Working the crowd for forensic research: A review of contributor motivation and recruitment strategies used in crowdsourcing and crowdfunding for scientific research

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A B S T R A C T

Crowdsourcing and crowdfunding have been successfully used in a range of scientific disciplines and present opportunities for forensic researchers to draw on the power of large numbers of people to contribute to research projects through participation or by providing an alternative source of funding. This review aimed to examine whether contributors to crowd science and crowdfunding for scientific research are motivated to participate or provide financial support by the same factors, and to examine recruitment strategies in an attempt to identify a potential crowd for forensic researchers to approach. There was found to be limited research into crowdfunding for scientific research that addressed the motivations of contributors or recruitment strategies used, and no conclusions could be made. There is a need to overcome low response rates and high attrition over the lifetime of a crowd science project or crowdfunding appeal. It is necessary to target a large number of people who are interested in the subject studied and who want to make a difference in some way and contribute to science. True crime podcast audiences are proposed as they present large numbers of listeners who are interested in forensic science, criminal investigation or law enforcement. These audiences have been targeted for successful fundraising efforts and invitations to participate in crowd activities previously. They should be considered by forensic researchers who are looking to venture into crowdsourcing or crowdfunding for research projects.

1. Introduction

For many years, 'success' in scientific research has largely been measured by achieving the goal of publication in a peer-reviewed journal [1–4]. With increased competition for funding [5–7], the pressure to be first to publish has created an environment where scientists must gather large amounts of data from a diverse range of subjects as quickly as possible [1] and at as low a cost as possible. In forensic science, as in all scientific fields, any new technique or process must also meet the required standards of rigorous empirical testing and validation that will stand up to the peer-review process and also meet the standards required by the courts [8]. The secretive environment fostered by this competition is being discouraged by funding bodies, which increasingly require more

transparency and visibility to data and for researchers to deliver education programs and participate in community outreach programs [1,2,9,10]. These challenges are not unique to forensic science, and a range of other scientific disciplines have already successfully turned to crowdsourcing and crowdfunding in order to address and overcome them.

1.1. Crowdsourcing

Crowdsourcing presents a means of accessing large numbers of resources at a reduced cost or offering financial incentives for solutions, rather than paying for the time spent developing solutions [11]. *Crowd science* or *citizen science* is the extension of this approach into the field of scientific research and is commonly defined as the intentional involvement [12–19] of volunteer contributors [9,10,20–22] to scientific research.

Contributors to crowd science have been described as non-experts [22], non-professionals [12,18] or non-scientists [4,18,23,24]. Still, some researchers have acknowledged that crowd science projects can benefit from contributors who have

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specific skills or expertise that scientists do not have [1,10,16]. Other benefits of crowd science include the ability to gather large volumes of data [4,16] over a more extended period [2,9,18,25–28] at much lower cost [4,10,16]. Wildlife monitoring, ecology and environmental projects benefit from being able to gather data from a larger geographical area [4,9,10,27,29–31], including from areas that are privately owned [12,25,26]. Some of these benefits are likely to be extended to forensic science research, particularly within disciplines that are population-based or require the gathering of large amounts of data from outside of the laboratory.

Previous studies have demonstrated that effective project design is essential for successful crowd science, including defined goals or hypotheses [10,27,30,32], clear experimental protocols [9,10,32], instruction or training for contributors [9,27,32,33], user-friendly tools and interfaces [22,27] and effective methods of validating data [9,10,27,33]. Ongoing communication is essential to provide feedback to contributors [10,26,34], progress updates and results, even after a contributor's direct involvement has ended [32].

In a few limited instances, forensic science has mostly taken the approach of bringing science to the crowd. The Netherlands' Lowlands Music and Performing Arts Festival is an annual event that runs over three days, attracting a crowd of around 50,000 visitors each year [35]. Since 2015, *New Scientist* has partnered with the festival to run the Lowlands Science Program, with a range of projects being selected from researchers' proposals [36]. The program invites festival visitors to volunteer to participate in the experiments, and researchers are able to gather their data [36]. The Netherlands Forensic Institute and the Police Academy were involved with studies conducted at the festival in 2015 and 2016, which have culminated in three publications in peer-reviewed journals [35,37,38]. The benefits of this approach included the ability to collect a relatively large amount of data in a short period of time [37,38]. Across the three projects, an average of 195 useable sets of data was collected. Volunteers showed a wide range of ages and educational backgrounds [35,37], and one of the studies noted this as a particular benefit because scenario-based studies are often dominated by university undergraduates [35]. Two of the studies described the process used to brief volunteers and obtain signed consent forms prior to their participation [35,37], which is necessary to ensure adherence to high research standards and compliance with ethical considerations.

More recently, researchers at Lancaster University in the United Kingdom embarked on a project to develop an automated system to search and compare images of hands, mapping individual features such as scars, veins and skin creases [39]. The project has evolved out of previous research relating to forensic identification of offenders in cases involving child exploitation and abuse, where photographic and video evidence depicts an offender's hands [40–42]. This type of database could be used to assist in linking multiple evidence sources as well as leading to the identification of an offender, similar to the way that a fingerprint database is used. With €2.5 million in funding from the European Research Council, this project is aiming to recruit 5,000 citizens to contribute images to their research [39].

1.2. Crowdfunding

Crowdfunding emerged as an alternative means of raising money for a range of activities, predominantly business development [43–46], creative and artistic ventures [47] and charitable fundraising [43]. A basic definition describes crowdfunding as an open call for financial resources [44,48,49], a request which is commonly made over the internet, with funds collected via a crowdfunding platform [43,45,48,49]. Crowdfunding reduces the reliance on a single source of finance by connecting a research team with multiple financial contributors, who can donate an amount of their choosing [43,50]. For scientific researchers, the primary benefit of crowdfunding is the ability to supplement existing funding or provide an alternative source of funding [5,50,51] outside traditional public and private funding networks [52].

Reward-based crowdfunding is perhaps the most common type of crowdfunding [49]. In return for financial support, contributors receive a reward, usually something tangible [53–55]. *Donation-based* or *charity* crowdfunding seeks financial support for a specific cause or benevolent organisation, and rewards are not commonly offered, although acknowledgement or recognition may be provided [53]. There is usually no set target or time limit to the appeal for charity funding [52]. *Crowdlending, equity-based* and *royalty-based* crowdfunding represent more business-like arrangements, where contributors are financially rewarded for their investment [53]. These business types of crowdfunding models are less relevant to forensic science opportunities and are therefore not discussed any further in this review.

Crowdfunding campaigns for scientific research follow two main models for the collection and disbursement of funds. In an *all-or-nothing* model, fundraisers set a financial target and a limited timeframe for achievement of the goal, but receive no funding if the goal is not met [48,56]. This approach is low-risk for contributors [56,57], who make their contribution as a pledge, but retain their funds if the project does not achieve the target goal [48]. It can be frustrating to spend valuable time preparing a campaign and promoting a project only to have the funding appeal fail [57]. In a *donation* or *keep-it-all* approach, a financial goal is set, and there may be a defined period for fundraising, but contributed funds are disbursed regardless of whether the goal is achieved [56]. A donation approach is used by the DNA Doe Project, which uses genetic genealogy to identify unknown human remains [58]. The DNA Doe Project was established in 2017 [59] as a non-profit organisation funded entirely by donation and staffed by volunteers [58]. In the past, law enforcement has worked closely with the DNA Doe Project, and the organisation has so far achieved success in identifying at least nine confirmed or suspected victims of crime [60].

Research into scientific crowdfunding has focussed mainly on projects that have successfully raised their target amount and analysis of common aspects of the campaigns. Platform selection [5,50], the offering of rewards [52,61], endorsements by third parties or organisations [5,52,61], communication styles [52,61], use of video to promote projects [52] and social networks [52,61] are all factors that contribute to successful crowdfunding for scientific research.

In order for forensic scientists to successfully leverage the power of crowdsourcing and crowdfunding for their research, it is necessary to gain a better understanding of why people choose to contribute to crowdsourced or crowdfunded projects and what types of recruitment strategies are effective. There appears to have been no research investigating whether common motivations drive contributors to crowdsourced and crowdfunded scientific projects. This literature review aimed to identify motivations for contribution to crowdsourced and crowdfunded scientific research projects across a range of different fields, to determine whether the same motivations apply to both crowdsourcing and crowdfunding and to investigate the different recruitment methods being used. Based on the findings, a target crowd for forensic science is proposed, along with a suggested method of promotion and recruitment to maximise success.

2. Materials and methods

Automatic searches were used to identify relevant literature for review, using databases that included ProQuest, PubMed, Sage Journals, Science Direct, Scopus, Web of Science Core Collection and the Wiley Online Library. Keywords used for the search included crowdsourc*, 'crowd sourc*', 'crowd science', 'citizen science', crowdfund*, 'crowd fund*', 'scientific research', motiv*, engage, engagement, engag*, recruit* and 'recruit* strategy*'. Searches were limited to English language from peer-reviewed journal articles. Initially, the first 50 search results, sorted by relevance, were judged on the content of the title and abstract. Literature that was marked for inclusion based on this preliminary search was read in its entirety to determine relevance for inclusion in the review. References cited in articles selected for inclusion were sought by manual search and analysed for inclusion based on the same criteria.

To investigate contributor motivations, the literature was restricted to articles that focused on initial motivations driving individuals to contribute to crowdsourced or crowdfunded scientific research projects as opposed to changing motivations over time. Studies into other types of crowdsourcing or crowdfunding were excluded, as were studies that investigated motivations of other parties, such as project creators or community groups. Literature was also excluded if contributors' participation was a compulsory requirement of an educational program. Meta-analyses and review articles were excluded as they potentially duplicated information that was provided in original publications.

Literature that was included in the review of recruitment strategies was selected based on the level of detail provided about the recruitment processes used. Articles were sought which provided specific information on the number of contacts invited to projects, numbers of actual contributors, methods of promotion of projects, selection criteria for contributors and the duration of the recruitment campaign.

3. Results

3.1. Motivations

3.1.1. Crowdfunding

Studies into contributor motivations across all types of crowdfunded projects tended to examine the characteristic donation pattern that is observed, rather than analysing underlying motivations for choosing specific crowdfunding projects. The donation pattern is not unique to crowdfunded scientific projects and is characterised by the rapid achievement of around 20% of the funding goal, followed by a period of slower growth until about 80% is reached, then the final 20% is again achieved more quickly [44,46,48,52,54,62].

Research into the motivations for crowdfunding of scientific research was extremely limited [52,63] and research into other types of crowdfunding was found to be not completely applicable to forensic science. While crowdfunded scientific projects are more likely to succeed if a reward is offered [52], rewards are not always offered. Junior and unestablished researchers are more likely to be successful in crowdfunding for research [52], which is in direct contrast with research into reward-based crowdfunding for business and creative ventures, where project creators who can demonstrate prior experience in their field tend to be more successful [64]. These findings suggest that motivations for reward-based crowdfunding don't apply to crowdfunding for scientific research.

In 2016, Dragojlovic and Lynd [65] reported on a speculative study to determine what types of medical treatment research projects would be more likely to succeed. They found that potential contributors considered research into treatments for diseases that afflict children and common diseases to be the most important, suggesting that there is a value judgement involved in the decision to contribute that is more akin to charity crowdfunding. However, a more recent analysis by Aleksina et al. [66] found that actual crowdfunding patterns did not support these results.

It was observed that contributors to crowdfunded research are likely to already have some form of relationship with the researcher that influences the decision to contribute. Dragojlovic and Lynd [5] reported in 2014 that prospective donors expressed a preference for appeals to come from friends, family or organisations with which they were already involved. The dominance of family and friends as contributors has been demonstrated in other studies into crowdfunding for scientific research [52,67]. However, if the relationship is more important than the funding purpose, then this finding contradicts the suggestion that the reliance on these relationships is linked to the higher success rate for junior and less established researchers [49,52]. This presents a challenge for forensic researchers considering crowdfunding because family and friends, and their finances, are a limited resource. To be successful in ongoing crowdfunding efforts or to achieve higher financial targets, forensic researchers must reach a broader audience [67,68]. This may be achieved by partnering with a third party who can promote the research project to a wider network of contacts interested in forensic science.

3.1.2. Crowdsourcing

The publications selected to review motivations came from a range of fields. Hands-on projects included those in wildlife and environmental monitoring, ecology, geography and disease research. Online projects were observed in the fields of astronomy, biological sciences and technology development. A summary of the fields is shown in Fig. 1.

Comparison of the results was complicated by the use of different types of surveys and different reporting methods, so it was necessary to categorise the responses. The selection of four categories for this study was guided by a 2018 article from the *Journal of Science Communication*. Lee et al. [69] investigated the response rates of contributors based on four different motivational messages used for recruitment. Email communications promoted potential involvement as an opportunity to: 1) contribute to scientific knowledge; 2) help scientists; 3) acquire new knowledge; or 4) participate in social activities by joining a community [69]. A total of 36,513 invitations were distributed to registered members of an online citizen science mailing list that is routinely used to promote new projects and encourage participation [69]. In the three weeks after the invitations were sent, researchers tracked the number of recipients who followed the email link to the website and the number who ultimately signed up as contributors [69]. Table 1 shows the number of invitations sent using the individual motivational messages as well as the number of recipients who followed the email link and the number who actively contributed to the new project.

As shown, the overall response rate was low, with only 5.35% of all recipients following the link in the email. The total number of contributors was even lower, with 808 contributors representing less than half of the recipients who followed the link and only 2.21% of all recipients. While *helping scientists* drew only 429 people to follow the email link, this motivational message resulted in the highest number of actual contributors, followed by *contributing to scientific knowledge*, and then *learning*. *Joining a community* was observed as the least effective message for recruiting contributors, attracting only 176 contributors [69]. As noted by Lee et al., *helping scientists* is similar to *contributing to science*, but differentiated
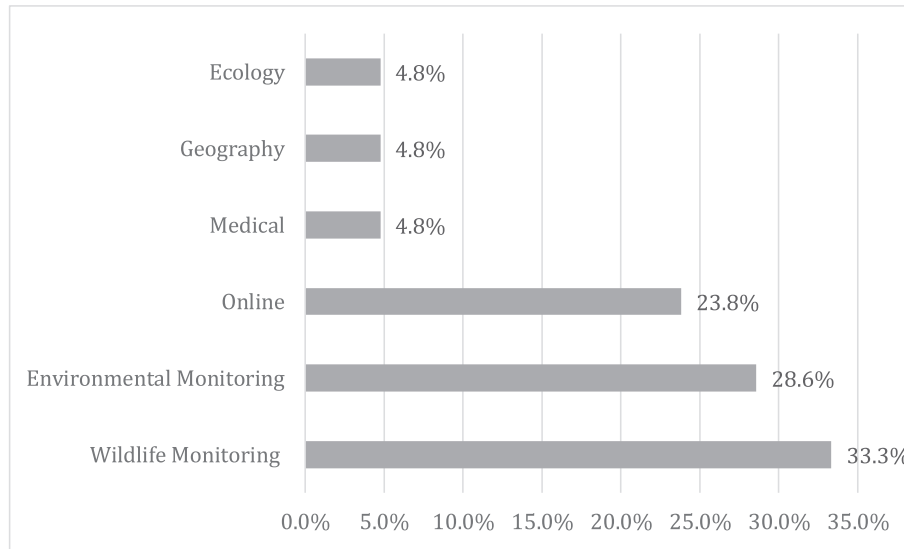
Fig. 1. Crowdsourced Project fields used for review.

Table 1
Response statistics based on different motivational messages [69].

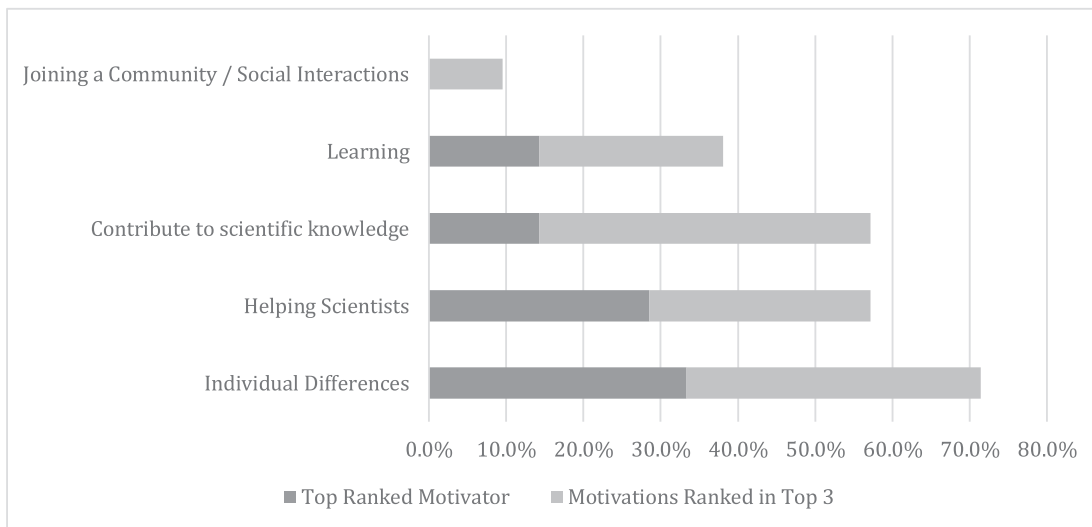| Motivational Message	Number of invitations sent	Recipients who followed email link		Recipients who actively contributed	
		No.	Percent of total	No.	Percent of total
Helping scientists	9,131	429	4.70%	223	2.44%
Contributing to science	9,129	508	5.56%	215	2.35%
Learning (about science)	9,123	529	5.37%	194	2.12%
Joining a community	9,130	490	5.80%	176	1.93%
Totals:	**36,513**	**1956**	**5.35%**	**808**	**2.21%**

Fig. 2. Top-ranked motivational categories.

based on more diverse motivations [69].

Fig. 2 provides a graphical representation of the top motivators identified through this review. The full length of each bar represents the total number of publications for which the motivational category was ranked in the top 3, with the percentage ranking it as the top motivator shown as a subsection.

3.1.3. Joining a community/social interactions

Just under half of the reviewed studies had social interactions listed as an initial motivator. It ranked in the top three in less than 10% of the studies, and no studies reported this as the top motivator. Motivations allocated to this category included the development of social relationships with other participants and scientists,

competition with other contributors and factors relating to career progression and reputation. Dem et al. [70] noted that social factors were seen to be important in promoting continued participation. This finding was supported by Aucott et al. [71], who emphasised the importance of developing ongoing relationships and communication with contributors. Additionally, Crall et al. [72], who used internet analytics to analyse the results of a marketing campaign for an online crowd science project, found that repeated promotion through social networks resulted in additional recruitment as well as renewed participation in the project by previously dormant contributors.

3.1.4. Learning

The findings in relation to learning were inconsistent, in part because not all of the reviewed articles assessed participants' interest in learning as an initial motivational factor. Even so, over one third of all of the reviewed projects reported contributors' desire to learn as one of the top three motivating factors in joining research projects, and 14.3% ranked it their top reason for contributing. Specific learning goals, as stated by contributors, included learning about the subject and learning new skills.

3.1.5. Contribute to science

A desire to contribute to science or scientific knowledge was a key factor driving individuals to contribute to crowd science projects across all types of projects reviewed, including for all of the online projects that were reviewed. Just under two thirds of the reviewed projects ranked contributing to science in the top three motivators, and 14.3% of contributors ranked it as the primary motivator. Additionally, although changing motivations was not a focus of this review, Carballo-Cárdenas et al. [73] noted that contributing to science emerged as an important reason for participants to continue their involvement in the crowd science project.

3.1.6. Helping scientists

Motivational statements allocated to this category commonly expressed a desire to *make a difference* to the environment or the community, for the future or to the specific field of study. Just under two thirds of the reviewed projects had these types of statements ranked in the top three motivators, while 28.5% ranked it as the top motivating factor for crowd science participation. A specific response that potentially ties crowdfunding and crowdsourcing together for research projects was demonstrated in Alender's 2016 publication [74], in which just over 70% of contributors expressed the desire to help the organisation to do more at a lower cost. This project also found that contributors placed a high value on continued communication from researchers regarding ongoing progress and results [74].

3.1.7. Individual differences

A number of factors that were consistently stated as primary motivations across all of the projects did not fit into any of the four selected categories, so a fifth category was designated *individual differences*. *Individual differences* is a term used in psychology to describe characteristics such as intelligence, personality traits and values, which help to define individuality [75]. Statements allocated to this category included an interest in the subject of study and participating in an activity that was fun, satisfying or addictive. One third of the reviewed literature had this type of motivational statement listed as the top reason for joining a crowd science project. A total of 71% of the articles reviewed included these statements in the top three motivators. Personal interest and fun were particularly highly rated in online game-type projects [76–79], hands-on projects that required specialised skills, such as

scuba diving [80] or narrow subject areas, such as a study involving the transcription of historical maps [71]. It has been noted that crowd science projects in ornithology recruit avid birdwatchers who are drawn by their interest in the birds [81,82].

Armed with the knowledge that individual factors are key motivators, it is proposed that forensic researchers target potential contributors who are interested in forensics, criminal investigation or law enforcement and use multiple motivational messages to maximise recruitment from this pool of individuals.

3.2. Recruitment strategies

3.2.1. Crowdfunding

Crowdfunding for scientific research projects was underrepresented in the literature, with few articles providing detailed information about how projects were promoted or how many people were contacted compared with the number who actually contributed. Some studies emphasised the importance of building or developing social networks in advance of launching crowdfunding campaigns [67,68], but no firm conclusions about the recruitment strategies being used could be drawn.

3.2.2. Crowdsourcing

The literature was dominated by wildlife monitoring projects, which included insects, reptiles, marine life, mammals and birds. Environmental monitoring projects related to air monitoring or water monitoring and online projects were all from the biological sciences. In some cases, individual publications provided the relevant data for more than one project or for the same project over multiple recruitment campaigns, for example, when the same monitoring activity was required on an annual basis. The fields of study of the publications selected to review motivations are shown in Fig. 3. Note that this represents a count of the articles use, and studies providing multiple sets of data were included once for this summary.

Three broad categories of recruitment strategies for crowd science projects were identified. *Direct* recruitment campaigns used direct methods to promote their research studies, such as email or letters, allowing for accurate determination of response and participation rates. Direct campaigns identified a specific audience based on characteristics such as geographical location, interest, skillsets or qualifications, affiliations with specific organisations, age and disease affliction. *Indirect* recruitment campaigns broadcast research projects via less specific means including press releases and media campaigns online and on television, public outreach programs and social media. In some cases, a particular target audience was identified. The indirect nature of recruitment campaigns meant that it wasn't always possible to accurately quantify the number of people who were contacted. *Combination* recruitment campaigns identified characteristics of the desired contributor, such as those used in the direct campaigns, and used both direct contact methods and more generalised approaches of print and online articles, television and radio interviews, and social media.

One of the most important findings across all types of projects, and regardless of the strategy used, was that the response rate is low and that not all respondents become contributors. In projects that used direct recruitment strategies, response rates were typically under 10%. Low response rates were also shown in the study by Lee et al. [69], which provided the motivational categories used in the earlier part of this review. Although a total of 5.35% of email recipients showing sufficient interest in the project to seek more information, only 2.21% ultimately became active project contributors [69].

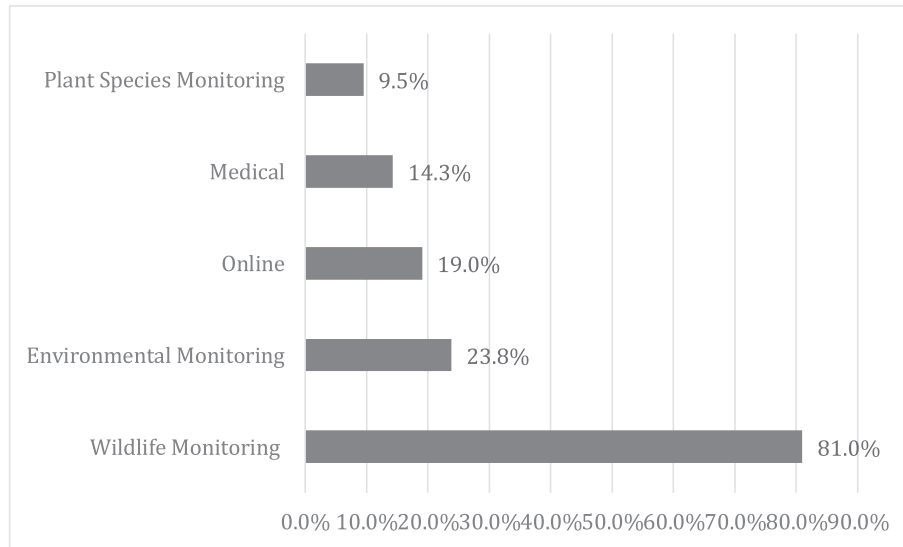With indirect and combination campaigns, it wasn't possible in

Fig. 3. Crowdsourced Project fields used for review.

this review to quantify the total number of people reached during recruitment campaigns. Where target contacts were estimated, generic and combination recruitment methods showed response rates of well under 1%. It is evident that in order to recruit a specified number of contributors for a forensic crowd science project, it is important to promote to a much large number of people.

Additional recruitment by contributors was noted as an important factor for many projects, whether it be through word of mouth, social media interaction, or simply bringing a friend while participating in project activities. In 2019, after mapping the social networks that formed between contributors to a bird conservation project focussed in the northeast of North America, Parrish et al. [83] commented on the value of contributors continuing to recruit while they were participating. The researchers noted that these individual influencers recruited an average of nine additional participants, with the highest recruiting individual bringing an additional 30 contributors [83]. Similar results have also been observed in crowdfunding, with researchers noting that successful campaigns are associated with ongoing social media activity, including frequent posts from research teams and comments and sharing of posts by other members of the social network [84]. The attraction of contributors is driven by building social networks and promoting projects in advance of launching recruitment campaigns [52,67] and by the ongoing promotion of projects by contributors and other interested parties outside the research team [66,68].

Partnering with a third party for promotional purposes was demonstrated to be highly effective in achieving recruitment goals. In 2009, Bonetta [85] reported on a medical disease study that partnered with genealogy testing company 23andMe, offering a hefty discount on the testing to those who were willing to donate their genetic data to a study into Parkinson's disease. Within the first seven weeks of recruitment, 2,000 individuals had contributed data to the study [85]. Similarly, Puhan et al. [86] partnered with the Swiss Multiple Sclerosis Society (Swiss MS Society) to promote their research, aiming to recruit 400 contributors within the first year. The recruitment campaign was launched in conjunction with the inaugural Swiss MS Day, and even with a detailed eligibility process, this goal was achieved within just 20 days. A total of 1700 contributors had enrolled to participate by the end of 18 months [86]. In addition, the Swiss MS Society continued to promote the project in their quarterly newsletter, and after each newsletter was published, a renewed interest in the project was evidenced by short periods of increased enrolments in the project [86], again demonstrating the importance of continuing to promote and recruit throughout the life of the project.

4. Discussion

To successfully recruit participants for crowdsourced research or achieve financial goals for crowdfunded projects, forensic researchers must identify an appropriate crowd to target and the best means of promoting the study to that crowd. Based on the low response rates demonstrated across this review, the target crowd must be very large. Individual differences should be considered; interest in forensic science, criminal investigation or law enforcement could be viewed as motivating factors for potential contributors. Multiple motivational messages should be used to encourage contributors to participate based on their desire to help scientists, contribute to science, learn something new or form social connections. The identification of a relevant third-party partner to assist in the promotion of a project is likely to increase the likelihood of recruiting contributors. Based on the results of this study, it is proposed that forensic researchers look to the true crime audience using the podcast medium to achieve these goals.

Increasing public interest in true crime has led to an increase in its coverage across all types of media. In 1995, Durham et al. [87] noted that this had led to the creation of dedicated true crime sections in book shops. More recently, in 2016, Bruzzi [88] commented not only on the popularity of true crime documentaries on television but also on their ability to have made an impact on real cases. With the release of *Serial* in 2014, the true crime genre exploded into the medium of podcasting [89,90]. At the time of its release, *Serial* was the fastest podcast ever to reach five million downloads earning recognition as the most popular podcast to that date [90–92]. In 2018, five true crime podcasts, including *Serial*, ranked in the Australian iTunes top 25 by downloads [93].

The Teacher's Pet and the first two seasons of *Serial* provided in-depth investigations into specific cases, presented over a series of linked episodes. *Casefile True Crime, Australian True Crime* and *My Favorite Murder* release new episodes on a regular basis, with most of these presenting cases that are independent of each other. The

regular release format provides an opportunity for the forensic researcher to partner with the podcast creators and encourage listener contributions by linking a forensic research project with a particular theme or case. Over time, this format also provides an avenue to acknowledge listener contributions and to provide ongoing updates on progress or results.

Crime Junkie, a weekly release true crime podcast from the USA, has already demonstrated the success of this approach in raising funds. In July 2019, *Crime Junkie*'s episode titled *Unidentified: Sumter County Does* told the story of two sets of unidentified remains found in South Carolina in 1976, which were awaiting funding for genetic analysis by the DNA Doe Project [94]. During the episode, the host launched and promoted a limited edition range of merchandise with proceeds going to the DNA Doe Project. In less than two weeks, listeners contributed over US $17,500 [95], which provided the funding for approximately five cases [96].

Having noted that the response rate is typically low for recruitment of crowd contributors, an attempt was made to determine the size of the audiences for each of the regular release titles. *Casefile True Crime, Australian True Crime* and *My Favorite Murder* were all approached by the authors and asked about listener numbers in the form of downloads. *Casefile True Crime* responded, and in an email dated September 16, 2019 (contact@casefilepodcast.com), provided summary download figures for the previous week, 30 days and for one full year across the full catalogue of 123 cases to that date. These download figures are provided in Table 2:

Additionally, the episode titled *Case 123: Mark Kilroy* [97] had been downloaded 1.26 million times in the nine days since its release. Lancaster University's target of 5,000 contributors providing images of their hands represents just under 0.4% of this total number for just one episode, illustrating the power that this medium may hold for other forensic research.

Social media platforms provide additional means for listeners to interact with their favorite podcasts and each other, and an additional method for forensic researchers to both recruit and provide ongoing information on progress and results. Fig. 4 shows the numbers of followers of the official accounts for *My Favorite Murder, Serial, Casefile True Crime* and *Australian True Crime* on Facebook, Twitter and Instagram as of February 2020. With the exception of Facebook and Twitter accounts for *Serial*, the number of followers was observed to have increased by an average of 17% in the six months from August 2019 to February 2020. Having been withdrawn, The Teacher's Pet has no official social media accounts, so it has not been included.

Some law enforcement agencies have already seen the value in podcasts and their audiences. In 2018, Newport Beach Police Department in California released *Countdown to Capture*, which detailed the alleged crimes of Peter Chadwick, who had been a fugitive since 2015, when he absconded while on bail awaiting trial for the 2012 murder of his wife [98,99]. Six short episodes were released in September 2018, and the podcast reached number 24 on the USA podcast charts [99]. The podcast was just one of the tools used by Newport Beach Police Department in their quest to locate Chadwick, who was ultimately taken back into custody in August 2019 [98]. In 2019, the Queensland Police Homicide Investigation

Unit approached the creators of *Casefile True Crime* and proposed using the platform to promote awareness of domestic violence, stating that they were looking at methods of disseminating information beyond traditional print media and local television and radio [100]. The collaboration resulted in the release of *Case 122: Leeann Lapham*, which detailed the progressively increasing violence through Leeann's relationship with her former partner, who was convicted in 2018 of Leeann's manslaughter in 2010 [101]. In 2019, former cold case investigator Paul Holes joined with true crime journalist Billy Jensen to host *Jensen and Holes: The Murder Squad* [102]. The premise of this podcast is to promote unsolved cases and draw on the crowd to assist in solving them, an activity that they refer to as "crowd solving" [103].

4.1. Limitations and future research opportunities

A significant limitation to examining crowdsourcing was the lack of quality research that identified critical motivational factors in a consistent framework. The use of different survey methods, response formats and differences in the way that results were reported made the comparison of motivations and recruitment strategies challenging. An unintentional element of bias may have influenced the way that responses were allocated to the motivational categories.

Crowdfunding for scientific research has had limited study, and with respect to forensic science, no research exists. Predictive surveys regarding priorities for funding do not match up with observed patterns of donation [74], and other than individual case studies [104], very little has been published relating to the promotion of crowdfunded projects other than in medical research [85,86]. There are many avenues for further research into this field. Similarly, the level of detail provided on how campaigns were launched and communicated for crowdsourcing for scientific research was inconsistent, and there is the opportunity for further research into this area as well.

In suggesting true crime podcast audiences as a potential target crowd for forensic research or campaigns, it is notable that podcasting as a whole has had little attention from researchers. Studies have generally been focussed on the medium rather than the content [89]. There is an opportunity to further analyse the motivations of the true crime audience in order to capitalise on it. One study which did attempt to do this found that the three highest-ranked reasons for listening were entertainment, convenience and boredom [89]. Entertainment and boredom could easily be applied to any subject or topic and don't begin to explain why an individual chooses to listen to true crime, while convenience is more indicative of the selection of the podcast medium. Podcast metrics are an emerging field and until 2017, downloads were the only way to track podcasts. While downloads remain a common measure, they do not accurately reflect listener behaviours [105].

5. Conclusion

The lack of relevant research into motivations for crowdfunding meant that it wasn't possible to draw conclusions about common motivations driving decisions to contribute to both crowdsourced and crowdfunded scientific projects. However, key findings of this review have helped to identify a potential audience for forensic researchers to target to assist in progressing research projects using financial or participatory crowd contributions. True crime podcasts provide a medium for targeting a massive, growing crowd that is interested in forensic science, criminal investigation or policing. The podcast medium offers opportunities for the initial promotion of a project, to provide ongoing updates on project status and results and to continue recruiting and promoting opportunities

Table 2
Download numbers for *Casefile True Crime*.

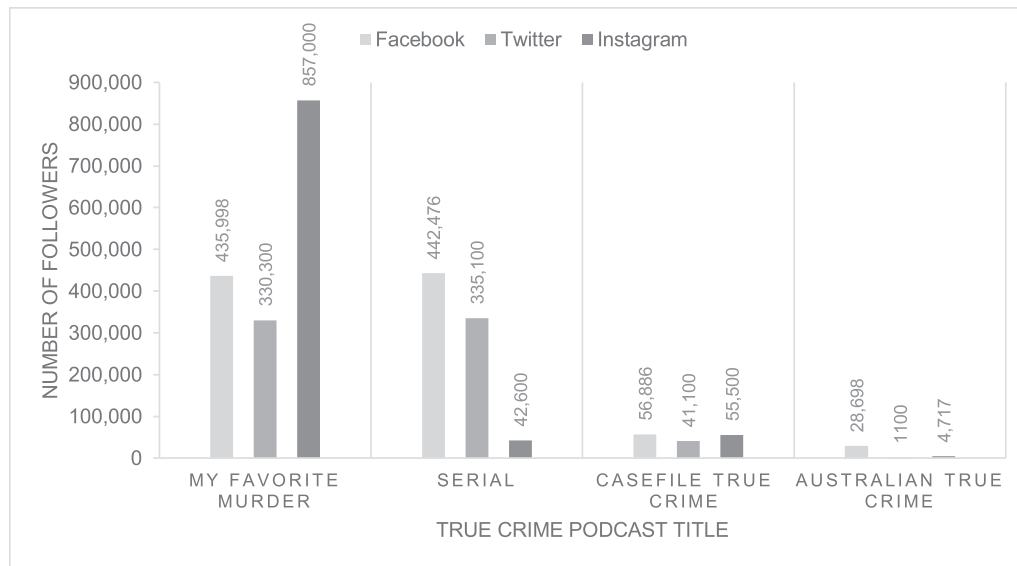| Time	Number of Downloads
7 days − full catalogue of 123 cases	2.9 million
30 days − full catalogue of 123 cases	12 million
1 year − full catalogue of 123 cases	134 million

Fig. 4. Number of followers of True Crime Podcast Official Social Media (as at Feb 2020).

throughout the life of a project. The willingness of audiences to contribute financially has been demonstrated by the ongoing sponsorship of the podcasts themselves as well as successful fundraising activities that have been conducted. This may be an untapped source of both financial support and resources on which to draw in the future.

Declaration of competing interest

The authors declare no conflict of interest.

CRediT authorship contribution statement

Rebecca Parrick: Writing - review & editing, Writing - original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Brendan Chapman:** Methodology, Project administration, Supervision, Writing - review & editing.

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