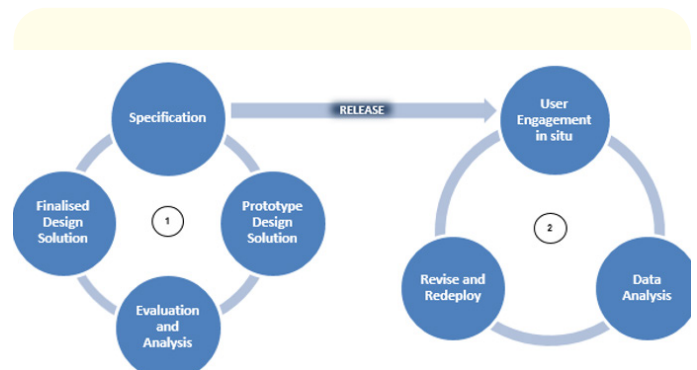

Figure 4: Triple R' Framework for participatory design pre- and post-product release.

For simplicity this is considered the 'Triple R' framework, referring to Release, Revise and Redeploy. Although designers and developers aim to ensure the products that are released meet all success criteria, it is clearly good practice to speak with users after the product is established and to be prepared to explore new ideas that may enhance the existing product or service. Following this frame-

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work and establishing a mechanism for doing so, enables manufacturers and developers to refine their products and respond rapidly and effectively to new and emerging business needs that may have been impossible to predict at initial release.

Although the study was primarily designed to capture information that would enhance business case development, the data gleaned possessed equal value for all parties on account of its emphasis upon better understanding users and their individual experiences, usage patterns, and existing knowledge. As well as providing unique and varied insights regarding business-as-usual operation and best practice, this approach helped to elicit knowledge of the unique, tangible, and organizational benefits adoption of the system presents in a language that resonates with fellow users and reviewers of the business case. In addition, it strategically identifies elements of the product that might profit from the supplier and developer revisiting.

Walters and Evans [18] recognised that there were historical challenges for the application of User-Centred Design approaches within commercial spheres that centred upon the commitment and investment of resources:

"...Research that relies on professional observation in the field for an extended period is likely to be costly, and ... the barrier to ... engagement with user research" (p.126).

This latter challenge was the driver behind the development of the commercially sensitive yet accessible approach presented. As a low-cost feedback strategy, it has clearly yielded high impact results and could be followed up easily with minimal inconvenience when further developments have been implemented. While some questions may have benefitted from being rephrased, particularly given the geographical reach and demographic involved, further iterations of the survey could easily address this.

Implications and Limitations of the Study

The exploration of capturing user experience post product establishment has been successful in identifying issues and for driving ideas forward for future product development, as well as harnessing 'hard data' for use in the business case for more widespread adoption. It is acknowledged that the sample size and response rate were limited, and that care must be taken when generalising from small samples. The number of COVID19 communications that were in circulation and the priority of the pandemic itself were key considerations of the survey administrators, who did not wish to overload respondents. However, this concern, in combination with reduced access to laboratories, may have had an adverse effect upon the response rate observed. Despite this, the approach identified a plethora of insights that possess the potential to directly impact future development work while increasing the developer's empathy with product users; enhancing trust and the truest sense of community. Engaging with and listening to users in this way allows us to learn what works and doesn't work for them, helps us understand the features that are useful, and the features that impede intuitive interaction [19]. Reinforcing the wider importance of this activity, Kos-Braun, Gerlach and Pitzer [20] highlight the impact on the output of research, stating that training, advising and communicating with users of core system facilities are all critical factors for achieving, improving and maintaining the quality of research output.

It is worth remembering that the pandemic forced many laboratories to close and to reduce admission to sites and occupancy of labs, particularly in the early stages of nationwide COVID19 response strategies. Thereafter, these booking systems and their inherent functionality became an even more effective tool to manage, control and maintain access to laboratory equipment and facilities, and formed an integral part of institution's recovery strategies.

Conclusion

There was an overarching desire to explore the physical and psychological impact of design on users whilst providing the design community with examples of simple techniques through which high impact design insight can be acquired cost-effectively and with the potential to improve interaction for all users. The aim of the study was twofold:

- To focus upon the use of a commercial equipment booking and monitoring system with the intention of eliciting data on the tangible benefits of system adoption that could be incorporated into a business case for the more widespread adoption of the system across institutions, and
- To simultaneously capture user feedback and insight into the strengths and weakness of the existing system in the marketplace.

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The initial business case developed included several testimonials and letters of support from existing users, detailing why they would be keen to see the extended use of the system and the benefits they had realised through its adoption. Due to the anecdotal nature of this content, there remained a need and opportunity to develop a more data-driven, objective, and informed business case. The questionnaire created targeted both qualitative and quantitative aspects of system use to capture 'hard data' in terms of efficiencies and timed saved through the automation of tasks, but also to understand in greater detail user's experiences of using the product. The survey was circulated to the user base of the system that collectively represented over 200 institutional contracts across territories within Europe, the United States, Australia and Singapore.

Collating and incorporating the data obtained, permits a much more focussed, specific, and data-driven approach to business case development, and enhances internal and external buy-in to the project. Not only does this provide a stronger business case, but the answers gained also provide a benchmark upon which to make comparisons when new instances of the booking system are introduced. These are in effect the success criteria against which future instances will be measured, monitored, and tracked. Whilst there remains a cost involved, such a low-cost, high impact, approach represents a handsome return on investment, and incorporating such a process to capture user feedback, provides an ideal opportunity for designers to understand and enhance their product following the mantra of "Release, Revise, and Redeploy".

While it was impossible to present the data captured fully due to commercial sensitivity, by highlighting the key findings, this article details a highly transferable approach that can be used across disciplines and products. It emphasises how some of the barriers that have traditionally impaired user involvement within the design process – particularly the need for participants to be present in the same location at the same time – can be reduced if not eliminated. Further, it shows how both the environmental and logistical impact of conducting user research can be reduced by implementing remote user testing. In combination, these factors effectively contribute toward a more sustainable and environmentally-friendly design future for all.

Conflict of Interest

No external funding was received and the author declares no conflict of interest.

Bibliography

1. Cardoso C and Clarkson PJ. "Simulation in user-centred design: helping designers to empathise with atypical users". *Journal of Engineering Design* 23.1 (2012): 1-22.

2. Hansen J., *et al.* "Attitudes to telecare among older people, professional care workers and informal carers: a preventative strategy or crisis management?" *Universal Access in the Information Society* 6.2 (2007): 193-205.

3. Grudin J. "Obstacles to User Involvement in Software Development, with Implications for CSCW". *International Journal of Man-Machine Studies* 34 (1991): 435-452.

4. Wilkinson C and De Angeli A. "Applying User Centred and Participatory Design Approaches to Commercial Product Development". *Journal of Design Studies* 35 (2014): 614-631.

5. Lindgaard G., *et al.* "User needs analysis and requirements engineering: Theory and practice". *Interacting with Computers* 18.1 (2006): 47-70.

6. Muller M. "Participatory Design: The Third space in HCI". In Jacko, J. and Sears, A (editions) The human computer interaction handbook: Fundamentals, evolving technologies and emerging applications. Lawrence Erlbaum, Mahwah, NJ, USA (2002).

7. Meder D., *et al.* "Institutional core facilities: Prerequisite for breakthroughs in the life sciences". *EMBO Reports* 17 (2016): 1088-1093.

8. Informed Decision Making, Provek © (2020).

9. Miles MB and Huberman AM. "Qualitative Data Analysis: An Expanded Sourcebook". UK: Sage publications (1994): 56.

10. Dorrington P., *et al.* "User-centered design method for the design of assistive switch devices to improve user experience, accessibility, and independence". *Journal of Usability Studies* 11.2 (2016): 66-82.

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11. Mao JY., *et al.* "The State of User-Centered Design Practice". *Communication of the ACM* 48.3 (2005): 105-109.

12. Von Hippel E. "Lead users: A source of novel product concepts". *Management Science* 32.7 (1986): 791-805.

13. Sanders E. "From User-Centred to Participatory Design Approaches". In Design and the Social Sciences: Making Connections (Contemporary Trends Institute); Frascara, J., Edition.; Taylor and Francis; London, United Kingdom (2002): 1-9.

14. Sharma V., *et al*. "Participatory design in the development of the wheelchair convoy system". *Journal of Neuro Engineering and Rehabilitation* 5 (2008): 1-10.

15. Wilkinson C., *et al.* "Creating and Testing a Model-Driven Framework for Accessible User-Centric Design". *The Design Journal* 19.1 (2016): 69-91.

16. Mayer R. "Build Better Products by Leveraging Feedback Effectively". *UX Booth* (2019).

17. Taffe S. "The hybrid designer/end-user: Revealing paradoxes in co-design". *Design Studies* 40 (2015): 39-59.

18. Walters A and Evans J. "Developing a Framework for Accessible User Centric Design". *Proc. of 18th International Product Development Management Conference Delft, Netherlands* (2011).

19. Wilkinson C. "Listen while the User Speaks: Harnessing User Insights to Improve Wheelchair Interaction and Design". 2016 Set for Britain Awards, House of Commons, March 7th, London, United Kingdom (2016).

20. Kos-Braun I., *et al.* "A survey of research quality in core facilities". *eLife* 9 (2020): e62212.