MAKERSPACES IN PUBLIC LIBRARIES IN SCOTLAND:

A STUDY OF PROGRESS AND BEST PRACTICE

CLAIRE RAE

This dissertation was submitted in part fulfilment of requirements for the degree of MSc Information and Library Studies

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Declaration

This dissertation is submitted in part fulfilment of the requirements for the degree of MSc of the University of Strathclyde.

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ABSTRACT

The purpose of this study is to determine the extent to which makerspaces and related technologies, such as 3D printers, have been implemented in public libraries across Scotland. It aims to explore the benefits that have resulted from the implementation of a makerspace and challenges encountered. Best practices currently being followed and the reasons that have influenced the decision not to implement a makerspace will also be examined.

A quantitative and qualitative web-based survey was conducted and distributed through email and Twitter to all 32 local authority library services in Scotland. Supplementary research was undertaken through consulting library service websites, social media sites and phone calls. Data analysis was conducted on the survey results, using excel to produce descriptive statistics and basic content analysis to analyse the free text.

Fifteen complete responses were received, giving a response rate of 47%. A total of eight makerspaces are currently provided, across five local authorities, six authorities have future plans and four authorities have no makerspace. In addition, 12 authorities advised that they offer 3D printing as an activity, while three do not. Through supplementary research, a further four makerspaces were identified, together with three authorities providing 3D printing. Unreliability of 3D printers was the main reason given for 3D printing not being offered as an activity, while physical space and staffing issues were the main reasons provided for not implementing a makerspace. The promotion of STEM/STEAM activities was cited as a benefit by all eight makerspaces in the survey, while the biggest challenge noted was staffing issues. Encouragingly, all eight makerspaces are following some form of practice in their makerspace.

No similar study is known to have been conducted in Scotland, with regards to makerspaces and related technologies in public libraries.

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1. Introduction

1.1 Introducing the Research Context

While not unique to libraries, 3D printers and makerspaces are becoming increasingly popular in public libraries throughout the world. Willingham and De Boer (2015, p.3) argue that since 2010, the development of "creative public spaces in libraries has been significant". The concept of makerspaces was influenced by the European expansion of hackerspaces in the 1990's and the publication in 2005 of the maker magazine titled 'Make:' (Burke, 2014; Willingham and De Boer, 2015). Taylor, Hurley and Connolly (2016) argue that makerspaces are "one of the most visible manifestations of an emergent maker culture." In the last decade, the UK has "witnessed an explosion of makerspaces, fablabs, hackerspaces and community workshops", with nearly 100 recorded as being in existence in 2015, across a variety of spaces (Sleigh, Stewart and Stokes, 2015, p.1).

Having gained momentum from academic libraries (Slatter and Howard, 2013; Taylor, Hurley and Connolly, 2016), such as the Center for Bits and Atoms Fab Lab at the Massachusetts Institute of Technology (MIT) (Burke and Kroski, 2018, p.12), this concept began to permeate school and public settings (Moorefield-Lang, 2015a), with makerspaces, according to Slatter and Howard (2013, p.272), becoming a "phenomenon in public libraries worldwide". Furthermore, responding to the revival of the "do-it-yourself culture" (Slatter and Howard, 2013, p.273) and influenced by changes in both technology and expectations by patrons (Kroski, 2015, p.ix), public libraries have sought "to further engage with their communities beyond their traditional core business of being repositories of, and providing access to, knowledge and information" (Boyle *et al*., 2016, p.31). Notable dates in makerspace growth include the opening of the first makerspace in a public library in 2010 at the Fayetteville Free Library in New York (Britton and Considine, 2012; Willingham and De Boer, 2015) and 2012, when Frysklab was launched as the first mobile library Fab Lab in Europe (De Boer, 2014).

Implementation levels vary, not only across the world, but within local areas. As a result of actively encouraging makerspaces in public libraries, a considerable amount of research has been conducted in the United States (Boyle *et al*., 2016; Slatter and Howard, 2013; Willett, 2018). Over the past decade, research on makerspaces has continued to increase, however, the majority of studies have tended to focus on a limited number of libraries, using case studies or interviews as the preferred data collection method. Current research is lacking a large-scale study solely of public library makerspaces across an entire country. Compared to the United States and despite their increasingly popularity in recent years, makerspaces are a relatively new concept in Scotland. Yet to be fully investigated, is the extent to which makerspaces have been implemented in public libraries in Scotland and the use of related technologies, such as 3D printers. To bridge this gap in knowledge, a survey of the 32 local authority library services in Scotland was undertaken.

1.2 The UK and Scottish Context

In the UK, makerspaces exist in various types of spaces, not just in libraries. However, they are encouraged and perceived as valuable within national library strategic frameworks. The Government strategy document, 'Libraries Deliver: Ambition for Public Libraries in England 2016 to 2021', outlined support for the "expansion of innovative initiatives such as makerspaces" (Libraries Taskforce, 2016, p.9) and an enthusiasm "to see more public libraries in England setting up makerspaces." (Libraries Taskforce, 2016, p.64) These spaces were an integral part of the 2017 Digital Strategy in the UK (Department for Digital, Culture, Media & Sport, 2017) The policy paper stated, "We will bring together people from across sectors to collaborate and support the expansion of makerspaces in public libraries in England."

Similarly, the current national strategy for public libraries in Scotland, including the 2019 refresh, 'Ambition and Opportunity: A strategy for Public Libraries in Scotland 2015 – 2020' (Scottish Library and Information Council (SLIC), 2015; 2019), promotes the use of and highlights a "growing interest in makerspaces" (SLIC, 2015, p.30). Evident is the value placed upon makerspaces in trying to fulfil strategic aims such as, promoting creativity and

digital inclusion (SLIC, 2015, p.30), with the Carnegie UK Trust (Wilson, 2016) advising that "Digital innovation is at the heart of Scotland's national strategy for public libraries."

In May 2014, Dundee Central Library became the first public library in the UK to introduce a 3D printer (Daly, n.d.). The following year, with funding obtained from the Scottish Government, the Scottish Library and Information Council (SLIC) introduced 3D printing to all Scottish library services. Having already been a feature in a limited number of libraries, this provided an "opportunity to expand and develop this growing area of interest and skills development to all Scottish library services" (Robertson, 2016, p.3). In addition, a staff member in each library service was nominated as a 3D printing champion, to help "implement, promote and support 3D printing, and its associated activities, within their library service." (Robertson, 2016, p.13). One day training sessions were held for the 3D printing champions, covering topics such as: 3D printing introductory basics, hardware, software and scanner tutorials (Robertson, 2016, p.14).

1.3 Research Questions, Objectives and Deliverables

As indicated above, research solely on public libraries on a large-scale, has to date, been limited. Makerspaces are valued within public libraries in the UK, however very little research has been undertaken particularly in Scotland, resulting in a lack of detailed knowledge on their use. In exploring the extent to which makerspaces and 3D printers have been implemented in public libraries across Scotland, this is the first known study to undertake this research.

With the introduction of 3D printing to all 32 Scottish library services in 2015 as a baseline, this dissertation addresses the following questions:

1.   How far have public libraries in Scotland progressed in their implementation of makerspaces since 2015?
2.   To what extent is 3D printing currently being utilised in public libraries in Scotland?
3.   What benefits and challenges have resulted from the implementation of a makerspace?

4.   What best practices are being followed in the running of a makerspace?

5.   What reasons have influenced the decision not to implement a makerspace?

With a gap in knowledge evident, in terms of public library makerspace implementation in Scotland, the main aim of this dissertation was to determine the extent to which makerspaces and related technologies are currently being used in public libraries. In addition, the benefits and challenges which have shaped this progression are explored and best practices currently being followed are identified.

Deliverables from this dissertation include the following:

1.   A colour-coded map of Scotland, showing makerspace provision, by local authority.

2.   A map of Scotland, plotting the public library makerspaces, by type.

3.   A colour-coded map of Scotland, showing 3D printer usage, by local authority.

4.   A national makerspace baseline which can inform further research in Scotland or in other countries.

5.   Recommendations and guidelines for the 32 local authority library services, branch libraries, the Scottish Library and Information Council (SLIC) and local authority 3D printing champions.

1.4 Methodology

To determine the extent to which makerspaces and related technologies are being utilised in public libraries across Scotland, a "mixed-method" (Bryman, 2016, p.34; Gorman and Clayton, 2005, p.12) quantitative and qualitative web-based survey was undertaken, with the aim of providing a large-scale nationwide response. The target population for the questionnaire was the 32 local authorities in Scotland, as these authorities are responsible for delivering library services across Scotland (COSLA, n.d.). This was considered to be the most effective way to gather factual, numerical and opinion-based data from a wide geographical area within a challenging time-scale. Analysis of the data was undertaken using Excel to produce descriptive statistics in the form of tables and charts and the

principles of content analysis were followed to determine key concepts and themes within the qualitative data.

1.5 Overview of Learning Outcomes

The in-depth literature review developed a greater understanding of general makerspace concepts, in addition to specific knowledge relating to public libraries. Awareness of factors which influence their implementation and progression, such as benefits and challenges, and types of best practices being deployed in the running of a makerspace have been enhanced.

New data collection skills were acquired in designing, testing, distributing (via email and Twitter) and analysing the responses of a web-based questionnaire, using the online survey tool Qualtrics. Knowledge was gained in applying statistical analysis to the quantitative questions using Excel and qualitative free-text content was analysed using basic content analysis techniques.

1.6 Dissertation Structure

The structure of this dissertation is as follows:

Literature Review:
This review introduces existing knowledge on makerspaces, identifying five core themes evident throughout the literature. Applicable to public libraries, the themes are: makerspace definitions, resources and characteristics, the development of makerspaces in public libraries, benefits and challenges and best practices.

Research Methodology:
Outlining the data collection approach chosen for this study, the following areas are covered in this chapter: justification for choosing the target population and a web-based questionnaire, survey design and testing, ethical approval, recruitment of participants and data analysis techniques.

Findings and Analysis:

This section outlines the main findings from the questionnaire, together with supplementary data collection in the form of phone calls and consulting library service websites and social media sites. The findings are then discussed within the context of literature identified in the review.

Conclusions and Recommendations:

In concluding the study, the main findings are summarised, survey and study limitations are stated, future work is outlined and five recommendations are proposed.

2. Literature Review

2.1 Introduction

A significant portion of the research into makerspaces has been undertaken in the United States and Australia (Boyle *et al*., 2016; Slatter and Howard, 2013; Willett, 2018). The United States has embraced the makerspace concept (Burke, 2014, p.11) over the last decade and makerspaces in Australia are becoming ever more prevalent (Boyle *et al*., 2016; Slatter and Howard, 2013). Literature has covered a variety of topics across the wide spectrum of "creative spaces" available (Boyle et. al, 2016, p.30), such as hackerspaces, fab labs, private enterprises and academic, school and public libraries. According to Moorefield-Lang (2014, p.584), much of the early work tended to be in the form of informal, unofficial websites and publications. Furthermore, Velasquez (2018) advises that a considerable amount of literature on makerspaces provides advice for libraries in planning the layout of a makerspace, together with practical guides, suitable projects and kits for their implementation.

Over the past number of years, makerspaces have progressively appeared throughout the world in public libraries (Boyle *et al*., 2016) and as such, research on makerspaces in relation to public libraries has increased. However, compared to other fields, research is even now relatively limited (Moorefield-Lang, 2014; 2015a). Case studies and in-depth interviews have been the methodology of choice for the majority of research, focussing on a limited number of different types of libraries (Boyle *et al*., 2016; Moorefield-Lang, 2014, 2015a; Slatter and Howard, 2013; Taylor, Hurley and Connolly, 2016; Willingham and De Boer, 2015).

Prominent surveys by Burke in 2013 and Kroski in 2017, were extensive, web-based anonymous surveys, similar in type to this dissertation, however the focus was not solely on public libraries. Over a period of two months in 2013, Burke conducted a survey on makerspaces in public, academic, school and other libraries (Burke, 2014). A total of 30 US states and seven other countries (i.e. Australia, Canada, China, Denmark, Japan, the Netherlands and the UK) responded to the survey, resulting in 143 respondents (Burke,

2014). Information gathered from the survey included: how long the makerspace had been in existence, funding sources, reasons for implementing a makerspace, the most common technologies provided including reasons for choosing them, classes, workshops and training provided and potential additions to the makerspace (Burke, 2014). Similarly, the web-based 'Makerspaces in Libraries' survey (using SurveyMonkey), undertaken by Kroski in 2017, requested anonymous responses from a diverse range of libraries across 44 states in the United States and five additional countries; Australia, Canada, Egypt, Ireland and the UK. Findings were included in substantial parts of the new edition of 'Makerspaces: A Practical Guide for Librarians' (Burke and Kroski, 2018). Covering a wide geographical area, several different libraries were surveyed, including: public, academic, school and special libraries (Burke and Kroski, 2018, p.168). Research however, on a large-scale solely on public libraries has been limited.

Minimal research has focussed on the UK and in particular on Scotland, as alluded to earlier, makerspaces are a relatively new concept for public libraries in Scotland. A UK study by Taylor, Hurley and Connolly (2016) collected data on 15 makerspaces via site visits and interviews, however little has been conducted on a wider geographical area, using surveys as a methodology. This Scottish study aims to build on the current literature by way of a survey across an entire country.

Providing a context for this analysis, five core themes, evident throughout the literature are the focus. These themes are: defining a makerspace, resources and characteristics of a makerspace, the development of makerspaces in public libraries, benefits and challenges encountered and best practices for a successful makerspace. Although these themes are applicable across a diverse range of makerspaces, this review will focus on their relevance to public libraries.

2.2 Defining a makerspace

Recognised throughout the literature, is the complexity in defining a makerspace (Bagley, 2013; Lomax, 2012), owing to subjectivity, different interpretations and various types of activities and spaces available (Bagley, 2013; Boyle *et. al*, 2016). According to Willingham

& De Boer (2015, p.5), the word makerspace is regularly used as an all-encompassing term to group together hackerspaces, fab labs and various types of makerspace under the one category. Although the terms are regularly used as if there are no differences between them (Willingham & De Boer, 2015, p.2), these spaces have historically had a different focus. Hackerspaces essentially started as an "open hardware movement" supporting more "development access to electronic and computer technologies" (Willingham & De Boer, 2015, p.2). While, fab labs, originating from the (MIT) Center for Bits and Atoms (Burke and Kroski, 2018, p.12), are traditionally linked with academic establishments, focusing on manufacturing through "rapid prototyping and knowledge development" (Taylor, Hurley and Connolly, 2016; Willingham & De Boer, 2015, p.3). These types of spaces are "part of a standardised and franchised global network" (Sleigh, Stewart and Stokes, 2015, p.13) and closely follow a specific charter. Conversely, Willingham & De Boer (2015, p.2) advise that a makerspace "is the more DIY-oriented cousin of the hacker-space", with an emphasis on creation (Slatter and Howard, 2013, p.273), or as Bagley (2013) states, "creating with technology".

When describing a makerspace in the literature, similar keywords and definitions are evident. IFLA (2019) defines a makerspace as "a place where informal, collaborative learning and discovery take place through hands on creation, via use of any combination of art and technology". Willingham and De Boer (2015, p.1) see them as "spaces where people can gather to create, invent, and learn". Furthermore, Burke and Kroski (2018, p.1) define them as "places to invent, tinker, build, and explore among like-minded individuals and fellow enthusiasts". Similarly, Britton (2012) describes these spaces as "places where people come together to create, collaborate, and share resources and knowledge". For the purposes of this study, a broad definition will be assumed when referring to a makerspace, typically a place to gather, create and collaborate. Figure 1.1 is a visual representation of the most common keywords from the above definitions.
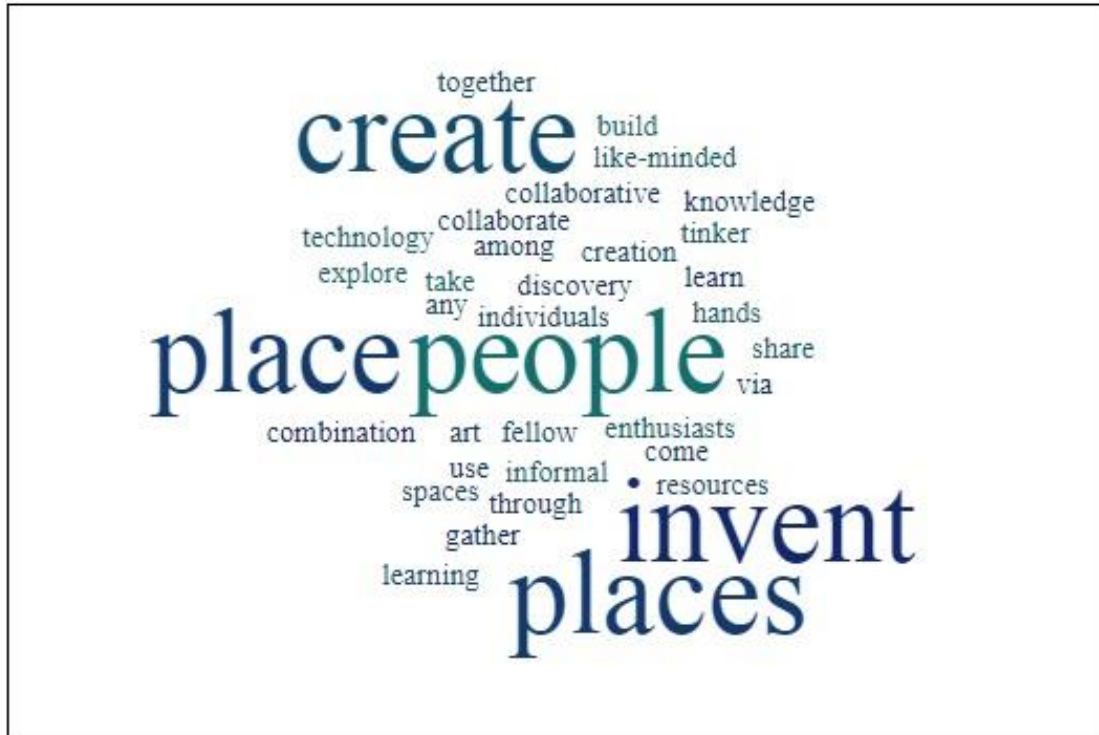
Figure 1.1 - Common makerspace keywords in literature definitions

As regards to 3D printing, one of the most common resources found in a makerspace, this is where "a three-dimensional object is created by laying down successive layers of material that adhere to one another, creating a three-dimensional output" (Kurt and Colegrove, 2012, quoted in Massis, 2013, p.351).

2.3 Resources and characteristics of a makerspace

Makerspaces typically contain a range of activities and resources, as shown in Figure 1.2 Some have a particular focus, while in others a diverse range of resources are provided. Common resources include: 3D printing, electronics, Raspberry Pi, robotics, and traditional arts and crafts (Britton, 2012; Burke, 2014; Uzwyshyn, 2015; Willingham and De Boer, 2015). At the smaller end of the scale, makerspaces tend to feature a limited number of resources, such as crafts or a 3D printer. Larger, more permanent makerspaces usually contain a wide range of resources and provide various activities. With regards to 3D printing, Willingham De Boer (2015, p.89) state, "In public opinion, the 3D printer reigns as the icon of maker culture." Likewise, Burke (2014, p.113) deems 3D printing to be the

"signature element of makerspaces". By contrast, Boyle *et al*. (2016, p.37) argue that "you definitely don't need a 3D printer to have a creative space!"
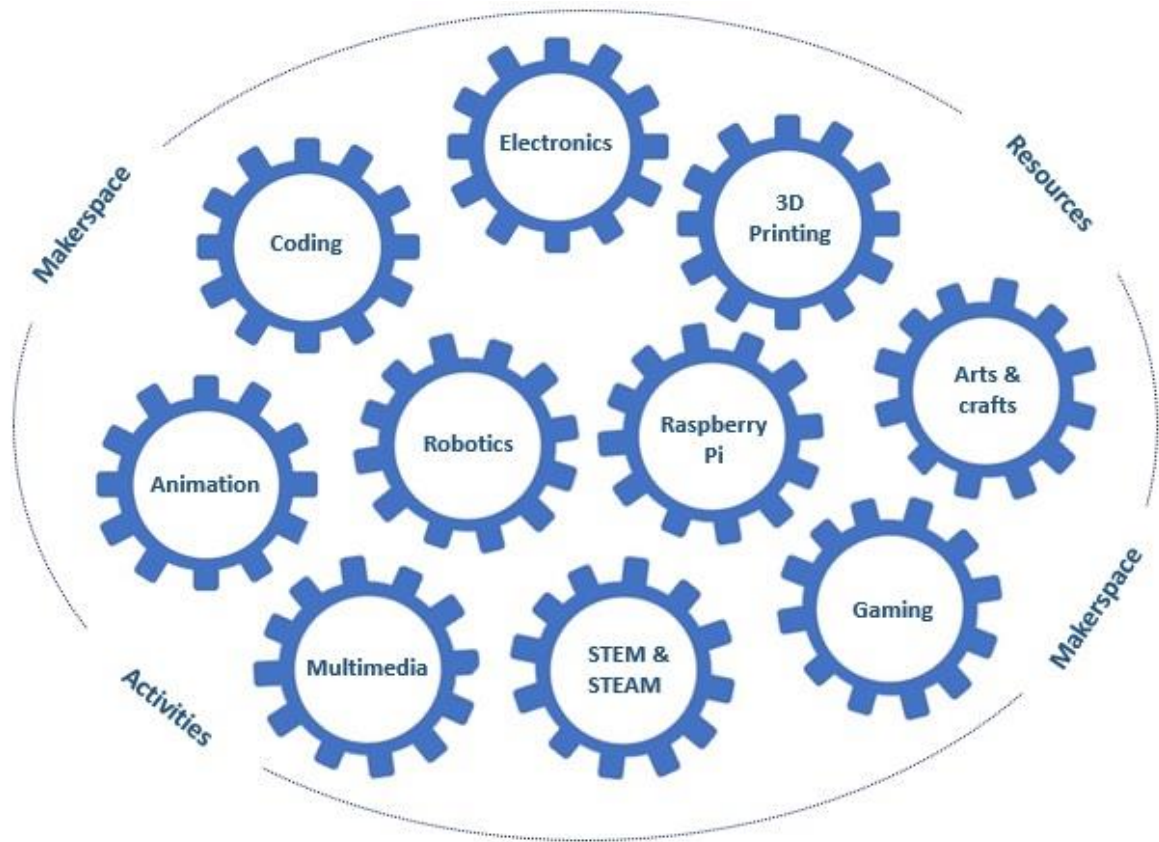
Figure 1.2 – Makerspaces – common activities & resources
(Sources: Britton, 2012; Burke, 2014; Willingham and De Boer, 2015)

Every makerspace is unique (Britton, 2012; Britton and Considine, 2012; Koerber, 2012; Moorefield-Lang, 2014), with varied equipment, resources and funding models (Boyle *et. al*, 2016). Different types of space include; permanent, which Lomax (2012) considers to be the most common type, mobile, 'pop-up' (Burke, 2014; Lomax, 2012), a shared space within a library, temporary and 'drop-in' events. A feasible alternative to a permanent makerspace, if physical space or funding is an issue, is a mobile makerspace (Britton, 2012; Moorefield-Lang, 2015b). Arguably the most well-known example of a mobile makerspace is Frysklab in the Netherlands, Europe's first mobile library fab lab (De Boer, 2014). Additionally, an option to provide 'pop-up' facilities when required can offer a solution. This type of makerspace can help facilitate pilot testing of resources and ideas (Lomax, 2012). Determining the type of space and number of resources therein, are a number of

influences including: funding issues, library location, staffing and the intended purpose of the space (Britton, 2012; Burke, 2014, 2018; Uzwyshyn, 2015; Willingham and De Boer, 2015).

Figure 1.3 shows various characteristics that Burke (2014, p.5) regards as being fundamental to various types of makerspace. These are: knowledge sharing, collaborating with others (co-working), "hands-on learning", STEM education, shared "'maker-culture" and tool sharing. Many authors regard the sharing of knowledge as a crucial part of the makerspace concept, as vital as it is to the traditional library (Lomax, 2012). Burke (2014, p.3) argues that this sharing of knowledge between librarians, patrons and experts is mutually beneficial, as all parties learn from each other, epitomising the principle of sharing for the good of everyone. A shared "maker culture" (Burke, 2014, p.5) inspires patrons to become actively involved, with hands-on learning "involving or offering active participation rather than theory" (Lexico, 2019). Britton (2012) argues that patrons are now "creators of information", transforming the traditional perception of public libraries (Ginsberg, 2012).
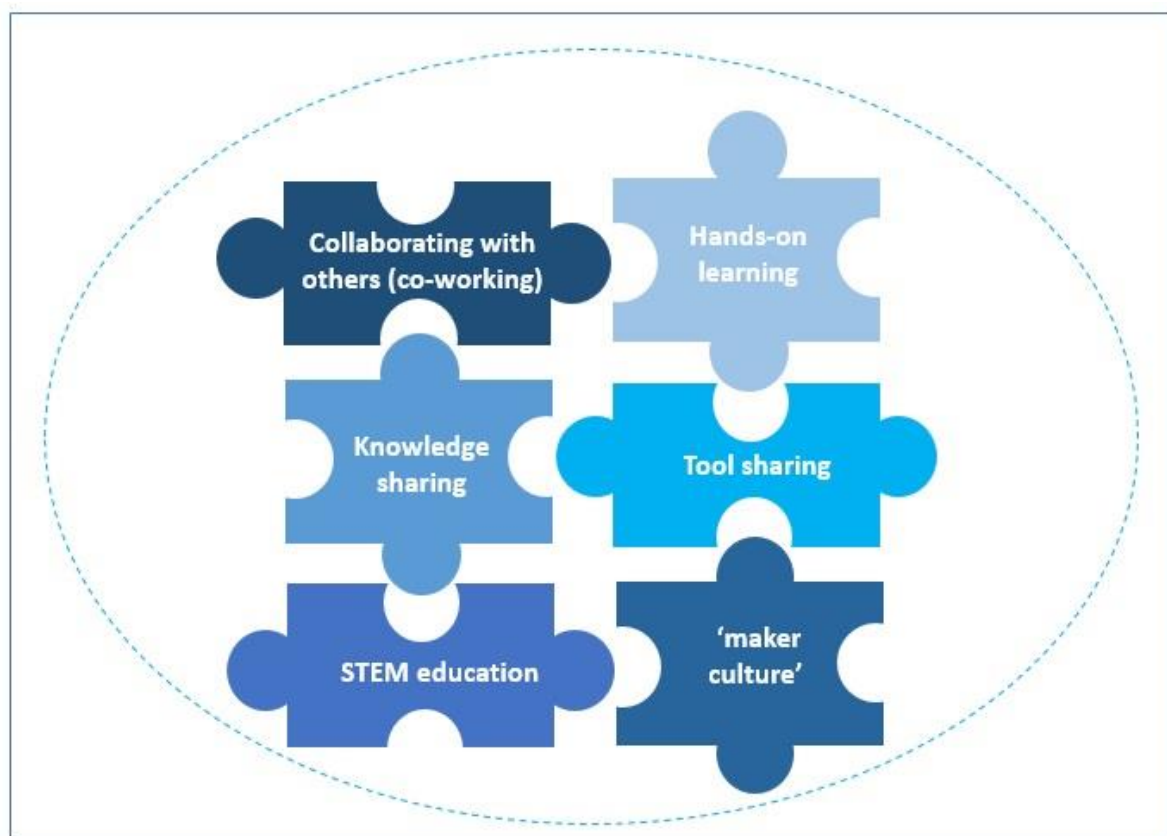
Figure 1.3 – Makerspace characteristics (Source: Burke, 2014, pp. 5-6)

Viewing makerspaces holistically, Burke (2014, p.6) highlights four key inputs that together with the key characteristics make up a makerspace in its entirety. As shown in Figure 1.4, these inputs are: physical space, resources available to the library, finance and the interest of the community.
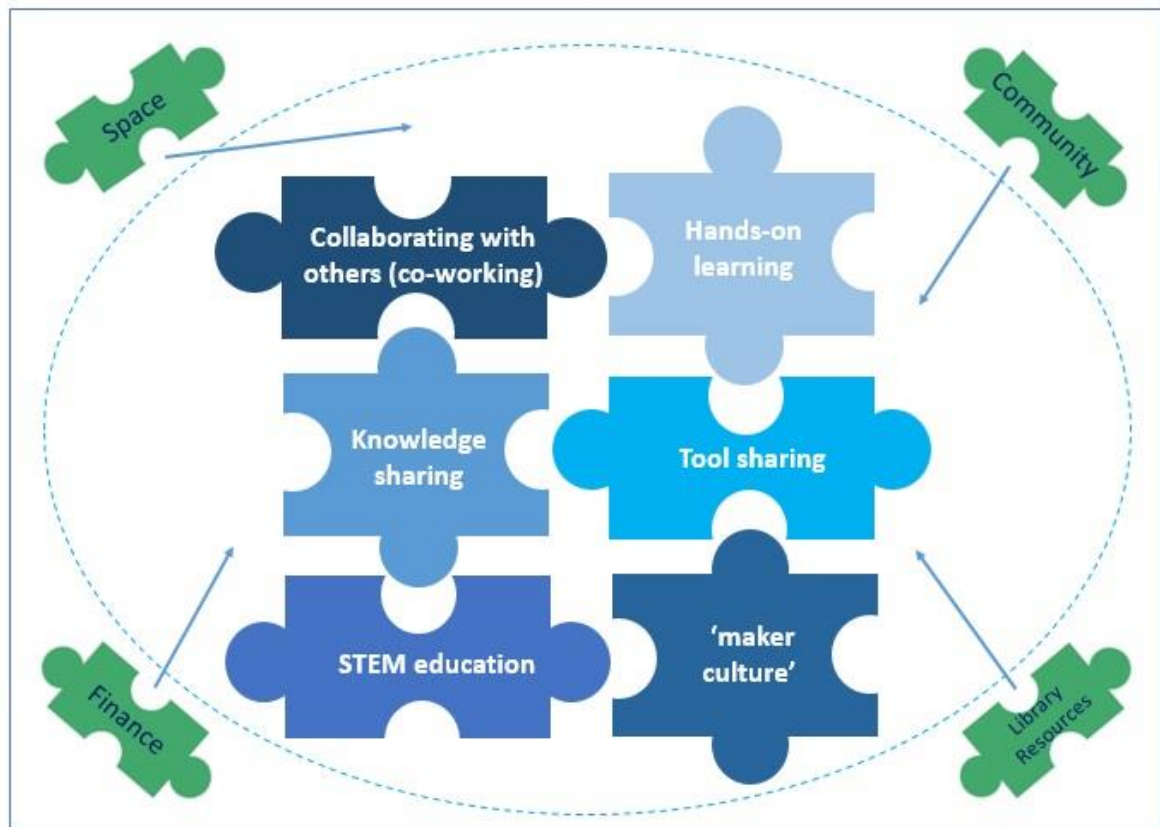
Figure 1.4 – Makerspace inputs and characteristics (Source: Burke, 2014, pp.5-6)

An area of agreement in much of the literature is the view that community is at the core of the makerspace ethos. At the core of a makerspace is the community and subsequent collaboration between everyone using the space (Boyle *et al.*, 2016, p.31). Similarly, community is regarded as "essential" to creating a successful makerspace (Britton, 2012), while Burke (2014, p.12) considers it as a "defining element of the maker movement". Likewise, Kelly (2013, p.2) advises, "It could be argued that one of the most important tools in a makerspace is the people." The visual representation outlined previously (see Figure 1.1), highlighted the significance of 'people' in the makerspace concept. In addition, Willingham De Boer (2015, p.12) strongly suggest that, "The libraries that succeed with their twenty-first century makeovers will be those that are community driven."

2.4 The development of makerspaces in public libraries

A study by Slatter and Howard (2013, p.272) identified makerspaces as a growing "phenomenon" in libraries around the world. In addition to the DIY resurgence (Slatter and Howard, 2013, p.273), a number of contributory factors to their growth, have been highlighted in the literature. Kroski (2015, p.ix) identifies a change in patron expectations and consumption of information, together with digital and technological advancements (Slatter and Howard, 2013). Furthermore, Burke (2014) acknowledges the promotion of STEM/STEAM skills, to supplement the school curriculum, as being influential. Moreover, the "shift away from physical collections" (Lomax, 2012) in many public libraries has freed up space for this maker concept in libraries (Burke, 2014, p.xvii). Many public libraries have reacted to these changes by implementing a makerspace or utilising related technologies with the aim of engaging with the local community in a way that they have not done previously (Boyle *et al*., 2016, p.31).

Lomax (2012) poses the question, "Why have makerspaces found such an affinity with libraries?" Consensus throughout much of the literature is that makerspaces in libraries are "a natural extension of library services" (Britton 2012) and are viewed positively (Burke, 2014; Kroski, 2015). Kroski (2015, p.ix) views libraries as a "passport" to the concept of makerspaces, ready to offer the complete set of services required. While Ginsberg (2012, p.91) states that "bringing makerism into libraries naturally extends the library's mission". Willingham and DeBoer (2015, p.1) maintain that makerspaces help "libraries take their rightful place as cultural and creative community hubs".

At the heart of both the public library mission (Willett, 2018) and makerspace culture (Boyle *et al*., 2016; Britton, 2012; Burke, 2012; Lomax, 2012) is the importance of meeting the needs of their communities, together with universal access and knowledge sharing. Reiterating the connection Taylor, Hurley and Connolly (2016) state, "Although the makerspaces in library environments might at first seem at odds, they share a common goal of making resources available to everybody at little or no cost". In addition, Scott (2012) argues that as well as promoting learning and literacy, "public library makerspaces can play an important role in developing a strong workforce" by providing access to new

technologies that would otherwise not be possible to access. Kelly (2013, p.3) advises that due to similarities between public libraries and makerspaces, they are both in a position to "serve their communities and help to promote lifelong learning."

Burke (2014, p.157) is one of many authors supportive of makerspaces, however he advises caution to the positivity noted above by stating that makerspaces could face resistance from the local community and that they "will not have an easy road to universal acceptance". Likewise, the National Centre for Universities & Business (n.d.) stress, "Makerspaces undoubtedly have a lot of potential, but they aren't a 'build it and they shall come' proposition." Adequate advertising and engagement of the community are required for these spaces to succeed.

Furthermore, Lauren Britton who set up the makerspace in the Fayetteville Free Library in New York and is regarded as one of the "groundbreaking leaders of the makerspace movement within libraries" (Clark, 2014) advises that libraries require to react to the specific requirements of their local community, as makerspaces will not be a suitable service for all libraries and "nor should they" (Clark, 2014). Groenendyk (n.d.) is somewhat more forceful in his views, arguing that makerspaces "are not for every public library", claiming that they usually appeal to a certain type of user, with the potential to be "a waste of money" if both the staff and the surrounding community are not "tech-savvy" enough to maintain and engage with the makerspace. In some instances, libraries and makerspaces may not be as natural a partnership as argued by some authors. In certain areas, the local community may not respond to, or require a makerspace, for reasons specific to that community.

Much of the negativity surrounding makerspaces in public libraries has been in the form of unofficial blogs online. One 'debate' focuses on whether 3D printing is a fit for the strategic framework of a library (Abram, 2013). With strong views on the topic, Rundle (2013) argues, "The harsh truth is that there is no business case for public libraries to provide 3D printing" and further states, "librarians need to ensure that they understand why they are providing them and what the ramifications are". This is true for all other services a public library provides, 3D printing is no different in this respect. His argument is that 3D printing

is not central to the mission of a library (Rundle, 2013). By contrast, Bradley (2013) is more positive about their role in libraries, by advising that if a 3D printer is beneficial to the local community then they are worth investing in and he notes, "Libraries need to embrace technology…to better their communities".

2.5 Benefits and challenges of makerspaces in public libraries

Well documented throughout the literature are the many benefits and challenges from implementing a makerspace, for both libraries and their community (Boyle *et al*., 2016; Slatter and Howard, 2013). Being an evolving concept, the literature is mainly positive with regards to makerspaces in libraries (Slatter and Howard, 2013), with a large portion of the research focusing on perceived benefits. However, as will be explored, there are also numerous challenges to the successful implementation and on-going running of a makerspace.

2.5.1 Benefits

Boyle *et al*. (2016, p.31) ask the question, "What benefits can a creative space bring to your library and community? A 2013 study by Slatter and Howard investigated the state of makerspaces in Australian public libraries. The authors undertook a qualitative study, conducting three interviews across three different states, with information professionals who were either developing or managing a makerspace. The aim of the study was to explore the benefits, challenges and future prospects of makerspaces. Findings identified several common benefits including: increased community engagement, digital inclusion and a transformation of the library's image "from that of a place where works are consumed to that of a place where works are created" (Slatter and Howard, 2013, p.272). Visible through an increase in library footfall, community engagement was regarded as the most significant benefit by participants (Slatter and Howard, 2013, p.279).

Moreover, partnerships with local schools, teacher associations, universities and local hackerspaces were considered key for successful collaboration between the library makerspace and the community (Slatter and Howard, 2013, p.276). Facilitating "equitable

access" (Slatter and Howard, 2013, p.277) to technologies such as 3D printers, to people who would not normally have access to them, was also regarded by participants as a way to actively bring in new library users (Slatter and Howard, 2013, p.276). As acknowledged by the authors, due to the small-scale nature of this research, further investigation is required to provide a greater representation of makerspaces in public libraries in Australia (Slatter and Howard, 2013, p.282).

Boyle *et al*. (2016), in their article 'Making the case for creative spaces in Australian libraries', summarise benefits from an extensive literature review they undertook, outlined previously in their creative spaces 'toolkit' (Boyle *et al*., 2014). Both public and non-library makerspaces, in three different locations; the United States, Glasgow (MAKlab) and Australia were the focus. Benefits identified were: community empowerment, developing a more engaged user base, facilitating "inter-generational learning and social connectedness" (Boyle *et al*., 2016, p.34), establishing an ethos of lifelong learning and enabling "future proofing and trans-literacy" (Boyle *et al*., 2016, p.33). The possibility of direct socio-economic benefits from establishing a makerspace were noted by Boyle *et al*. (2016, p.35), who highlight a 2011 "landmark" report for the Public Libraries of Victoria Network and State Library Victoria titled '*Dollars, Sense and Public Libraries'.* This report outlined direct economic benefits by highlighting, "For every dollar invested in Victoria's public libraries, $3.56 is the average rate of return in community benefits." (SGS Economics and Planning, 2011, p.17)

Library services that provided access to, technologies, literacy and engagement with communities, were used to calculate financial value (SGS Economics and Planning, 2011, quoted in Boyle *et al*. ,2016, p.35). With makerspace benefits including access to a wide variety of technologies and community being at the heart of the makerspace ethos, Boyle *et al*. (2016, p.35) argue that these makerspace benefits can add socio-economic value to a library.

Referring to it as an "internationally reported phenomenon" and similar to findings by Slatter and Howard (2013), Boyle *et al*. (2016, p.35) identify a further key benefit; an increase in new library users. The authors state, "Perhaps the benefit which is most likely to catch the attention of those considering a funding application is the increase of library patrons walking through the door and accessing services." (Boyle *et al*., 2016, p.35). Figure 1.5 summaries the main benefits identified in the literature.

Figure 1.5 – Summary of makerspace benefits
(Sources: Boyle *et al*., 2016; Burke, 2014, 2018; Chandler, 2017a, 2017b, Lomax, 2012; Slatter and Howard, 2013; Wilson, 2016)

As indicated earlier, much of the literature on makerspaces in public libraries is positive towards the makerspace concept. Willett (2018) however, challenges some of these more favourable aspects in the article, 'Making, Makers, and Makerspaces: A Discourse Analysis of Professional Journal Articles and Blog Posts about Makerspaces in Public Libraries'. The analysis focused on public library journal articles and blog discussions that took place between 2011-2014, related to public library makerspaces. It is noted that some articles

mention "community empowerment", however Willett (2018, p.322) argues that they do so, "without specifying how this empowerment manifests itself". Additionally, it is felt that the significance of a possible transformation among patrons, to now being "creators of information" (Britton, 2012), is not adequately demonstrated (Willett, 2018, p.322).

In contrast to Boyle *et al.* (2016, p.35), who as alluded to earlier, highlighted the possibility of "direct socio-economic benefits" resulting from a makerspace, Taylor, Hurley and Connolly (2016) discuss the difficulty in quantifying the added value of makerspaces and measuring social and economic benefits. In their study, collecting data on 15 makerspaces in the UK through site visits and interviews, the authors highlighted an "inability to track outcomes" by organisers, while stressing that "being able to communicate these outcomes is important in securing the future of this resource".

2.5.2 Challenges

Makerspaces and their associated technologies, even the modest ones, present numerous challenges to both librarians and their communities. Makerspaces by their nature, "need an immense amount of effort to keep running." (Sleigh, Stewart and Stokes, 2015, p.12) Findings by Slatter and Howard (2013) identified significant challenges in the implementation and running of makerspaces in public libraries in Australia. These included: budget limitations, a "steep learning curve", resistance to change within public bodies (Rowley, 2011, quoted in Slatter and Howard, 2013, p.280), concerns over copyright and validating the "value and relevance" of such spaces in a library setting (Slatter and Howard, 2013, p.277).

Acquiring sufficient knowledge in the use of new technologies in a makerspace, affects both library staff and their patrons, as does accepting change to the "traditional library model" (Slatter and Howard, 2013, p.277). Awareness of legal and copyright implications is particularly challenging and regarded as being a "grey area" (Slatter and Howard, 2013, p.278) for new technologies such as 3D printers. Being perceived as an "expensive indulgence" is a potential barrier to success, especially against a backdrop of budget cuts (Slatter and Howard, 2013, p.275). Similarly, Massis (2013, p.353) questions whether critics

view 3D printing as an "extravagance", with only a limited number of library users benefiting from it.

The above study was conducted when makerspaces in public libraries were a relatively new occurrence in Australia, similar to the current picture in Scotland. Of value therefore is the view held by the authors that this scenario "created a unique set of challenges for participants who are often trying things for the very first time", in other words, an "uncharted territory" for some participants (Slatter and Howard, 2013, p.277). According to Britton and Considine (2012), the achievements of the Fayetteville Free Library in New York, the first makerspace in a public library (Britton and Considine, 2012; Willingham and De Boer, 2015), have to some extent resulted from a "culture of innovation that requires the team to think beyond the limitations of the past and to imagine a new vision for the community".

A study by Moorefield-Lang (2014) in the United States, investigated the implementation of 3D printing and makerspaces across four states. Six case studies involved in-depth interviews with librarians working in school, higher education and public libraries, focussing on successes, benefits and relevant projects (Moorefield-Lang, 2014, p.585). Findings highlighted that 3D printing in particular creates a unique set of challenges. Training was identified as crucial for both library staff and patrons, as 3D printers are not the "most intuitive of technologies" (Moorefield-Lang, 2014, p.589), are time consuming, occasionally unreliable and require ongoing maintenance. In libraries with only one librarian these challenges can intensify. Funding in a makerspace is on-going, however as Moorefield-Lang (2014, p.592) highlight, cost can be kept as low as required with appropriate planning from the onset. The authors advise that "Librarians have to be fearless in implementing this technology, willing to learn on their feet, and be excited to explore" (Moorefield-Lang, 2014, p.583). Although not specific to public libraries and with a relatively small sample size, this study highlights important considerations for all makerspaces.

A further study by Moorefield-Lang (2015a), consisting of 12 individual interviews with librarians working in library makerspaces, aimed to provide a "thematic analysis of how makerspaces were integrated in library settings" (Moorefield-Lang, 2015a, p.109). Eleven libraries in the United States and one in Canada, comprising of school, public and university libraries, were investigated. Findings showed that librarian and patron training was "an area of concern but practicing librarians are finding ways to gain the knowledge they need to manage their makerspaces" (Moorefield-Lang, 2015a, p.111). With respect to 3D printers in particular, "many patrons have never seen or worked with one" (Moorefield-Lang, 2015a, p.111). This study reaffirmed the view that staffing in libraries is a challenge, even more so when a makerspace is located in the library. However, being imaginative with staffing, through flexible staff schedules and opening hours, as shown by librarian participants in this study, is one way to mitigate these challenges (Moorefield-Lang, 2015a, p.110). Deciding on whether to staff a makerspace with permanent staff, volunteers, local expertise or a combination can be difficult. Further research focussing specifically on training issues as identified in this study, would be a valuable addition to the increasing literature on makerspaces.

Additional challenges identified in the literature include, availability of space (Burke, 2014; Lomax, 2012) and difficulties associated with acquiring management approval for the implementation of a makerspace (Britton, 2012; Uzwyshyn, 2015). Important to consider when choosing the type of makerspace being implemented is the physical space available. As outlined previously, this can determine if a makerspace is permanent, mobile or 'pop-up' (Burke, 2014; Lomax, 2012). With regards to management approval, Britton (2012) argues that full support from senior management, together with an ability to take risks is fundamental to senior management sanctioning the implementation of a makerspace.

In addition to the issues with 3D printing identified above (Moorefield-Lang, 2014; 2015a; Slatter and Howard, 2013), Massis (2013, p.352) raises potential legal issues with 3D printing, such as intellectual property and copyright violations through "reproducing copyrighted designs". Specific to Scotland, a '3D Printing in Scottish Public Libraries' report by SLIC in 2016 also identified several challenges with regards to 3D printing. These included: ongoing costs associated with the printers, staff requiring time to become

familiar with the equipment and processes and whether to charge for the 3D printing service (Robertson, 2016, p.17). Figure 1.6 summaries the main challenges identified in the literature.

Figure 1.6 – Summary of makerspace challenges
(Sources: Boyle *et al*., 2016; Britton, 2012; Burke, 2014, 2018; Chandler, 2017a, 2017b, Lomax, 2012; Massis, 2013; Moorefield-Lang, 2014, 2015a; Robertson, 2016; Slatter and Howard, 2013; Uzwyshyn, 2015)

2.6 Best practices for a successful makerspace

"It's not enough to just make something - it's also important to be able to tell others about the projects and why they are great." (Maker Media, 2013, p.45)

Establishing best practices for a concept where "no two makerspaces are the same" (Moorefield-Lang, 2015a, p.107) is challenging, especially since being a relatively new concept, practices themselves are evolving. Boyle *et al*. (2016) highlight in their findings, several good practice standards to follow for successfully implementing a makerspace:

collaborate with your local community, evolve with the space by being flexible, customise the space according to the local context the space is operating in, promote and market the space and understand the national strategic context the library is working within (Boyle *et al*., 2016, pp.37-38). It is argued that community collaboration is the most significant element in creating a successful makerspace (Boyle *et al*., 2016).

Similarly, Willingham and De Boer (2015, pp.119-122) outline "tips and tricks" for "creating agile and enduring library makerspaces". Through "descriptive" case studies, the authors identify several best practices to be encouraged in a makerspace. These are as follows:

- prioritise people, over technology
- involve staff and the community to customise the space and meet local needs
- be aware of global trends and other makerspaces and customise the space accordingly
- collaborate with experts
- phase the development of the space, in line with available resources
- customise the space and evolve with the library users
- good planning and sensible risk taking
- liaise with other makerspaces and information sources before investing
- find ways to innovatively fund the makerspace

Focusing on people is a view supported by Kelly (2013, p.1) who advises, "The community behind the makerspace is where libraries should focus their attention". Finding appropriate information sources can be difficult for some libraries, however, as makerspace implementation levels within countries and regions can vary substantially. In areas where the concept of makerspaces in public libraries is relatively new, accessing adequate training, suitable project ideas and other library makerspaces can prove difficult (Moorefield-Lang, 2015a, p.110). To help fulfil the above practices, Willingham and De Boer (2015, p.13) propose sharing ideas and opinions in "discovery sessions", akin to brainstorming and to create a "makerspace handbook" so that policies, procedures and protocols can be replicated in other libraries. As makerspace technologies and spaces are

ever changing, this handbook should aim to be "dynamic", covering topics such as: health and safety regulations, legal requirements, a code of conduct for staff and patrons, practical considerations when implementing such a space in a library and general policies surrounding the use of space.

2.7 The UK and Scotland

The majority of literature on makerspaces within the UK has focussed on non-public library makerspaces. Where research has focussed on public libraries, it has tended to be through Government publications with a focus on England. As a relatively new concept for public libraries in Scotland, limited makerspace literature has tended to be in the form of Government reports and publications, national library strategy documents, information on individual library service websites and social media platforms and general articles. On occasion, these articles focus on specific public library makerspaces. Lacking however, is a clear picture of the makerspace landscape across Scotland as a whole.

In 2015, Nesta, an innovation charity foundation based in the UK, commissioned an open dataset of UK makerspaces using desk-based research and a survey. As of January 2015, there were 97 makerspaces across the UK, with 11 in Scotland. This dataset provided information on location, resources, space, membership and users, external partnerships, legal structure, challenges and services (Sleigh, Stewart and Stokes, 2015). However, this research did not include public libraries, instead focussing on fab labs, hackerspaces and commercial and non-profit makerspaces (member and non-member). Similarly, a UK study by Taylor, Hurley and Connolly (2016), which was previously mentioned, collected data on 15 non-public library makerspaces through site visits and interviews, exploring the role that these spaces play within the wider community. Various spaces in the investigation included: commercial makerspaces, fab labs, hackerspaces and 'grassroots' makerspaces, who rely on goodwill and limited generated income.

Specific to public libraries in England in 2017, the Government Libraries Taskforce held makerspace masterclasses in both Canada Water Library (Chandler, 2017a) and Leeds Central Library (Chandler, 2017b). Results from these masterclasses, echoed a number of best practice findings from other studies outlined above (Boyle *et al*., 2016; Willingham and De Boer, 2015). With regards to the Leeds Central Library makerspace masterclass (Chandler, 2017b), good practice in public library makerspace development was identified as being: effective marketing of the space, collaboration with neighbouring volunteer centres, supporting staff training and time management, building partnerships with local schools, universities and community groups, effectively utilising local authority IT systems, adequately researching equipment purchase and creating 'lesson plans' (Chandler, 2017b). The sharing of policies and plans with other public library makerspaces can help to "avoid reinventing the wheel" (Chandler, 2017b) and is particularly important for a service which is continually evolving and uses challenging technologies such as 3D printers. Additionally, a list of public library makerspaces in England is obtainable from the Government publication 'Libraries and makerspaces', as is a map created by the Libraries Taskforce, plotting 32 makerspaces in libraries across England (Department for Digital, Culture, Media & Sport, 2018). Until this study was conducted, no such known list or map was available for public library makerspaces in Scotland.

A 2016 article by the Carnegie UK Trust (Wilson, 2016), acknowledged that several libraries were already using 3D printers. However, specific details on which libraries or how many were using makerspace technology was absent from the information provided. Similarly, within the 2019 'Ambition and Opportunity' refresh supplement (SLIC, 2019, p.2), it advises that "Several libraries have introduced makerspaces", though exact details are absent. The 2016 SLIC report titled '3D Printing in Scottish Public Libraries' (Robertson, 2016) appears to be the most extensive research to date, in relation to makerspace technology in Scotland. However, the focus of this report was entirely on 3D printing across a small number of libraries, early on in the rollout of 3D printing.

2.8 Conclusion

As an evolving concept, literature on makerspaces in public libraries is increasing, however gaps remain particularly in terms of studies solely on public libraries across a wide geographical area. Limited research has focused on Scotland, with information on makerspaces for the most part, being within Government reports, publications and national library strategy documents. Literature on the whole is mostly positive regarding the role of makerspaces in public libraries, with many authors offering the view that makerspaces are "a natural extension of library services" (Britton 2012). Much of the literature is devoted to defining a makerspace, highlighting the difficulties that this entails, together with outlining characteristics and resources found in makerspaces. The benefits and challenges of implementing and running a makerspace are well documented within the literature, as are best practice suggestions for achieving a successful makerspace.

3. Research Methodology

3.1 Introduction

The aim of this study was to examine the extent to which makerspaces and 3D printers, are currently being used in Scottish public libraries. In addition, it sought to identify benefits and challenges that may have been influential to progress, and to determine if best practices are being followed. Using the introduction of 3D printing by SLIC in 2015 as a baseline, this study addressed the following research questions:

1. How far have public libraries in Scotland progressed in their implementation of makerspaces since 2015?
2. To what extent is 3D printing currently being utilised in public libraries in Scotland?
3. What benefits and challenges have resulted from the implementation of a makerspace?
4. What best practices are being followed in the running of a makerspace?
5. What reasons have influenced the decision not to implement a makerspace?

Having highlighted the deficit of large-scale national studies, solely on public library makerspaces, and with limited research on Scotland, a survey of the 32 local authority library services aimed to bridge this gap. The approach taken to answer the above research questions will be outlined in detail, as will the rationale behind choosing both the target population and a web-based questionnaire as the research method. Additionally, the means by which the survey was designed and tested, participants recruited and data analysed, will be described.

3.2 Target Population

Limiting the focus of the study to public libraries in Scotland was not a decision based on convenience; rather it was one of intrigue and strategy (Bryman, 2012). The 32 public library authorities in Scotland are in a unique position, having had 3D printing introduced in 2015 (Robertson, 2016). This provided an opportunity to explore the extent to which 3D

printing is being offered as an activity, essentially a 'progress report' and to determine current makerspace practice. The target population for this survey was all 32 local authority library services in Scotland, with the hope being that each library service would provide one response and fulfil the research goal of determining the extent of makerspace technology in public libraries across Scotland. As highlighted by Bryman (2012, p.418), "in purposive sampling the researcher samples with his or her research goals in mind."

Being responsible for over 500 library branches in Scotland (Daly, n.d.) and having access to the appropriate person to undertake the survey, the library services matched the selection criteria. A form of what Bryman (2012, p.419) calls "criterion sampling", where the researcher samples "all units (cases or individuals) that meet a particular criterion." In this case, the 32 local authority library services. Deciding to distribute the questionnaire to the local authorities rather than individual library branches was also due to the limited timeframe available. Acquiring responses at the local authority level would provide an insight into the Scottish makerspace landscape, fulfilling one of the research deliverables to provide a colour-coded map of makerspace provision across Scotland. This was deemed a more efficient way to obtain the current state in each authority, as opposed to sending out questionnaires to each individual library.

3.3 Data Collection approach

With the aim of delivering a large-scale, nationwide study of current makerspace usage in public libraries in Scotland, it was important to select an appropriate methodology that would fulfil this goal within a challenging timeframe. A "mixed-method" (Bryman, 2016, p.34; Gorman and Clayton, 2005, p.12) quantitative and qualitative survey in the form of a web-based questionnaire was chosen, which can be seen in Appendix A. This study sought to gather factual and numerical data on the current makerspace landscape of Scotland, together with gaining an insight into opinions with regards to benefits, challenges, best practices and perceived makerspace success. Bryman (2012, p.253) refers to factual questions as "informant factual questions" which are "essentially about characteristics of an entity of which they have knowledge". The "entity" in this study is the makerspace.

According to Gorman and Clayton (2005, p.3), quantitative research "focuses more on numerical or statistical data", while the "ultimate goal of qualitative research is to understand those being studied from their perspective, from their point of view." As advised by Connaway and Radford (2017, p.97), a "*Survey* refers to a group of research methods commonly used to determine the present status of a given phenomenon", further highlighting that this type of research is particularly suited to participants that are "geographically dispersed" (Connaway and Radford, 2017, p.98). Thus, for a population across an entire country, this method was considered the most effective way to gather the data.

Before proceeding with the questionnaire, several alternative methods such as interviews and case studies were evaluated. However, taking into account the short timescale available, these approaches would have resulted in small-scale studies similar to previous studies in the literature (Moorefield-Lang, 2014; Slatter and Howard, 2013). Consequently, the desired nationwide study of Scotland would not have been possible. This study sought to not only build on limited knowledge in Scotland, but to also enrich makerspace research in the field by conducting a national study, with the potential to be used for comparison with other countries.

Undertaking a web survey has many recognised advantages and disadvantages which were deliberated over at the onset. Often cited as the biggest risk to a survey is a low return rate (Bryman, 2012), which on occasion can invalidate the research by being too low. Additionally, Connaway and Radford (2017, p.98) highlight that surveys offer "less control of the research environment", with the target population very much in control of the following factors: introductory emails being looked at, surveys being passed onto the appropriate person, questionnaires being completed or abandoned and responses being accurate and honest. Other disadvantages often cited include: respondents being unable to clarify questions resulting in partial or no response, the risk of "respondent fatigue" if a questionnaire is too long (Bryman, 2012, p.235) and typically a questionnaire requires follow-up reminders (Bryman, 2012; Connaway and Radford, 2017).

Mitigation of the above disadvantages is possible, if certain measures are taken at the design stage. These include: providing clear and concise instructions for the recipient, creating a simple layout and colour scheme, making sure questions are unambiguous, keeping the questionnaire as short as possible to gather the appropriate information and limiting the number of open-ended questions, as greater effort is required in answering these (Bryman, 2012). Additionally, despite being considered a shortcoming, Bryman (2012, p.236) stresses that the "importance of reminders cannot be overstated".

Taking into account the disadvantages highlighted and the alternative methods available, a web-based questionnaire was deemed the most appropriate way to achieve the overarching goal of a large-scale geographical study in Scotland. Figure 1.7 summaries the rationale behind choosing a web-based questionnaire for this study.

Figure 1.7 – Reasons for choosing a web-based questionnaire for data collection

Qualtrics, an online survey tool, was the preferred choice as previous use during the course highlighted benefits such as: a user-friendly interface, an array of question types on offer, the ability to customise the user experience and free online training. This platform was used for the design, pilot testing, distribution (via email and Twitter) and preliminary analysis of the responses. The survey was open for three weeks, from Thursday 20 June to Thursday 11 July.

3.3.1 Designing the questionnaire

Careful design of a questionnaire is crucial from the onset, with optimal survey design well documented in the literature (Braun and Clarke, 2013; Bryman, 2012, 2016; Connaway and Radford, 2017; Fink, 2003). Several authors were referred to during the planning stage, assisting with all aspects of questionnaire design. Connaway and Radford (2017, p.109) advise that "Proper construction of the questionnaire is essential to its success" and that the "information needs" of the researcher require to be met through the data collection. Similarly, Bryman (2016, p.10) recommends that questions should be designed in a way "that will allow data to be collected to answer those research questions." A professional, yet straightforward feel to the questionnaire, with clear and concise questions, was the aim. Fink (2003, p.11) stresses the importance of this by stating, "A straightforward question asks for information in an unambiguous way and extracts accurate and consistent information." No elaborate themes or backgrounds were chosen, as these can distract from the actual questions. Black text on a white background, with questions in bold, was the preferred colour scheme throughout.

The first page introduced the questionnaire to the recipient, outlining key points such as: the purpose of the study, anonymity of responses, no personal information required, the importance of reading the participant information sheet before proceeding to the consent form, the expected duration of the survey and the closing date. Both the participant information sheet and the consent form can be viewed in Appendices B and C respectively. An email address was also provided, to allow recipients to send queries or to express interest in the findings. As advised by the Departmental Ethics Committee, a consent form should not only be provided but should also be auditable. The second page of the

questionnaire contained the consent form with the statement "I consent to being a participant in the survey. Please click yes or no below to confirm." The participant could not proceed with the questionnaire until the "Yes" radio button had been selected. In line with ethical requirements, the option chosen for this question was recorded in Qualtrics.

With regards to the type of questions to include in the questionnaire, the following sources were consulted prior to creating the questions. The 2017 web-based survey by Kroski, highlighted in the literature review, provided insight into a web-based anonymous survey, as it was created using SurveyMonkey, a tool similar to Qualtrics. Although covering public, academic, school and special libraries, several of the 14 questions in the 2017 Kroski survey were relevant to the research in this study. As a result, the following four questions in this Scottish survey had a similar focus to the 2017 Kroski survey: "Do any public libraries within your Local Authority provide a Makerspace?", "Which year did your Makerspace open/start?", "Please indicate the resources/activities included in your Makerspace" and "Does your Makerspace offer workshops, events, classes or activity sessions?". These questions were included in this survey to fulfil the research aim of determining how far public libraries in Scotland have progressed in their implementation of makerspaces.

An email survey by Benjes-Small *et al*. (2017, p.429), looking at success factors in 64 academic library makerspaces in the United States included the following free text qualitative question, "Would you consider your makerspace a success? Why or why not?" Acknowledging the difficulties of quantifying the responses, the authors proposed that "Additional research in this area would benefit from the inclusion of a quantitative rating scale on the level of perceived success" (Benjes-Small *et al*., 2017, p.429). These findings prompted the inclusion of a 7-point Likert scale question in this Scottish survey, to gather attitudes on perceived success. With the scale ranging from "Strongly disagree" to "Strongly agree", the following statement was presented, "I consider this Makerspace to be a success". The objective was to determine the types and number of resources, activities, benefits and best practices associated with makerspace 'success'. Bryman (2012, p.166) advises that "The goal of the Likert scale is to measure intensity of feelings about the area in question." To avoid forcing a response to this question, a neutral middle point in the scale, "Neither agree nor disagree", was included.

In addition, to build on existing personal knowledge, several authors (Burke, 2014; Burke and Kroski, 2018) were consulted to assist with decisions relating to the kind of resources and activities to include in the pre-defined list for the question, "Please indicate the resources/activities included in your Makerspace". Likewise, "tips and tricks" outlined by Willingham and De Boer (2015, pp.119-122), best practice findings by Boyle *et al.* (2016) and results from the Libraries Taskforce masterclasses in England (Chandler, 2017a; 2017b) helped inform the types of best practices to include in the questionnaire.

Connaway and Radford (2017, p.111) advise that in the field of Library and Information Science (LIS), a questionnaire will usually "consist of a variety of questions addressing a number of components of a broader topic." This questionnaire consisted of 18 questions. The first question, "Please choose your Local Authority from the list below" was the only mandatory question in the form of a drop-down list, where the participant could choose their local authority. Being the first question in the survey, the question type was chosen carefully to make the response as easy as possible for the participant. This was to encourage participation from the beginning and to set the tone for the rest of the questionnaire. No other questions were set up with 'forced response' validation, allowing the participant to choose which questions to answer. Four questions were single answer multiple choice, seven questions were multi answer multiple choice, four questions were input (in the form of either a number, year or library name) and, as advised above, one was a 7-point Likert scale question. Ten of the multiple-choice questions, included input boxes in the form of "please enter", "please state", "please specify"), and "Other (please specify)". The question, "If you have any additional comments regarding Makerspaces, please add them below.", provided participants with the opportunity to add to their previous responses.

Not all participants were required to answer all the questions, depending on their answer to the question "Do any public libraries within your Local Authority provide a Makerspace?" Three options were provided, "Yes", "No, but there are future plans" and "No". From this point, the survey flowed in three different directions using Qualtrics branch logic functionality, giving each participant a customised experience by not having to answer irrelevant questions. The tailored survey flow directions can be seen in Appendices D, E

and F. Additionally, for those respondents answering "Yes" to the makerspace question outlined above, depending on the answer to the subsequent question, "How many public libraries within your Local Authority provide a Makerspace?", some may have answered more than 18 questions. The 'Loop & Merge' function was utilised in Qualtrics, automatically repeating the same set of 10 questions once for each library makerspace indicated by the respondent (see Appendix D). Due to the three different survey flows, a decision was made to exclude question numbers, as the numbers would not be continuous. It was thought that this could potentially complicate the questionnaire, resulting in abandonment if participants thought that questions had been missed or that the questionnaire was not functioning correctly.

The questions were designed in such a way as to try and encourage responses and simplify analysis. Wording of questions is very important in a survey, as unlike in interviews, they do not allow for clarification (Bryman, 2012). Attempting to follow 'design rules', outlined by Bryman (2012, pp.255-258), the questionnaire strived to avoid the following question types: leading, general, ambiguous, double-barrelled, long, technical and questions including negatives such as "not like". The majority of questions were closed, allowing the participant to select answers from a pre-defined list, generating factual, numerical and opinion-based data, which could be converted into usable statistics. Closed questions are easier to analyse and quicker for the respondents to complete. Fink (2003, p.18) advises that "the results lend themselves more readily to statistical analysis and interpretation". However, there is a risk that some possible answers may be missed. As Bryman (2012, p.250) highlights, "There is always the possibility that they might come up with interesting replies that are not covered by the fixed answers that are provided." However, Kerr and Pennington (2018, p.241) advise against using unrestricted free text boxes, by stating, "textboxes encourage spontaneous response, though this complicates analysis and should be avoided."

To counter these potential issues and to "provide a full range of responses" (Kerr and Pennington, 2018, p.241), seven of the multiple-choice questions included an option "Other (please specify)", so that participants could add to items in the pre-defined list (Bryman, 2012; Fink, 2003). This is "useful when the intricacies of an issue are still

unknown" (Fink, 2003, p.17) and can produce "rich" (Braun and Clarke, 2013, p.4) qualitative data. In this case, to gain a deeper understanding of the benefits and challenges and an insight into best practices being followed. While not entirely open-ended, the opportunity for free text answers was provided to a certain degree. According to Fink (2003, p.17), open-ended questions are important because "some respondents prefer to state their views in their own words and may resent having to choose from among preselected answers." The answers provided by the participants were used to good effect in supplementing the more numerical data.

The only fully open-ended question, "If you have any additional comments regarding Makerspaces, please add them below.", sought to capture attitudes and opinions that could not be expressed through the closed questions. The number of open-ended questions was limited, as questionnaires can be abandoned if they involve too much user input. It is very much a 'balancing act', aiming to keep the questionnaire as short as possible, while long enough to gather sufficient data (Connaway and Radford, 2017). By way of an example, the question, "Please indicate the resources/activities included in your Makerspace (choose all that apply)" typifies the challenging decisions that are required when designing a questionnaire. Initially this question was to be open-ended, as the range of resources and activities in a makerspace can be extensive, making it difficult to include all the variations in a pre-defined list. A compromise was sought due to potential data analysis difficulties with free-text answers and concerns over participant reluctance to input a significant amount of data. Thus, a list of 15 common resources and activities were included in the multi answer multiple choice question, with an "Other (please specify)" option, to try and capture all possible answers.

With every library service being 'gifted' a 3D printer by SLIC in 2015, there was a 'concern' that several authorities would advise that they provided a makerspace, even if this was not an accurate picture. As highlighted earlier in the literature review, Burke (2014, p.113) argues that 3D printing is the "signature element of makerspaces". Having access to a 3D printer however, does not necessarily mean that a makerspace has been implemented, particularly if the 3D printer is not being actively used. In the Participant Information Sheet, the statement, "For the purposes of this study, Makerspaces can be defined as a place to

gather, create and collaborate" was added to highlight the definition being used in this study. Careful thought was therefore given as to the wording of the 3D printing and makerspace questions, so that a 'true' reflection of makerspaces in Scotland was established. To achieve this, the 3D printing ("Is 3D printing offered as an activity within any public library in your Local Authority?") and makerspace ("Do any public libraries within your Local Authority provide a Makerspace?") questions were asked separately.

3.3.2 Testing the survey

Pilot testing of the questionnaire was conducted on a small group and a first draft was sent to the dissertation supervisor. Testing is a crucial element of the whole process, as designing the survey well can result in an increased response rate amongst participants (Bryman, 2012; Connaway and Radford, 2017). The consent question was tested to make sure that participants could not progress to the survey without giving the appropriate approval. Branch logic was checked, confirming that the survey flowed in one of 3 directions, at the appropriate point; "Yes", "No, but there are future plans" and "No". The 'Loop & Merge' function was tested by entering a variety of numbers for the question, "How many public libraries within your Local Authority provide a Makerspace?", to try and replicate possible answers. Furthermore, email distribution was tested by checking emails were being sent to correct test email addresses and verifying the survey link in the email worked correctly. In the Data & Analysis section, test responses were reviewed in the 'View Responses' section.

After the first round of testing, suggestions were proposed and amendments made. Navigation was improved by adding text to the arrows, such as, 'Previous' and 'Next'. Wording was updated on particular questions for succinctness, various single answer multiple choice questions were correctly updated to multi answer and some options listed in the multiple choice questions were removed or merged for clarity and concerns over questionnaire duration. The original best practice questions were deemed ambiguous in the feedback received by all of the testers, and were therefore split into two questions and reworded accordingly. The questionnaire underwent another round of testing before being finalised, with timings noted. Participants were expected to take between 5-10 minutes to

complete the survey. Ideally, no longer than 10 minutes, as overly long surveys can discourage participation or cause participants to leave the survey before submitting. It was difficult to predict exact timings however, as the number of makerspaces in each local authority was unknown. The number entered by the participant for the question, "How many public libraries within your Local Authority provide a Makerspace?" impacted the duration of the questionnaire, with the same set of 10 questions being asked for each makerspace identified as a result of the 'Loop & Merge' functionality. Additionally, survey length also depended on the amount of free text added by the participants in the "Other (please specify)" and additional comments questions.

3.3.3 Gaining ethical approval

Before distributing the questionnaire to the target population, ethical approval was sought and received through the Departmental Ethics Committee. Ethical approval is required for any "investigations involving human participants" (University of Strathclyde, 2017, p.4). Several steps were taken to ensure ethical research was being undertaken. While the literature is mostly supportive of makerspaces in public libraries, limited research in Scotland meant that attitudes and opinions were very much unknown. It was decided that this survey would be anonymous, with no personal information being requested, as it was not required for the purposes of the study. It was hoped that this anonymity, together with the individual libraries not being named would encourage participation, irrespective of the views being expressed. Sometimes participants feel that they can be more honest if a survey is anonymous. The 'Anonymize Responses' setting was chosen in Qualtrics, ensuring that participant responses could not be connected to an IP addresses and location data (Qualtrics, 2019). Responses captured through Qualtrics were held on secure, password protected University of Strathclyde servers and the data was securely stored on the University H: drive.

As advised previously, apart from the first compulsory question, 'Please choose your Local Authority from the list below', all questions were optional. Local authority and library name information was collected for the purposes of high-level statistics and for creating a colour-coded map of Scotland, representing makerspace and 3D printing use and plotting the

public library makerspaces, by type. In line with ethical procedures, a participant information sheet and consent form were provided for the participants (see Appendices B and C respectively). The main points outlined in the information sheet were: purpose of the study, what the study intended to achieve, general description of participant instructions, how and where the data would be reported and the expected duration of the questionnaire. Informed consent is a requirement (University of Strathclyde, 2017, p.17), ensuring that participants know what they are being asked to do beforehand, so they don't feel pressured to take part. The consent form highlighted that participation was voluntary and that the survey was anonymous.

3.3.4 Recruitment of participants

Having established the population, participants were initially recruited through Qualtrics email distribution. Although not directly relevant to this dissertation in terms of topic, the study 'Public library mobile apps in Scotland: views from the local authorities and the public' (Kerr and Pennington, 2018) provided insight into distributing a survey to local authorities in Scotland. For this dissertation, 32 generic email addresses were identified through individual library websites, or confirmed by phone calls as required, the majority of which were general library service emails. Where one did not exist, the survey was sent to either a generic local authority email address or a culture and leisure services email, as occasionally they provide the library service for the local authority. Each authority received an introductory email, with a link to the survey requesting that it be forwarded onto the relevant person in the library service. A generic email was used, instead of approaching individuals, as this could be seen as coercion; pressurising people to undertake a survey that they did not want to take part in.

After one week of the survey being live, a reminder email was sent to the same generic emails as noted above. Due to a limited number of responses after the first two weeks of the survey being open, it was decided that a reminder would be sent to the local authority library services using the Qualtrics Twitter distribution. This reminder was retweeted by the dissertation supervisor and subsequently by SLIC, with the aim of increasing the response rate.

3.3.5 Supplementing the data collection method

With the aim of this dissertation being a nationwide study of makerspaces in Scotland, a supplementary approach was required due to the response rate from the web-based questionnaire being lower than anticipated. An initial approach to phone libraries in the local authorities, asking if they provided a makerspace and utilised a 3D printer was not feasible in the time remaining for the study. It became evident after a number of phone calls that an alternative approach was necessary, as difficulties arose including; being provided with an email address to direct the question to as the relevant person was on holiday and due to a makerspace being an unknown concept for some phone call recipients.

A decision was therefore made to primarily consult library service websites and associated social media platforms, to determine if makerspaces existed and if 3D printing was being offered as an activity. The aim being, to establish a more comprehensive picture of the makerspace and 3D printing landscape in Scotland.

3.4 Data Analysis

According to Bryman (2016, p.12), data analysis is "The management, analysis and interpretation of the data." Qualtrics was initially used to review each response via the 'View Response' option, checking for incomplete and erroneous data. With the findings being of potential interest to the Scottish Library and Information Council (SLIC), the 32 local authority library services, including the 3D printing champions and branch libraries across Scotland, the aim was to present the results in as clear and concise a way as possible for the intended audience. Thus, a statistical package such as SPSS was not required for this analysis. The questionnaire responses were exported into Excel to produce descriptive statistics, in the form of charts and tables, from the data collected from the closed questions.

Kerr and Pennington (2018, p.241) advise, "The main principle of content analysis is the identification of emergent themes and key concepts, sorting these into categories and establishing relationships." Basic content analysis was used on some of the responses provided in the free text "Other (please specify)" boxes and on the additional comments question. Due to the limited number of free-text questions and responses, the use of a content analysis tool such as NVivo was not required to facilitate this analysis. Key concepts, themes and categories were identified, however there was insufficient data to necessitate determining relationships and frequency.

4. Findings and Analysis

4.1 Introduction

The survey closed on 11th July 2019, with 25 recorded responses in Qualtrics. This included six 'Responses in Progress', which moved to 'Recorded Responses' when 'Pause Response Collection' was activated at survey close. However, seven of the recorded responses were unusable, as six of the respondents didn't proceed after selecting "Yes" for the Consent question and one respondent read the introductory page but didn't proceed to the Consent question. Another response was a partial response, with the respondent only answering the first five questions. In addition, two of the local authorities responded twice, firstly through the original email link and secondly through the Twitter link. Both answered the question, "Do any public libraries with your Local Authority provide a Makerspace?" in a different way the second time. The first response chosen was "No, but there are future plans", while the second response was "No". A decision was taken to only include the first response in the analysis, with the second response being discounted.

Taking into account the above, for the purposes of this dissertation a decision was made to only include complete responses in the analysis. In line with the calculation outlined by Bryman (2012, p.199), the survey resulted in a response rate of 47%, as a total of 15 complete and valid survey responses were received.

$$\frac{number\ of\ usable\ questionnaires\ (15)}{total\ sample - unsuitable\ or\ uncontactable\ members\ of\ the\ sample\ (32)} \times 100\ = 47\%$$

Forming the basis of these results therefore, are 15 local authority library services, representing a total of 165 libraries across Scotland. Within this Findings section, the local authority library services will be referred to as authorities. As advised in the Methodology section (see 3.3.5 Supplementing the data collection method), in addition to the survey responses, supplementary research was undertaken to try and ascertain a more comprehensive picture of the makerspace and 3D printing landscape in Scotland. Library

service websites and associated social media platforms were consulted, together with phone calls, to determine if makerspaces existed and 3D printing was being offered in other local authority areas.

4.2 3D printing provision

The question, "Is 3D printing offered as an activity within any public library in your Local Authority?", sought to determine the extent to which 3D printing is currently being utilised in public libraries in Scotland. As Figure 1.8 shows, of the 15 authorities who completed this question, 12 offer 3D printing, while three are not currently offering this service. Additionally, eight of the authorities offering 3D printing do not currently provide a makerspace, although six authorities have indicated future plans. Furthermore, one authority that does provide a makerspace does not currently offer 3D printing as the printer is faulty.
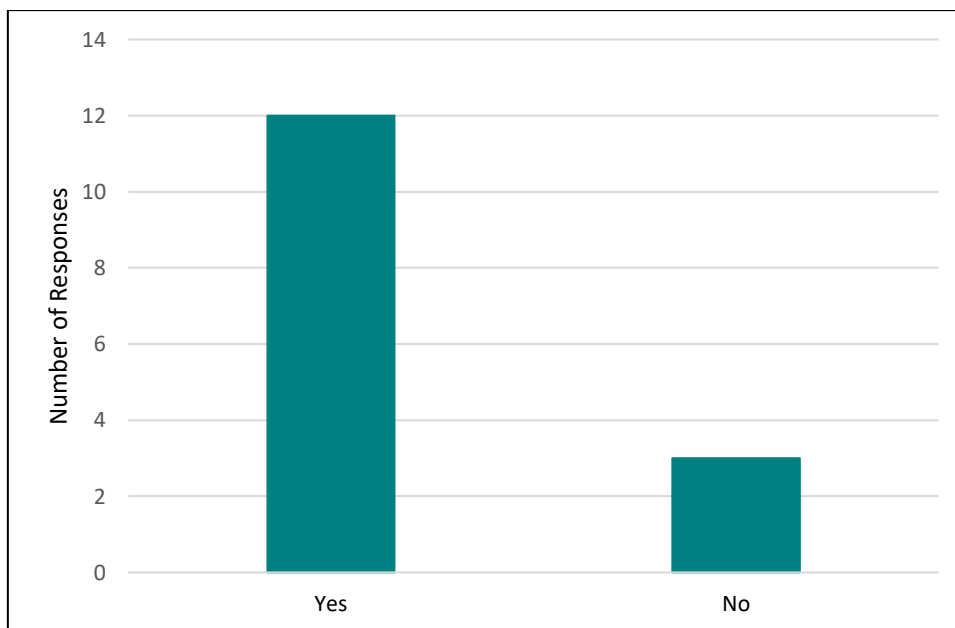
Figure 1.8 - Local authority 3D printing provision

With regards to the authorities who do not currently provide 3D printing, the overriding factors outlined were that the 3D printers were either faulty or unreliable. An authority that usually provides 3D printing as part of its makerspace, does not currently provide this service, due to the printer being faulty, advising that they are "*exploring how to fix it and*

looking at a refurb machine". Typically, the 3D printer would be used in their branch libraries. One authority advised that their 3D printer is used on occasion, in a controlled manner, at "*Digital Drop-ins, and other digital and STEM events*", however it is regarded as being "*too unreliable to be available for permanent use*".

The 3D printing question asked the respondents who answered "Yes", to indicate the number of libraries within each authority offering 3D printing as an activity. This was to determine the actual number of libraries providing this service. The 12 authorities that said "Yes" to 3D printing are responsible for 131 libraries. However, three authorities (responsible for a total of 33 libraries) refrained from indicating how many libraries in their authority offer 3D printing and were discounted from this further breakdown. Thus, out of a total of 98 libraries (across nine authorities), 35 libraries are offering 3D printing as an activity. In two of the authorities, 3D printing is being offered as an activity in every library in the authority. Conversely, in 7 out of 9 authorities, 3D printing is not currently offered as an activity in all libraries, with six authorities offering it to less than a quarter of the libraries within their authority.

4.3 Makerspace provision

In seeking to determine the extent to which makerspaces are currently being used in public libraries in Scotland, the question, "Do any public libraries within your Local Authority provide a Makerspace?" was asked. As Figure 1.9 shows, five authorities currently provide a makerspace, six do not, but have future plans to do so and four do not provide a makerspace.

4.3.1 Public library makerspaces

Each authority who answered "Yes" to having a makerspace, were asked to state how many public libraries within their authority provide a makerspace. A total of eight library makerspaces exist across the five authorities who answered "Yes", with five makerspaces having opened in 2017 and three in 2018. With regards to the breakdown of makerspaces, by authority, three of the authorities have implemented one makerspace each, one

authority provides three makerspaces and another authority has implemented two makerspaces.
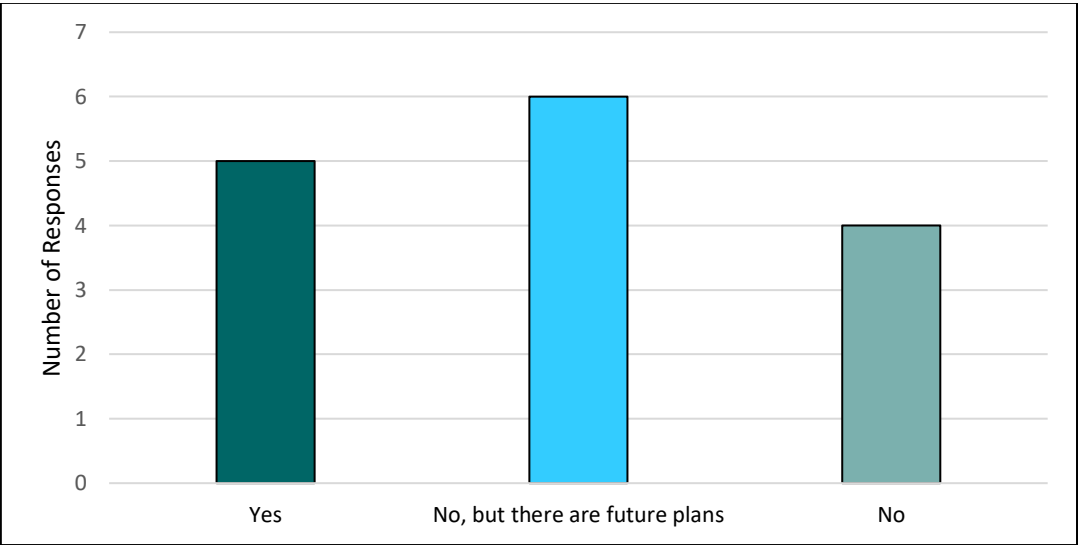
Figure 1.9 - Local authority makerspace provision

Type of space

Table 1.1 shows the different types of space provided. The majority of makerspaces (5 out of 8) indicated that they provide a permanent space, two makerspaces offer 'pop-up' facilities and two makerspaces advised that their type of space is a combination of types. Both are shared spaces, offering drop-in facilities, with one of the spaces permanent.

Table 1.1 - Makerspace by type

Type of space	# Responses	Percentage (%)
Permanent	5	62.5
Pop-up	2	25.0
Drop-in event	2	25.0
Shared within the library	2	25.0
Mobile	0	0.0
Temporary	0	0.0
Other	0	0.0

Resources and activities

Table 1.2 details the resources and activities provided in each makerspace. Each respondent could choose all of the resources and activities that applied to their makerspace. 3D printing and coding are offered in all eight makerspaces, with arts and crafts, gaming and invention kits well represented in 6 out of 8 makerspaces. Half of the makerspaces offer resources such as animation, Raspberry Pi/Arduino/BBC Micro:bit and video editing.

Table 1.2 - Resources/activities included in each makerspace

Resources/activities	# Responses	Percentage (%)
3D printing	8	100.0
Coding (e.g. Scratch, Kodu)	8	100.0
Art & Crafts (e.g. sewing, knitting, jewellery, painting)	6	75.0
Gaming (e.g. Minecraft, Osmos)	6	75.0
Invention kits (e.g. robotics, Makey Makey, LEGO Mindstorms)	6	75.0
Animation	4	50.0
Raspberry Pi/Arduino/BBC Micro:bit	4	50.0
Video editing	4	50.0
Digital sound recording	3	37.5
Other	3	37.5
Photography (including editing)	3	37.5
Scanning	3	37.5
Virtual reality	3	37.5
3D Modelling (computer graphics)	2	25.0
Electronics	2	25.0
Website creation	1	12.5

Of those libraries responding with "Other (please specify)", one of the libraries advised that "*wide format printing on a variety of media*" was taking place in their makerspace, with another indicating that digital sound recording would be offered soon. Another library advised, "*We have other resources that we are getting ready to promote - Code-a-Pillars, Ozobots, access to Arduinos, access to 3d-scanners, access to PC with computer graphics design, access to Adobe Cloud software, animation, green screen, film club, etc.*"

Workshops, events, classes and activity sessions

In response to the question, "Does your Makerspace offer workshops, events, classes or activity sessions?", all eight makerspaces advised that they did in one form or another. Four makerspaces advised that they offer all of these, with three makerspaces advising that these are provided "*across a range of subjects*". Further ways in which the spaces are being utilised are as follows: coding clubs, Minecraft sessions, craft sessions, junior events, "Yap & Yarn sessions", summer reading challenge events, Bookbug events, book launches, community events and charity events.

Benefits from implementing a makerspace

In trying to establish benefits resulting from the implementation of a makerspace, the following question was asked, "Please indicate any benefits from implementing your Makerspace". Each respondent could choose all of the options that applied to their library, as shown in Table 1.3. All eight libraries indicated that the promotion of STEM/STEAM activities was a benefit from running their makerspace, while seven libraries cited partnership building. Community engagement, an increase in library users and social and digital inclusion was seen as a benefit by 6 out of 8 libraries. Adding to the list of benefits, helping small business start-ups, was outlined by one library.

Table 1.3 - Benefits from implementing a makerspace

Benefit	# Responses	Percentage (%)
Promotion of STEM/STEAM activities	8	100.0
Partnership building (with schools, universities, local companies, community groups)	7	87.5
Community engagement	6	75.0
Increase in library users	6	75.0
Social and digital inclusion	6	75.0
Increased creativity and critical thinking	5	62.5
Other	1	12.5

Challenges encountered with implementing a makerspace

The most cited challenge, indicated by all eight libraries is staffing, as shown in table 1.4. Physical space issues are encountered by 5 out of 8 libraries, while three indicated, funding and ongoing costs. In addition to the challenges listed in the questionnaire, two libraries highlighted technical problems with 3D printers and one library felt that the library service was being undervalued, thus being a "*long-term target for budget cuts and not invested in*".

Table 1.4 - Challenges encountered implementing a makerspace

Challenge	# Responses	Percentage (%)
Staffing issues (training, time constraints, resistance to change)	8	100.0
Physical space	5	62.5
Funding	3	37.5
Ongoing costs (maintenance & replacing consumables)	3	37.5
Other	3	37.5
Equipment selection	2	25.0
Promoting the space	1	12.5

Resources utilised to gain knowledge

In response to the question, "During the implementation of your Makerspace, were any of the following resources utilised to gain knowledge? Table 1.5 shows that 6 out of 8 libraries had used library websites/social media and published literature. Whilst, five libraries had utilised libraries with existing makerspaces and workshops/events/conferences to gain knowledge. Two of the libraries indicated that none of the resources had been utilised, while one library added to the pre-defined list of choices, advising that they had used "*basecamp network*" to acquire relevant knowledge.

Table 1.5 - Resources utilised to gain knowledge

Resources used to gain knowledge	# Responses	Percentage (%)
Library websites/social media	6	75.0
Published literature	6	75.0
Libraries with existing Makerspaces	5	62.5
Workshops/events/conferences	5	62.5
Masterclasses	3	37.5
None	2	25.0
Other	1	12.5
University Makerspaces	1	12.5

Practices used in the running of the makerspace

As shown in Table 1.6, the use of social media for marketing/promotion and building partnerships are the most common practices being used in the running of a makerspace, with 7 out of 8 makerspaces utilising these. Customisation of space to meet community needs and developing specific training models for patrons and staff are practices used by 5 out of 8 libraries. Half of the libraries are providing appropriate resources by having defined a clear purpose for the makerspace and are implementing health and safety policies where required. All of the eight libraries are using some form of practice to help with the running of the makerspace.

Table 1.6 - Practices used in the running of the makerspace

Practices used	# Responses	Percentage (%)
Use of social media for marketing/promotion	7	87.5
Building partnerships (with experts, schools, universities)	7	87.5
Customising your space to meet community needs	5	62.5
Developing specific training models for patrons and staff	5	62.5
Defining a clear purpose and providing appropriate resources	4	50.0
Implementing specific H&S policies	4	50.0
Keeping up to date with trends/news	3	37.5
Other	0	0.0
None	0	0.0

Success of the makerspace

The libraries were asked for their opinion on whether they considered their makerspace to be a success, by choosing one of 7 options on a Likert scale, ranging from "Strongly disagree" to "Strongly agree". The following statement was presented to the participants, "I consider this Makerspace to be a success". As shown in Figure 2.0, half of the libraries chose the option "Strongly agree", one library chose the option "Agree", two chose "Somewhat agree" and one chose "Neither agree or disagree". None of the libraries disagreed with the statement.
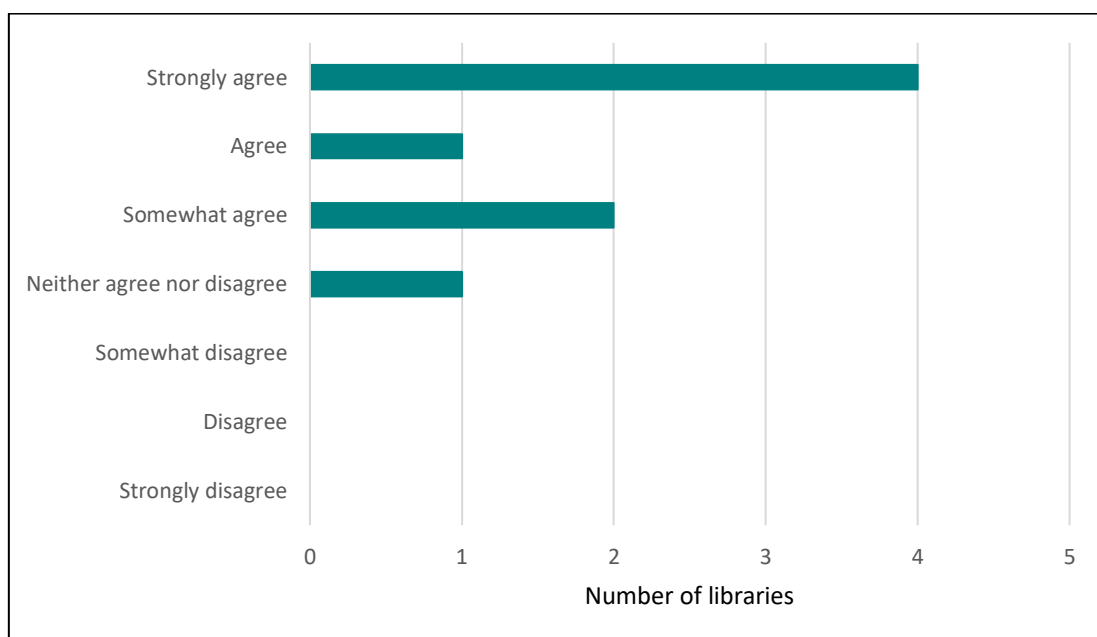
Figure 2.0 - Do you consider your makerspace to be a success?

4.3.2 Authorities with future plans

Six of the local authorities advised that they have future plans to provide a makerspace. With regards to a proposed date for implementation, five of the authorities advised that there is no proposed date, with one authority advising the year 2020. Currently, all six of these authorities (responsible for 78 libraries) offer 3D printing as an activity, across 21 libraries. This figure of 21 libraries does not include the two authorities that did not advise on how many libraries in their authority offer 3D printing as an activity.

4.3.3 Authorities with no makerspace

The four authorities who advised that they are not currently providing a makerspace, were asked to outline the reasons for this decision, as shown in Table 1.7. Each respondent could choose all of the reasons that applied to their authority. Physical space and staffing issues were a factor for 3 out of 4 authorities. Adding to the list of reasons, one library advised that they hadn't implemented a makerspace because they "*haven't been aware of them*".

Table 1.7 - Reasons for not implementing a makerspace

Reason	# Responses	Percentage (%)
Physical space	3	75.0
Staffing issues (training, time constraints, resistance to change)	3	75.0
Budget constraints	1	25.0
Expense of equipment	1	25.0
Low priority	1	25.0
Management decision	1	25.0
Other	1	25.0

4.3.4 Additional comments

Of the 15 authorities who responded to the questionnaire, seven authorities added additional comments when asked, "If you have any additional comments regarding Makerspaces, please add them below." Below are comments from four of the authorities currently providing a makerspace (library names and areas have been anonymised):

"*Makerspace project has engaged a wide range of the community and revitalised the library service in …, providing a model for future expansion across …*"

"*Makerspaces are always a work in progress. We're striving to do more and better but it's a struggle when it's not recognised as a core strategic aim of library services.*"

"*Although we do not have a dedicated Makerspace, we use available rooms and spaces within the library building to allow community groups to use the space, hold craft sessions and junior sessions.*"

"Our current Makerspace has been such a success we are currently in the process of buying equipment to set up four more Makerspaces in rural … so that the communities in less built-up areas will have easy access to the various technologies we offer in …. We hope to start installing the new Makerspaces at the end of July. Although they will have a core set of equipment we are hoping to customise each to local requirements and there will also be extra items which can be booked and moved around as needed."

Key themes identified in the above free text answers, together with categories, are shown in table 1.8. There was insufficient data to necessitate determining relationships and frequency. The most common theme identified from the four responses was 'Community', with key themes identified as: community engagement, community groups, community access and customising the space for the community.

Table 1.8 - Key themes – authorities with makerspaces

Participant comment	Key theme	Category
"engaged a wide range of the community"	Community engagement	Community
"to allow community groups to use the space"	Community groups	
"communities in less built-up areas will have easy access to the various technologies"	Community access	
"we are hoping to customise each to local requirements"	Customise space	
"revitalised the library service in the area"	Revitalisation of library service	Benefits
"current Makerspace has been such a success"	Successful	
"providing a model for future expansion across the local authority"	Benchmark	Best practice
"future expansion"	Expansion	
"to set up four more Makerspaces in rural areas"		
"always a work in progress"	On-going	Challenges
"but it's a struggle when it's not recognised as a core strategic aim of library services"	Undervalued	
"we use available rooms and spaces within the library building"	Shared space	Type of space

Three authorities not currently providing a makerspace, but who have future plans to do so, provided the following comments (areas have been anonymised):

> "*The start-up cost of introducing a makerspace would be challenging enough, but ensuring any equipment remains relevant and sustainable is a real obstacle.*"

> "*We visited a library in …, who had received funding for a Makerspace. We were looking for similar funding before beginning to make suitable progress. We also hope to work closely with the local college which has already invested in a number of new technologies. It is hoped we can facilitate a number of temporary Makerspaces.*"

> "*We hope to offer a variety of services including knitting, sewing and craft services as well as traditional IT services.*"

Key themes identified in the above free text answers, together with categories are shown in table 1.9. As with the previous free text responses, there was insufficient data to necessitate determining relationships and frequency. The most common theme identified from the three responses was 'Challenges', related to funding and sustainability of equipment in the makerspace.

Table 1.9 – Key themes – authorities with future plans

Participant comment	Key theme	Category
"*start-up cost of introducing a makerspace*"	Funding	Challenges
"*We were looking for similar funding before beginning to make suitable progress*"		
"*ensuring any equipment remains relevant and sustainable is a real obstacle*"	Sustainability	
"*hope to work closely with the local college*"	Local partnership	Benefits/Resources
"*hoped we can facilitate a number of temporary Makerspaces*"	Temporary	Type of space
"*We hope to offer a variety of services including knitting, sewing and craft services as well as traditional IT services.*"	Resources	Service provision

4.4 Supplementary data collection

As noted earlier, an additional method of data collection was carried out to supplement the survey results, with the aim of providing a fuller picture of makerspace and 3D printing coverage in Scotland. Through checking library service websites and associated social media platforms, an additional three authorities were deemed to be offering 3D printing as an activity within their authority. Therefore, based on survey results and this additional research, Figure 2.1 shows a total of 15 local authorities offering 3D printing as an activity in their authority. Provision of 3D printing in some areas could not be determined by checking library service websites and associated social media platforms, as the information available was inconclusive.

Figure 2.1 - Local authority 3D printing provision (survey results and additional research)
(Original blank map available at https://d-maps.com/carte.php?num_car=18227&lang=en)

As regards makerspace provision, a further four local authorities were identified, from information gained from phone calls, library service websites, associated social media platforms and personal knowledge. Consequently, the local authority makerspace landscape map (Figure 2.2) shows a total of nine local authority library services providing a makerspace. The provision of makerspaces in some areas could not be determined by checking library service websites and associated social media platforms, as the information available was inconclusive.
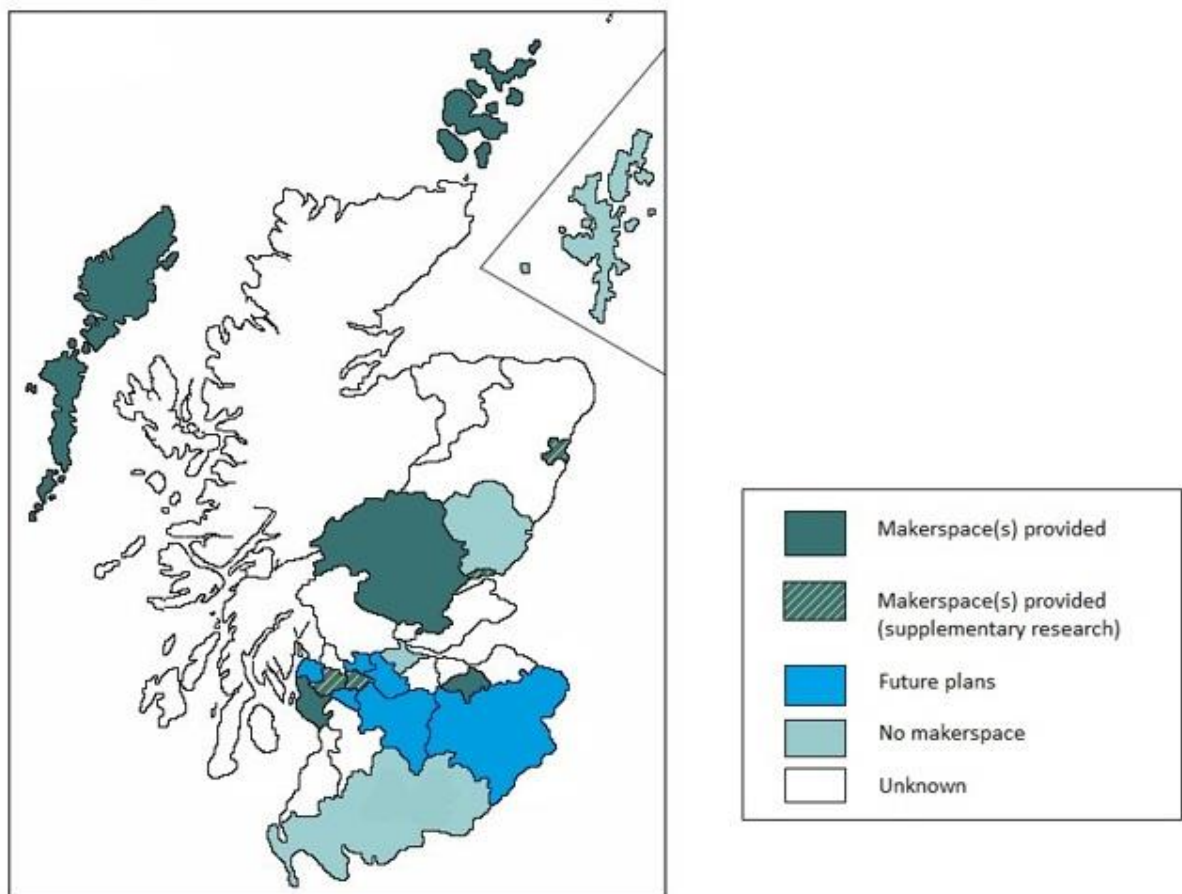
Figure 2.2 - Local authority makerspace landscape of Scotland (survey results and additional research)
(Original blank map available at https://d-maps.com/carte.php?num_car=18227&lang=en)

In addition, Figure 2.3 plots a total of 12 makerspaces currently operating in Scotland, deemed from survey results (eight makerspaces) and additional research (four makerspaces). It should be noted that authorities with future makerspace plans, libraries who consider themselves to have a makerspace and authorities who offer 3D printing, may be underrepresented on these maps (Figures 2.1, 2.2 and 2.3), as this information could

not be accurately established from the additional sources utilised. For example, in the past few months a library has been showcasing their 3D printer on Facebook indicating future plans to make this a library service. As to whether this service is currently being provided, could not be confirmed through web or social media sources.
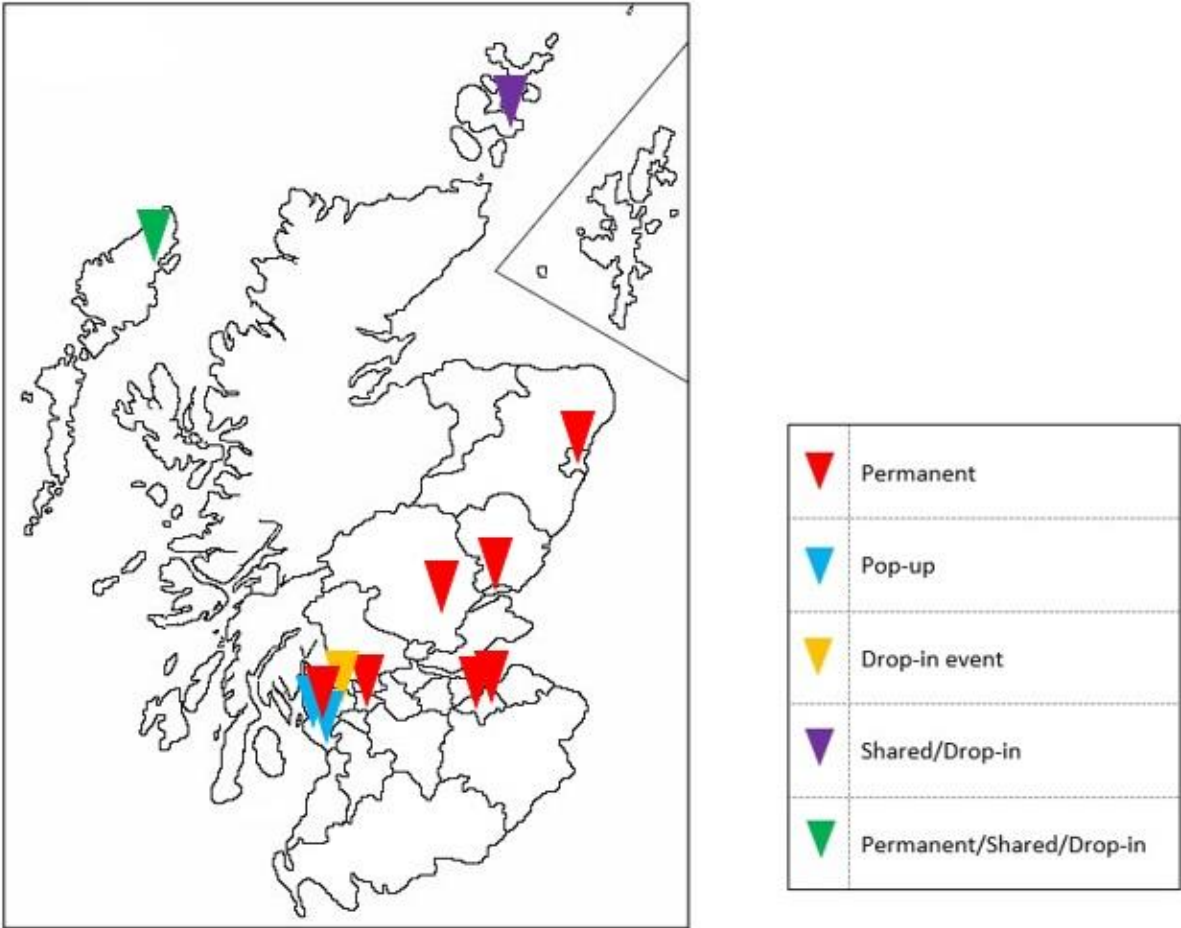
Figure 2.3 - Makerspace provision in public libraries in Scotland (survey results and additional research)
(Original blank map available at https://d-maps.com/carte.php?num_car=18227&lang=en)

As indicated in the Literature Review, defining a makerspace is difficult, due to subjectivity and the uniqueness of these spaces. Therefore, some library services who consider themselves to have a makerspace, may not be plotted on Figure 2.3, due to the difficulty in determining if the activities and events (i.e. coding clubs, craft sessions, knitting clubs) highlighted on their websites and social media sites constitute a makerspace, particularly with the word itself not being evident. Thus, the exact number of makerspaces may be underrepresented. For example, one authority plotted on Figure 2.3 hosts drop-in digital

events at a number of libraries, thus the number of spaces operating as makerspaces is unknown. Additionally, one of the makerspaces plotted on Figure 2.3 as a result of the additional research, is close to being launched by the authority. A decision was made to include this makerspace on the map.

4.5 Discussion

While not the large-scale study of Scotland desired at the onset, with a response rate of 47%, the responses from the 15 local authority library services represent 165 libraries across Scotland. As a subset of the total number of public libraries in Scotland, nationwide generalisations are unable to be derived, however this study provides key insights into the makerspace landscape of Scotland, together with the use of their related technologies such as 3D printers. The results provide details on the type of space being offered by public libraries in Scotland, together with resources, activities and events within each makerspace. The most common benefits and challenges are highlighted, together with the types of resources used to gain knowledge on makerspaces and the best practices that are currently being followed. The findings will be discussed within the context of each research question.

4.5.1 Public library 3D printing provision

To what extent is 3D printing currently being utilised in public libraries in Scotland?

Although unable to present a full picture of 3D printing activity across Scotland, valuable information is provided by the 15 survey responses. Having been 'gifted' 3D printers by SLIC in 2015, this study looked to determine if 3D printing is actually being used within the library services and to what extent. As Kelly (2013, p.1), argues, "Simply dropping a 3D printer into your public access system isn't enough - the community needs to engage with the space…." Moreover, Willingham and De Boer (2015, p.78) advise that 3D printer use in libraries varies significantly, with some libraries offering wide-ranging activities, whereas other libraries "exhibit" their 3D printer, like they would a gadget.

The majority of authorities represented in the survey, 12 out of 15 (80 per cent) offer 3D printing as an activity in at least one library in their authority, while three are currently not offering this service. A further three authorities, as a result of supplementary research are understood to be offering this service within their authority, giving a total of 15 authorities. Focussing on the nine authorities in the questionnaire, that provided 3D printing figures; out of a total of 98 libraries, 35 libraries are offering 3D printing as an activity.

With only two authorities, out of the nine who provided library figures, offering 3D printing as an activity in all of their libraries in their authority and 6 out of 9 authorities providing this activity in less than a quarter of its libraries, further research is required in this area. Determining the reasons for 3D printing not being offered on a more widespread basis within each authority and in what way the printers are being used, requires to be explored. One would expect cost is a factor; transporting a 3D printer and associated 'paraphernalia' throughout numerous library branches is expensive, especially in the larger more remote authorities. One of the authorities indicated that "One 3D printer moves around all libraries for events and courses". Determining the logistics of this would be beneficial for other authorities hoping to offer a similar service.

Well documented throughout the literature are the challenges related to 3D printing in libraries. Previous research, in particular by Moorefield-Lang (2014), has identified issues such as unreliability and on-going maintenance. This study has raised similar issues, with one authority advising that their printer is "too unreliable" for permanent use, another that their device is not functioning and one authority, that usually offers 3D printing as part of their makerspace, not currently able to do so, as the printer is faulty. In addition to the authorities not offering 3D printing due to the issues highlighted, two makerspaces cited technical problems with 3D printers as being a challenge.

The on-going costs and support that 3D printing entails, is a significant challenge for public libraries wishing to offer this as an activity and certainly requires to be taken into consideration at the onset. The issues with 3D printing appear to be universal, as studies within a variety of countries have identified similar issues (Massis, 2013; Moorefield-Lang, 2014; 2015a; Slatter and Howard, 2013). As a recurring theme, for libraries offering this

service, either within a makerspace or not, attention requires to be paid to these difficulties before they become an unsurmountable barrier to new technologies being introduced in public libraries or to makerspace development. The makerspaces and libraries within Scotland, that are regularly using their 3D printing facilities can offer valuable insights into dealing with these 3D printing challenges.

4.5.2 The extent of makerspaces in public libraries

How far have public libraries in Scotland progressed in their implementation of makerspaces since 2015?

The survey results confirm, that since SLIC 'gifted' 3D printers to all 32 local authority library services in Scotland in 2015, eight makerspaces have been implemented in public libraries in Scotland, with five having opened in 2017 and three in 2018. Supplementary research indicates a further four makerspaces, however opening dates are not available for those. Thus, 12 makerspaces are currently in existence in Scotland, across nine local authorities, with a further six authorities advising that they have future plans to implement a makerspace. Operating within a positive strategic framework for makerspace technology within public libraries in Scotland, as highlighted in the strategy documents 'Ambition and Opportunity: A strategy for Public Libraries in Scotland 2015 – 2020' (SLIC, 2015; 2019), it is evident that progress is being made. Given that current makerspace provision and future plans may be underrepresented in this study, due to the fact that not all 32 local authorities completed the questionnaire, the extent of makerspace coverage within public libraries in Scotland could be somewhat higher.

If future makerspace plans manifest themselves among the six authorities who specified these plans, nearly half of local authority library services within Scotland will be providing a makerspace at some point in the future. With all six of these authorities currently offering 3D printing as an activity, the foundation exists for future progress. Unfortunately, only one authority advised of a proposed date for their makerspace, with 2020 being the stated aim. One of the authorities voiced concerns over the start-up costs involved with the introduction of makerspace and highlighted that "*ensuring any equipment remains*

relevant and sustainable is a real obstacle." Another authority advised that they were hoping for similar funding to that received by an existing makerspace. As with any new library venture there are barriers to overcome; the implementation of a makerspace is no different.

Even across a relatively small number of makerspaces, eight identified in the survey, different types of space exist and a wide variety of resources, activities and events are provided, reiterating the point made in the literature that each makerspace is unique (Britton, 2012; Britton and Considine, 2012; Koerber, 2012; Moorefield-Lang, 2014). The majority of makerspaces in this study are permanent, supporting the view held by Lomax (2012) that the most common type of makerspace is permanent. Additionally, the most common types of resources and activities being offered by the makerspaces in this study are consistent with previous research (Britton, 2012; Burke, 2014; Uzwyshyn, 2015; Willingham and De Boer, 2015), with 3D printing, coding, traditional arts and crafts and gaming being amongst the most popular.

Unsurprisingly, 3D printing and coding are offered in all eight makerspaces, although as noted earlier, this figure includes a makerspace which does not currently offer 3D printing as the printer is faulty. However, the library included 3D printing as one of their resources in the questionnaire as it typically does provide this service. 3D printing is also offered in 2 out of the 4 makerspaces identified in the additional research, reinforcing the view held by several authors, including Burke (2014; 2018) that "the 3D printer reigns as the icon of maker culture." (Willingham De Boer, 2015, p.89)

The implementation of a makerspace is only the start; is the makerspace actually being used, and how effectively? A large number of resources and activities are being offered in the eight makerspaces identified in the survey (see Table 1.2). Additionally, all eight makerspaces advised that they provided either workshops, events, classes or activity sessions, with half of the makerspaces informing that they offer all of these in their makerspace. The effectiveness of these resources, activities, events, workshops and classes are beyond the remit of this study. However, the number and variety on offer indicate an

effective use of space and considerable progress since the introduction of 3D printing by SLIC.

4.5.3 Benefits and challenges

What benefits and challenges have resulted from the implementation of a makerspace?

As alluded to previously, much of the research on makerspaces to date, has focussed on the benefits and challenges from implementing a makerspace. With regards to the benefits, all the options listed in the pre-defined list in the questionnaire were chosen, indicating that makerspaces in Scotland are experiencing similar benefits to other countries. The promotion of STEM/STEAM activities was identified as a benefit by all eight libraries, supporting the view held by Burke (2014) that there has been a drive for STEM skills, to complement the school curriculum.

Certainly in Scotland, STEAM (Science, Technology, Engineering, Art and Mathematics) has been one of the main priorities in the school curriculum over the past number of years. In areas of Scotland where school libraries do not provide a makerspace, local libraries with a makerspace are perfectly placed to compliment the schools, by offering STEM activities. The promotion of STEM/STEAM appears to be established in the eight makerspaces identified in the survey and in the process, are helping to fulfil one of the strategic aims of the national library strategy; the promotion of economic wellbeing by improving STEM skills in children (SLIC, 2015, p.22).

Consistent with previous studies, partnership building with local schools, universities, companies and community groups was indicated as an important benefit, with 7 out of 8 libraries choosing this. This is an encouraging finding, as it is identified as a key aspect of best practice and makerspace success by several authors (Chandler, 2017b; Slatter and Howard, 2013; Willingham and De Boer, 2015).

Arguably the word most commonly associated with makerspaces is 'community'. Well documented in previous studies is the notion that the local community is at the heart of the makerspace, with Burke (2014, p.12) for example, regarding it as a "defining element". Community engagement was chosen as a benefit by 6 out of 8 library makerspaces. Supporting this, as shown previously in Table 1.9, the local community was referenced four times in the additional comments provided by four respondents who are currently running a makerspace, with themes identified as; community engagement, community groups, community access and customising space. Reiterating previous literature on makerspaces (Boyle et al., 2016; Britton, 2012; Burke, 2014, 2018; Kelly, 2013; Willingham and De Boer, 2015), the community is evidently an important focus for makerspaces in Scotland, albeit documented within a limited number of responses.

Apparent from the fact that all the challenges listed in the pre-defined list in the questionnaire were chosen, indicates that makerspaces in Scotland are experiencing similar issues to makerspaces in other countries. All eight libraries indicated that staffing issues (training, time constraints, resistance to change) was one of the challenges encountered with the implementation of their makerspace, a challenge also highlighted by several authors in the literature (Moorefield-Lang, 2014, 2015a; Slatter and Howard, 2013). Implementing a makerspace in an already challenging environment, as is the case with most public libraries today, requires sufficient investment in the librarians tasked with running the new space. As a key challenge identified by several authors (Burke, 2014; Chandler, 2017b; Moorefield-Lang, 2014, 2015a; Slatter and Howard, 2013), training is at the heart of this investment. Further research breaking down the staffing issues would be beneficial, to determine the exact challenges related to training, time constraints for librarians and the reasons for resistance to change by both librarians and patrons.

Several authors (Burke, 2014; Lomax, 2012) have identified physical space as a challenge and this was also chosen as an issue by 5 out of 8 libraries in this study. With five makerspaces indicating that they provide a permanent space in their library, continuing to provide this space may be an on-going challenge. Illustrating this point, one of the libraries advised:

"we're currently being told that our makerspace (the only room the library has where we can have activities) has been offered as office space…so we might not have our Makerspace for much longer."

As advised previously, alternative solutions such as 'pop-up' facilities (Lomax, 2012) and combining the space are feasible and these are options which have been taken by four of the makerspaces. Prioritising library space for a makerspace is an issue many libraries will face at some point, especially in this challenging economic climate. It is very much a balancing act, weighing up the costs versus the potential benefits a makerspace can yield.

Adding to the challenges previously discussed, one of the makerspaces noted in the additional comments, "*Makerspaces are always a work in progress*", which is consistent with previous research (Moorefield-Lang, 2014; Sleigh, Stewart and Stokes, 2015). With constant changes to technology resulting in patron expectations ever increasing, meeting the needs of the local community is an on-going challenge. Very much a characteristic of a makerspace is 'trial and error', which requires dedication and perseverance.

4.5.4 Best practices

What best practices are being followed in the running of a makerspace?

In determining the best practices being followed in the running of makerspaces in Scotland, it was also important to explore if certain resources had been consulted to gain knowledge, especially since makerspaces in public libraries in Scotland are a relatively new concept, compared to other parts of the world. Being in what Slatter and Howard (2013, p.277) refer to as ""uncharted territory", the use of a wide variety of information sources can be vital for successful implementation (Willingham and De Boer, 2015; Witherick, 2016). Encouragingly, 6 out of the 8 libraries, who are currently providing a makerspace had consulted some form of resource to expand their knowledge of makerspaces, with library websites/social media and published literature having been referred to. Only two libraries had not used any form of resource listed. Masterclasses, a popular resource in England for

sharing makerspace knowledge (Chandler, 2017a; 2017a), had been used by three of the libraries.

One of the authorities with future plans to implement a makerspace advised that they had visited an existing library makerspace in Scotland and that they were hoping to work closely with a local college, as it had "*already invested in a number of new technologies*". As new makerspaces are implemented and others evolve, it is envisaged that these resources will be continually referred to or utilised.

As alluded to earlier, with a concept that is relatively new and evolving at a fast pace as technologies constantly change, establishing best practices is a significant challenge. All eight makerspaces are following at least one of the practices listed in the questionnaire. A positive finding considering an option to select 'None' was provided and more importantly, due to the fact that makerspaces in public libraries in Scotland are still in their infancy. The use of social media for marketing/promotion is being utilised by 7 out of 8 makerspaces, not surprising since Twitter and Facebook are used on a regular basis by the library services. Effective promotion of the space is fundamental to success, if patrons are unaware of a makerspace, no matter the facilities on offer, it will not succeed. With collaboration a key aspect in the running of a makerspace, an encouraging finding from the survey is that 7 out of 8 makerspaces recognise the importance of establishing partnerships with experts and establishments such as schools and universities.

As advised previously, libraries require to tailor their makerspace to meet local needs (Britton, 2012; Clark, 2014; Willingham and De Boer, 2015). With regards to customising their space to meet local needs, 5 out of 8 libraries are undertaking this. The importance placed on the training of staff and patrons in using a makerspace has been a recurring theme in the literature (Burke, 2014; Chandler, 2017b; Moorefield-Lang, 2014, 2015a; Slatter and Howard, 2013). Five out of 8 libraries indicated that they have developed specific training models for patrons and staff. These practices will continue to develop as the makerspaces grow and adapt and will provide invaluable advice and expertise to the authorities looking to implement a makerspace in the future and to those makerspaces wishing to make improvements or expand.

With half of the libraries strongly agreeing that their makerspaces are a success, albeit not quantifying in what way successful, the other public library makerspaces and authorities looking to implement a makerspace would be advised to liaise with these makerspaces, to establish the reasons for this perceived success. These four libraries are making good use of their spaces, providing a wide range of resources including, 3D printing, coding, arts and crafts, gaming and robotics, with two of the makerspaces providing, all but one, of the resources and activities listed (see Table 1.2 for the list of resources and activities). All of the libraries offer workshops, events, classes or activity sessions and all six benefits listed in the pre-defined list were chosen by all four libraries (see Table 1.3 for the list of benefits). In addition, a variety of resources were used to gain knowledge during the implementation of their makerspaces, with three libraries having utilised 5 out of the 6 resources listed in the pre-defined list (see Table 1.5 for the list of resources). Similarly, a variety of best practices are being followed in these libraries, with three of the libraries indicating that they follow all seven practices that were listed in the questionnaire (see Table 1.6).

Two of the libraries highlighted 'achievements' in the additional comments, with one stating that their makerspace "*has engaged a wide range of the community and revitalised the library service*" in the area. The other library added, "*Our current Makerspace has been such a success we are currently in the process of buying equipment to set up four more Makerspaces….*" Setting up in surrounding rural areas, the plan was to start installing them at the end of July 2019. As new implementations, these four makerspaces can provide valuable lessons for those authorities hoping to implement a makerspace in the future.

4.5.5 Reasons for not implementing a makerspace

What reasons have influenced the decision not to implement a makerspace?

The two main reasons (physical space and staffing issues) influencing the decision not to implement a makerspace, cited by 3 out of 4 authorities, echo the top two challenges encountered by libraries implementing a makerspace. This finding is not unexpected, as staffing and space issues are significant barriers, not only to implementation of a makerspace, but are also on-going throughout the lifespan of a makerspace.

5. Conclusion

This study aimed to establish the extent to which makerspaces and their related technologies, such as 3D printers, are currently being used in public libraries in Scotland. Taking into account the limitations of the study, it is evident that considerable progress has been made since the introduction of 3D printing in 2015. A total of 15 survey responses, together with supplementary research, indicate that there are currently 12 makerspaces of various type, operating across nine local authorities, with six authorities advising in the survey that they have future plans to implement a makerspace. Two of the makerspaces currently operating, indicated that they have plans to expand, with one advising that they are in the process of setting up a further four makerspaces in rural areas. Four authorities do not currently provide a makerspace. Furthermore, this study found that a total of 15 local authority library services are offering 3D printing as an activity within their authority; 12 authorities confirming this through the survey and an additional three identified from additional sources, specifically library service websites and social media sites.

Unreliability of 3D printing was the main reason cited as to why this is not being offered as an activity, while physical space and staffing issues were the main reasons for not implementing a makerspace. The promotion of STEAM activities was highlighted as a benefit by all eight makerspaces in the survey, while the biggest challenge noted was staffing issues. Encouragingly, all eight makerspaces are using some form of practice in their makerspace, regarded in the literature as best practices. In various stages of implementation, these makerspaces offer a wide variety of resources and activities and provide a range of events, workshops, classes and activity sessions.

Of further interest, was establishing the reasons that have influenced the decision not to implement a makerspace, together with the benefits and challenges that have resulted from the implementation of a makerspace. The findings here were consistent with previous research (Burke, 2014; Lomax, 2012; Moorefield-Lang, 2014, 2015a; Slatter and Howard, 2013), with physical space and staffing issues confirmed as key challenges, not only in deciding whether or not to implement a makerspace but also in terms of implementing one. A key finding of this research are the problems associated with 3D printing, impeding

the ability of some authorities to offer it as an activity and impacting makerspaces providing this resource due to "technical problems".

Through this research it has been demonstrated that makerspaces in public libraries in Scotland are experiencing similar positive outcomes and benefits from their makerspaces, as seen in other countries. Such benefits have included; the promotion of STEM/STEAM activities, local partnership building, community engagement, an increase in library users, social and digital inclusion and increased creativity and critical thinking.

Similar to best practices outlined by Boyle *et al.* (2016) and Willingham and De Boer (2015), the survey established that several practices are currently being deployed by all eight libraries running a makerspace. The most common utilised were: the use of social media for marketing/promotion, building local partnerships, customisation of space to meet local needs and developing specific training models for patrons and staff. Together with the fact that six of these libraries also utilised external information sources to gain knowledge during the implementation of their makerspaces, these positive findings can help foster an ethos of sharing best practice among existing and future makerspaces.

With the ever-present threat of budget cuts and funding issues for library services, makerspaces like all other services require to justify their existence. As previously advised, one authority, with regards to operating a makerspace, commented, "*it's a struggle when it's not recognised as a core strategic aim of library services.*" Another advised that the reason for not implementing a makerspace in their local authority area was because they "*Haven't been aware of them*". Perhaps the value placed on makerspaces in trying to fulfil national strategic aims requires to be reaffirmed with the local authority library services.

On the basis of the findings of this study, the overall outlook for makerspace growth in Scotland is a positive one. Considerable progress has been made in the four years since 3D printing was introduced to Scotland. Significant challenges remain, not least continued economic uncertainty in the UK, requiring public libraries in Scotland to be observant of the context they are operating in and react appropriately (Burke, 2014). With 12 makerspaces currently operating in Scotland and six authorities with future plans, the

groundwork has been laid for an optimistic future. The important role of makerspaces in helping to develop STEM/STEAM skills amongst children was shown by the fact that all eight makerspaces in the survey, considered this to be a benefit from the implementation of their makerspace.

5.1 Survey limitations

Choosing a survey as the data collection method presented various challenges. Firstly, distributing the questionnaire by email and Twitter to 32 generic library service or council email addresses, relies on the questionnaire being passed to the appropriate person to answer the questions. As highlighted previously by Connaway and Radford (2017, p.98), there is a lack of control over whether a questionnaire is completed, accurate and even looked at. Sending follow-up reminder emails does not fully alleviate these issues with reminders also being sent to general addresses. Sending the questionnaire or reminders directly to a targeted participant were not available options, due to ethical considerations, therefore lack of participation was one of the biggest risks. Deploying additional distribution channels (i.e. Twitter) sooner, or in conjunction with emails, could have improved response rates.

Secondly, in endeavouring to mitigate the above potential risks, the following principal measures were taken: keeping the survey length to between 5-10 minutes (this is dependent on the number of makerspaces), limiting the number of open-ended questions and trying to create clear and unambiguous questions. However, even with these measures, limitations with the questionnaire were apparent during the analysis phase of this study. For example, providing a greater number of pre-defined answers to choose from in some of the questions would have resulted in more in-depth analysis. Breaking down answers such as, 'Partnership building (with schools, universities, local companies, community groups' and 'Staffing issues (training, time constraints, resistance to change)' into further options for the respondent to choose from would have allowed for greater granularity in the analysis.

Lastly, the Likert scale question on whether the libraries deemed their makerspace to be a success, provided quantitative data in the form of a perceived success opinion scale. However, this question did not provide an opportunity for the respondent to indicate the reasons for the rating chosen, by way of free text.

5.2 Study limitations

Several factors have limited this study. Out of 32 local authority library services in Scotland, there were only 15 usable questionnaires. A higher response rate would have increased the significance of the results and been more representative of the authorities in Scotland. Generalisations across the whole of Scotland could therefore not be made.

Supplementing the survey results with additional research, by way of phone calls, library service and individual library websites and social media platforms, provided high-level statistics on the number of makerspaces and authorities offering 3D printing. However, gaps in the research from this additional data collection method remain with the possibility that various information may be underrepresented in this study. This includes the following: the exact number of makerspaces within an authority, especially if digital drop-in events are taking place, authorities with future plans to implement a makerspace, or who are providing 3D printing as an activity. This information could not be accurately established from additional sources utilised, in particular library websites and social media sites. Additionally, this study does not take into account makerspaces that may have closed over the past number of years, only new ones that have been established, nor does it establish the motivation behind some authorities wishing to implement a makerspace in the future.

5.3 Future work

As a snapshot of the current makerspace landscape in Scotland, including related technologies such as 3D printers, the findings in this study provide a baseline for further research. Future studies would benefit from conducting a further survey with the aim of gaining responses from all 32 local authority library services to represent the whole of

Scotland. An alternative approach to the survey should be considered, with various distribution methods available.

To gain a greater understanding of the challenges faced and the reasons why some authorities have not implemented a makerspace, in-depth interviews with local authority library services should be conducted. Similarly, to better understand the issues highlighted with 3D printing and staffing, interviews would provide a greater insight into the challenges being experienced. Interviewing librarians who are responsible for running the makerspaces that are currently in operation in Scotland, particularly those deemed a 'success', would substantially expand on the information gathered in this study. Gaining a greater insight into the challenges encountered and benefits achieved from implementing a makerspace, together with further details on the best practices being followed, will be an invaluable resource for future makerspaces. As an alternative to interviews, specific case studies or focus groups should be considered as a way of enhancing current makerspace knowledge In Scotland.

Conducting studies similar to this one in other countries would expand the current literature on public library makerspaces, providing nationwide studies which could be compared at a national level.

5.4 Recommendations

Despite the limitations, these findings provide a basis for future research on makerspaces in Scotland. Taking into account the challenges and benefits highlighted and the best practices being followed by the current makerspaces, this study may also provide valuable insights for the following audiences in Scotland: the local authority library services, libraries either currently running a makerspace or those who have future plans to do so, libraries hoping to expand their current makerspaces or establish further makerspaces in their local area, the 32 nominated library service 3D printing champions and the Scottish Library and Information Council (SLIC) who introduced 3D printing to all local authority library services in Scotland.

This study makes the following five recommendations:

- With makerspaces being a key component of the national strategy for public libraries in Scotland since 2015, their value and role within public libraries in Scotland should continue to be promoted amongst the 32 local authority library services. Especially since in relation to makerspaces, one of the authorities in this study advised that they "Haven't been aware of them", while another stated that running a makerspace was a challenge because they are "not recognised as a core strategic aim of library services".

- Yearly masterclasses, similar to those operated by the Libraries Taskforce in England should be undertaken, with librarians attending to discuss challenges and successes of running their makerspaces. Authorities and libraries hoping to establish a makerspace or make improvements can gain valuable insight from these discussions. Several benefits and challenges were highlighted in this Scottish study and holding masterclasses are the perfect arena for addressing these.

- 3D Printing Champion sessions should be held on a regular basis, to discuss new ventures, but also to address specific issues with 3D printing and share best practice.

- Formal visits should be arranged with the makerspaces 'leading the way' and who consider themselves to be 'successful' so that experiences can be shared.

- A national makerspace best practice manual should be published, sharing general best practice advice, together with case study examples from the different makerspaces in existence in Scotland to showcase examples of good practice. A contact list of 'expert' librarians in makerspace implementation in Scotland, ranging from physical space ideas to building partnerships with local groups, should be provided for authorities with future plans or libraries at the start of their implementation. This 'go-to' list in the manual would avoid having to 'reinvent the wheel' every time a new makerspace is planned.

Daly (n.d.) previously advised that by 2020, once the public libraries national strategy 'Ambition and Opportunity' (SLIC, 2015) has been delivered, libraries will be "hubs for information, inspiration and innovation", with a key element of this being, "the introduction of maker spaces across Scotland, offering access to bleeding-edge technologies, harnessing the creativity of local people…" Implementing a makerspace in a public library is not a mandatory requirement, however the positive aspects outlined in this study are worth considering. According to Willingham and De Boer (2015, p.16), "The true library of the future will be collaborative and community driven". Based on the makerspace benefits indicated in this study, several public libraries in Scotland have suitably positioned themselves.

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Appendix A - Local authority library services survey

(Note: Due to the questionnaire having 3 different direction flows, the questions below are not in the order presented to the participant. All available questions in the questionnaire are included below. See Appendices D, E and F for the different survey flows.)

MSc Student Survey - Makerspaces in Public Libraries in Scotland

MSc Student Survey
Makerspaces in Public Libraries in Scotland: a study of progress and best practice

Hello, my name is Claire Rae and I am a postgraduate student undertaking a Masters in Information and Library Studies at the University of Strathclyde.

I am conducting a study to determine the extent to which Makerspaces and their related technologies, such as 3D printers, are currently being used in public libraries in Scotland. Information collected from this survey will be anonymous, with no personal identifying information being requested.

IMPORTANT: Please read the Participant Information Sheet in the link below before proceeding to the Consent Form. Participant information sheet for respondents

The survey should only take **5-10 minutes** to complete and it will close on **11 July 2019**.
If you have any questions or you are interested in the results of this study, I can be contacted at claire.rae.2018@uni.strath.ac.uk

Consent Form for Local Authority Public Library Survey Respondents

Name of department: Computer and Information Sciences
Title of the study: Makerspaces in Public Libraries in Scotland: a study of progress and best practice

- I confirm that I have read and understood the Participant Information Sheet for the above study.
- I understand that my participation is voluntary and that I am free to withdraw from the survey at any time, up to the point of clicking the submit survey button, without having to give a reason and without detriment.
- I understand that if I exercise my right to withdraw from the survey, any data that I have provided will be destroyed.
- I understand that anonymised data (i.e. data that does not identify me personally) cannot be withdrawn once it has been submitted in the survey.
- I understand that any information recorded in the survey will be completely anonymous and that no personal identifying information will be collected. Only aggregated data will be used in the study, and/or publications.

I consent to being a participant in the survey. Please click yes or no below to confirm.

Yes

No

Please now start the survey below.

Please choose your Local Authority from the list below.

▼ Aberdeen City Council ... West Lothian Council

How many public libraries are within your Local Authority? (please enter number)

_____

Is 3D printing offered as an activity within any public library in your Local Authority?

Yes (please enter number) _____

No (please state the reason(s) why)

_____

Do any public libraries within your Local Authority provide a Makerspace?

Yes

No, but there are future plans

No

Please indicate the reason(s) for a Makerspace not being implemented in your Local Authority area? (choose all that apply)

☐   Budget constraints

☐   Physical space

☐   Expense of equipment

☐   Staffing issues (training, time constraints, resistance to change)

☐   Low priority

☐   Management decision

☐   Other (please specify) _____

Is there a proposed date for implementation?

    Yes (please enter year) _____

    No

How many public libraries within your Local Authority provide a Makerspace? (please enter number)

_____

For each public library Makerspace in your Local Authority, please indicate the following:

Library Name (please enter one library at a time)

_____

Which year did your Makerspace open/start? (please enter year)

_____

Type of space? (choose all that apply)

☐   Permanent

☐   Pop-up

☐   Mobile

☐   Shared within the library

☐   Temporary

☐   Drop-in event

☐   Other (please specify) _____

Please indicate the resources/activities included in your Makerspace (choose all that apply)

- [ ] 3D printing

- [ ] Coding (e.g. Scratch, Kodu)

- [ ] Electronics

- [ ] 3D Modelling (computer graphics)

- [ ] Arts & Crafts (e.g. sewing, knitting, jewellery, painting)

- [ ] Video editing

- [ ] Scanning

- [ ] Raspberry Pi/Arduino/BBC Micro:bit

- [ ] Gaming (e.g. Minecraft, Osmos)

- [ ] Animation

- [ ] Photography (including editing)

- [ ] Digital sound recording

- [ ] Website creation

- [ ] Virtual reality

- [ ] Invention kits (e.g. robotics, Makey Makey, LEGO Mindstorms)

- [ ] Other (please specify) _____

Does your Makerspace offer workshops, events, classes or activity sessions?

Yes (please specify which one(s)) _____

No

Please indicate any benefits from implementing your Makerspace (choose all that apply)

☐   Social and digital inclusion

☐   Promotion of STEM/STEAM) activities

☐   Community engagement

☐   Increased creativity and critical thinking

☐   Increase in library users

☐   Partnership building (with schools, universities, local companies, community groups)

☐   Other (please specify) _____

Please indicate any challenges encountered with the implementation of your Makerspace (choose all that apply)

☐   Funding

☐   Physical space

☐   Equipment selection

☐   Staffing issues (training, time constraints, resistance to change)

☐   Ongoing costs (maintenance & replacing consumables)

☐   Promoting the space

☐   Other (please specify) _____

During the implementation of your Makerspace, were any of the following resources utilised to gain knowledge? (choose all that apply)

☐ Workshops/events/conferences

☐ Library websites/social media

☐ Masterclasses

☐ Published literature

☐ Libraries with existing Makerspaces

☐ University Makerspaces

☐ Other (please specify) _____

☐ None of the above

Please indicate if any of the following practices are used in the running of your Makerspace (choose all that apply)

- [ ] Customising your space to meet community needs

- [ ] Keeping up to date with trends/news

- [ ] Building partnerships (with experts, schools, universities)

- [ ] Implementing specific H&S policies

- [ ] Use of social media for marketing/promotion

- [ ] Defining a clear purpose and providing appropriate resources

- [ ] Developing specific training models for patrons and staff

- [ ] Other (please specify) _____

- [ ] None of the above

Please indicate the extent to which you agree or disagree with the below statement.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I consider this Makerspace to be a success.							

If you have any additional comments regarding Makerspaces, please add them below.

_____

_____

_____

_____

_____

Appendix B - Participant Information Sheet

Participant Information Sheet for Local Authority Public Library Survey Respondents

Name of department: Computer and Information Sciences
Title of the study: Makerspaces in Public Libraries in Scotland: a study of progress and best practice

Introduction
My name is Claire Rae, a postgraduate student currently undertaking a Masters in Information and Library Studies at the University of Strathclyde.

What is the purpose of this study?
To determine the extent to which makerspaces and their related technologies, such as 3D printers, are currently being used in public libraries in Scotland. Absent from the current research, is a large-scale study solely of public library makerspaces across an entire country. The main objectives are to:

- Determine how far public libraries in Scotland have progressed in their implementation of makerspaces since 3D printing was introduced by SLIC in 2015.
- Explore benefits and challenges which may have influenced this progression
- Identify best practices currently being deployed

For the purposes of this study, Makerspaces can be defined as a place to gather, create and collaborate.

Do you have to take part?
Participation is voluntary and you have the right to withdraw from this survey without giving a reason and without detriment.

What will you do in the study?
This is an online survey that will take 5-10 minutes to complete.

Why have you been invited to take part?
As this is a national study of public library makerspaces in Scotland, I am looking to gather data from the 32 Local Authorities responsible for the public library service.

What information is being collected in the study?
Information collected from this survey will be anonymous, with no personal identifying information being requested. Local Authority and Library Name information will be collected for the purposes of creating a colour-coded map of Scotland, representing 3D printing use and plotting the public library makerspaces, by type and number of resources. No Local Authority or Library names will be used in this study. Aggregated data from the survey responses will be presented in this study.

Where will the information be stored and how long will it be kept for?
All responses will be held on secure, password protected University of Strathclyde servers. Individual survey responses will be held for a maximum of six weeks from the completion of the survey. Aggregated data will be held for a maximum of one year and then destroyed. Please use the contact details below if you are unsure about what is written here.

What happens next?
If you would like to undertake this survey, please select **yes** on the survey consent form to confirm that you wish to take part.

If you do not want to take part in this survey, please select **no** on the survey consent form and thank you for taking the time to read this.

The deadline for participants to submit this survey is **11 July 2019**.

Thank you for reading the above. Please see contact details below for any questions regarding this study.

Researcher contact details:
Claire Rae
Postgraduate student, University of Strathclyde
claire.rae.2018@uni.strath.ac.uk

Supervisor contact details:
Dr Diane Pennington
Senior Lecturer in Information Science, University of Strathclyde
+44 (0)141 548 3900
diane.pennington@strath.ac.uk

This study was granted ethical approval by the Department of Computer and Information Sciences Ethics Committee. If you have any questions/concerns, during or after the study, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Departmental Ethics Committee
Computer & Information Sciences
Livingstone Tower
26 Richmond Street
Glasgow, G1 1XH

Telephone: +44 (0) 141 548 3189
Email: enquiries@cis.strath.ac.uk

Appendix C - Consent form

Consent Form for Local Authority Public Library Survey Respondents

Name of department: Computer and Information Sciences
Title of the study: Makerspaces in Public Libraries in Scotland: a study of progress and best practice

- I confirm that I have read and understood the Participant Information Sheet for the above study.
- I understand that my participation is voluntary and that I am free to withdraw from the survey at any time, up to the point of clicking the submit survey button, without having to give a reason and without detriment.
- I understand that if I exercise my right to withdraw from the survey, any data that I have provided will be destroyed.
- I understand that anonymised data (i.e. data that does not identify me personally) cannot be withdrawn once it has been submitted in the survey.
- I understand that any information recorded in the survey will be completely anonymous and that no personal identifying information will be collected. Only aggregated data will be used in the study, and/or publications.
- I consent to being a participant in the survey.

(PRINT NAME)	
Signature of Participant:	Date:

Appendix D - Survey Flow – Option - Yes

```
┌─────────────────────────────────────────────────┐
│   Please choose your Local Authority from the list below.   │
└─────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────┐
│   How many public libraries are within your Local Authority?   │
│                (please enter number)                │
└─────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────┐
│   Is 3D printing offered as an activity within any public library   │
│   in your Local Authority? **Yes (please enter number)**   │
│          **/No (please state the reason(s) why)**          │
└─────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────┐
│   Do any public libraries within your Local Authority provide a   │
│   Makerspace? **Yes/No, but there are future plans/No**   │
└─────────────────────────────────────────────────┘
                          │  **Yes**
                          ▼
┌─────────────────────────────────────────────────┐
│   How many public libraries within your Local Authority   │
│        provide a Makerspace? (please enter number)        │
└─────────────────────────────────────────────────┘
                          │
                          ▼
```

For each public library Makerspace in your Local Authority, please indicate the following: Library Name (please enter one library at a time)
Which year did your Makerspace open/start? (please enter year)
Type of space? (choose all that apply)
Please indicate the resources/activities included in your Makerspace
Does your Makerspace offer workshops, events, classes or activity sessions?
Please indicate any benefits from implementing your Makerspace
Please indicate any challenges encountered with the implementation of your Makerspace
During the implementation of your Makerspace, were any of the following resources utilised to gain knowledge
Please indicate if any of the following practices are used in the running of your Makerspace
Please indicate the extent to which you agree or disagree with the below statement

Loop round for each Library

```
┌─────────────────────────────────────────────────┐
│   If you have any additional comments regarding   │
│       Makerspaces, please add them below.       │
└─────────────────────────────────────────────────┘
```

Appendix E - Survey Flow – Option - No, but there are future plans

Please choose your Local Authority from the list below.

How many public libraries are within your Local Authority?
(please enter number)

Is 3D printing offered as an activity within any public library
in your Local Authority? **Yes (please enter number)
/No (please state the reason(s) why)**

Do any public libraries within your Local Authority provide a
Makerspace? **Yes/No, but there are future plans/No**

No, but there are future plans

Is there a proposed date for implementation?
Yes (please enter year)/No

If you have any additional comments regarding
Makerspaces, please add them below.

Appendix F - Survey Flow - Option - No

```
┌─────────────────────────────────────────────────────┐
│    Please choose your Local Authority from the list below. │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│   How many public libraries are within your Local Authority? │
│                  (please enter number)                 │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│  Is 3D printing offered as an activity within any public library │
│  in your Local Authority? **Yes (please enter number)**  │
│         **/No (please state the reason(s) why)**         │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│  Do any public libraries within your Local Authority provide a │
│   Makerspace? **Yes/No, but there are future plans/No**  │
└─────────────────────────────────────────────────────┘
                          │
                        **No**
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│      Please indicate the reason(s) for a Makerspace not │
│     being implemented in your Local Authority area?     │
│                 (choose all that apply)                │
└─────────────────────────────────────────────────────┘
                          │
                          ▼
┌─────────────────────────────────────────────────────┐
│       If you have any additional comments regarding     │
│          Makerspaces, please add them below.            │
└─────────────────────────────────────────────────────┘
```