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Perspective

Planning an innovation marathon at an infectious disease conference with results from the International Meeting on Emerging Diseases and Surveillance 2016 Hackathon

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A B S T R A C T

A hackathon is best described as an 'innovation marathon'. Derived from the words 'hacking' and 'marathon', it brings together multidisciplinary teams to collaborate intensely over a short period of time to define a problem, devise a solution, and design a working prototype. International scientific meetings are conducive to successful hackathons, providing an audience of expert professionals who describe challenges and ensure the proposed solutions address end-user needs. Collaborations with local organizations and academic centers are crucial to attracting complementary specialties such as IT advisors, engineers, and entrepreneurs to develop sustainable projects. The core process of first identifying and deconstructing a problem followed by solution iteration is applicable to challenges at workplaces around the world. Ultimately, this model can be used to drive innovation and catalyze change in the global health community. The planning, execution, and outcomes of a hackathon event organized in conjunction with the International Meeting on Emerging Diseases and Surveillance (IMED 2016) are described in this article. Physicians, public health practitioners, veterinarians, IT professionals, engineers, and entrepreneurs came together for 2 days to develop solutions at the intersection of emerging infectious diseases and climate change. Projects that resulted from the IMED 2016 Hackathon included environmental impact assessment software for humanitarian organization relief efforts; enhanced communication tools to prevent disease outbreaks; a participatory mobile application to speed the elimination of rabies in Indonesia; integrated disease surveillance platforms; and an improved search function for infectious disease outbreak reports in the ProMED-mail network.

Introduction

Infectious diseases cross all national, regional, and political boundaries. The recent Ebola outbreak in West Africa, ongoing Zika and Middle East respiratory syndrome coronavirus (MERS-CoV) epidemics, and fear of pandemic influenza highlight the need to understand the drivers of emerging pathogens. The development of innovative approaches that detect, manage, and ultimately prevent outbreaks is crucial in our changing geographic climate (Groen and Calderhead, 2015). Professionals in the area of emerging infectious diseases gather at international meetings to

disseminate the latest research findings, discuss ongoing outbreaks, and take part in educational opportunities (Lassmann and Madoff, 2016). Given the multidisciplinary nature of emerging infectious diseases, these gatherings provide a valuable mix of veterinarians, physicians, public health professionals, and researchers, as each specialty contributes a unique insight to pressing problems. To capitalize on the potential reserved in these intellectual meetings, participatory programs were sought to advance the field of infectious diseases. The hackathon model was identified as being uniquely suited for this setting (DePasse et al., 2014).

A hackathon is best described as an 'innovation marathon'. Derived from the words 'hacking' and 'marathon', it was initially started in the IT community to accelerate the development of novel software technologies. Since its introduction, the model has been applied to a number of different professional fields, including public health, to foster and accelerate innovation (Groen and Calderhead, 2015; Ostrovsky and Barnett, 2014; Walker and Ko, 2016). Not intended to be solely educational or social, hackathons focus on creating practical, usable solutions that attract funding and program support, which lead to product development. Bringing a broad range of disciplines to bear on a specific challenge, participants are able to apply non-traditional methods to achieve unconventional solutions (Asch et al., 2014).

Hackathon principles

Core principles unique to the hackathon model include a problem-oriented approach that encourages participants to understand a challenge from all sides. Additionally, experts from various disciplines are involved in providing teams with real-time feedback and guidance, resulting in immediate project changes (DePasse et al., 2014). Small multidisciplinary teams collaborate intensely over a short period to define a problem, devise a solution, and design a working prototype (Aboab et al., 2016; MIT, 2016). For hackathons at international infectious disease meetings, a diverse audience representing multiple professions, different career stages, and geographic regions ensures that projects address relevant economic, cultural, and infrastructure barriers. Within teams, participants are encouraged to voice their opinions and contribute their experiences to devise solutions that are applicable across numerous barriers.

The hackathon model varies according to the event goals, with some events focusing on collaborative solution development, where all of the participants or 'hackers' work on different components of an overall project (Table 1 provides the terminology and definitions associated with hackathon events). Others are more competitive, with small teams developing individual solutions, which are then assessed by a panel of judges.

Ultimately, hackers follow a design thinking process where they first identify and deconstruct a problem, allowing them to brainstorm ideas and develop an integrated solution. The Massachusetts Institute of Technology (MIT) Hacking Medicine model, published in a freely accessible handbook (MIT, 2016), can be used in the development of a hackathon program.

IMED 2016 Hackathon development

On a biennial basis, the International Meeting on Emerging Diseases and Surveillance (IMED) brings together veterinarians, public health, and human health professionals from around the world for 4 days of scientific exchange, educational symposia, and networking. In line with the One Health principle that human, animal, and environmental health are inextricably linked and should no longer be researched and viewed in a siloed manner, IMED is a unique opportunity for global multidisciplinary experts to exchange information.

To capitalize on this unique gathering, the IMED 2016 Hackathon recruited hackers, mentors, and judges from the meeting through joint outreach collaborations. Hackathon organizers recruited regional participants with complimenting skills, such as social entrepreneurship, IT and programming, through local partners.

It is believed that the IMED 2016 Hackathon was the first hackathon offering at an international infectious disease conference. To ensure event success, the organizer – the International Society for Infectious Diseases (ISID) – partnered with MIT Hacking Medicine, the Center for Public Health at the Medical University of Vienna, and Epidemico. MIT Hacking Medicine, a community-run volunteer initiative based at MIT, advises organizations in their hackathon planning activities, in addition to hosting their own events. With an understanding of regional infectious disease knowledge deficits, the Center for Public Health at the Medical University of Vienna collaborated with organizers to establish the event theme and to attract talented participants from local universities. Epidemico, a program of Booz Allen Hamilton, provided hackathon IT support through dataset curation and onsite mentorship.

The IMED 2016 Hackathon was unique in its purpose to foster innovation in the field of One Health. There are limited opportunities for professionals operating in the One Health realm to gather and collaborate. There are even fewer opportunities for these professionals to work on self-identified projects in a creative environment with seed funding possibilities. Events of this nature

Table 1
Hackathon specific terms and definitions.

Accelerator	Organization that provides financial and professional resources to develop an idea into a marketable program
Co-working space	Shared work space and tools used by different professionals, used to create programs
Hackathon	Gathering of multidisciplinary professionals to rapidly develop solutions to unmet needs in a short period of time
Hacker	A hackathon participant working to develop a prototype solution
Iteration	Refining and improving a program through expert feedback, guidance, and/or trial-and-error
Judge	A representative or professional with experience in a particular field designated to review and score prototype solutions at the end of the hackathon. Judges may work individually or as teams
Mentor	A professional with work experience and background knowledge who answers questions from hackathon teams and provides guidance during program development
Organic team formation	Process whereby hackathon attendees self-assemble into teams based on one of the proposed problems, based on mutual interests and skill sets
Problem pitch	Component at the start of a hackathon where a participant stands in front of attendees and verbalizes a problem they are interested in solving during the event
Pivot	Process where a proposed solution is heavily adapted or abandoned in favor of an alternative approach
Practice presentation	Session where hackathon teams can give their final presentation to mentors who suggest improvements
Venture capital	Funding provided by an organization or accelerator to develop a program beyond a prototype

are needed to solve current infectious disease challenges and preempt new outbreaks. The IMED 2016 Hackathon filled this need, with numerous programs developed that transcend professional, species, and geographic barriers.

IMED 2016 Hackathon event

At the IMED 2016 Hackathon, 100 participants, mentors, and judges gathered in Vienna, Austria for 2 days to form interdisciplinary teams determined to solve public health challenges related to climate change and infectious disease outbreaks. Although focused on climate change, problems in the broader field of public health were not barred from inclusion. Participants were allowed, and even encouraged, to use data resources beyond the ones offered by event organizers to inform their work and create solutions.

At the start of the IMED 2016 Hackathon, participants identified challenges in the area of emerging infectious diseases and verbalized these problems to fellow attendees in 60-second problem pitches. Hackers then mingled and teams formed organically based on skill sets and interest in presented problems. Following team formation, groups worked to develop prototype solutions through multiple rounds of iteration, where they quickly altered their prototype design based on comments from subject area experts. At some points, teams 'pivoted' – completely abandoning a proposed solution and shifting in an entirely new direction. Once teams had developed a prototype, they presented their solution in practice sessions to mentors, who provided immediate feedback for improvement. The remaining steps in the model included the final presentation of prototyped solutions to a panel of judges, who scored projects and distributed awards. Post-event evaluations and sustained collaboration efforts were used to spur program success in the post-event environment.

IMED 2016 Hackathon results

Attendees represented 29 countries, 16 languages, and 20 unique professions (Table 2). Thirty percent of the participants in the event were students ($n = 30$) and 45% of the attendees were female ($n = 45$). The average age of attendees was 25–34 years old. Post-event survey responses were received from 51 participants. Eighty-six percent of event survey respondents ($n = 44$) said that the IMED 2016 Hackathon was the first hackathon they had attended.

A total of 32 individuals pitched problems to their fellow attendees, with 12 teams forming based on mutual interests and complimenting skills. Each of the 12 teams worked on a different project. One participant noted, "My team was an excellent combination of a variety of talents – an epidemiologist, a veterinarian, an architect, a nurse, and a One Health specialist". The average team size was five members, with the smallest team having three and the largest consisting of six members.

Participants had access to a variety of climate change data resources, including global surface temperature readings from the National Aeronautics and Space Administration (NASA) (NASA, 2017) and precipitation measurements from the National Oceanic and Atmospheric Administration (NOAA) (NOAA, 2017). The innovative infectious disease surveillance network known as the Program for Monitoring Emerging Diseases – ProMED-mail – which was the first to identify the severe acute respiratory syndrome (SARS) outbreak in 2003 and the MERS-CoV outbreak in 2012, provided 53 000+ infectious disease outbreak reports for use in prototype program development (Allen, 2015; Fisher et al., 2012; Hartley et al., 2013; Madoff and Li, 2014; Petersen et al., 2014).

Over the course of 27 hours, teams defined their problem of interest, brainstormed potential solutions, and developed a sustainability model to turn their idea into reality. "I really enjoyed the creative process of designing a tool to address an unmet need", said one attendee. Twenty-eight mentors with experience in entrepreneurship, public health, veterinary health, infectious diseases, IT, and healthcare advised teams as they developed their programs. Mentors provided feedback and answered questions, ensuring teams presented comprehensive solutions. On average, six mentors advised each team.

At the conclusion of the 2-day event, teams had 4 minutes to present their prototyped solution to fellow hackathon participants and a panel of judges, which included a representative from a local startup incubator, two public health practitioners, an infectious disease specialist, and an IT data expert. Judges rated each project in terms of feasibility, innovation, novelty, and scalability. Immediately following the presentations, judges deliberated to select winners for several monetary awards, shared co-working space at a local startup accelerator, and acceptance to an upcoming funding challenge. Winning teams were invited to present their projects at an IMED oral abstract session.

Projects resulting from the IMED 2016 Hackathon included environmental impact assessment software for humanitarian organization relief efforts; enhanced communication tools to prevent infectious disease outbreaks; a participatory mobile application to help eliminate rabies in Indonesia; integrated disease surveillance platforms; and an improved search function for the ProMED-mail archive using natural language processing

Table 2
(A) Countries and counts represented by the 100 participants, mentors, and judges at the IMED 2016 Hackathon. (B) Self-identified professional field and counts for the 100 total IMED 2016 Hackathon participants.

(A) Countries represented (number of participants)		(B) Professions represented (number of participants)	
Albania (1)	Nepal (1)	Architect (1)	IT Professional (5)
Austria (24)	Netherlands (1)	Bioinformatics (2)	Mathematician (2)
Belgium (4)	Nicaragua (1)	Data scientist (12)	One Health specialist (1)
Bratislava (1)	Norway (1)	Developer (3)	Physician – MD (13)
Brazil (1)	Australia (1)	Engineer (3)	Physicist (1)
Canada (1)	Poland (1)	Entrepreneur (9)	Policy maker (1)
Chile (1)	Romania (2)	Epidemiologist (2)	Public health professional (21)
China (1)	Slovakia (2)	Graphic designer (1)	Researcher/scientist (11)
Finland (1)	South Africa (1)	User design (1)	Veterinarian – DVM (8)
Germany (5)	Spain (1)	Infection preventionist (1)	Writer (2)
Hungary (1)	Switzerland (2)		
India (3)	Taiwan (3)		
Malta (1)	Uganda (1)		
Mexico (1)	UK (3)		
Myanmar (2)	USA (32)		

Table 3
Summary of the 12 projects developed at the IMED 2016 Hackathon. Each project was presented to a panel of five judges who scored the prototype solutions based on feasibility, innovation, scalability, and novelty. Judges deliberated to distribute monetary prizes and co-working space.

Team name	Program summary
Footprint	Footprint is a Web platform that builds on existing energy calculators and emissions monitoring software to allow humanitarian organizations to easily assess the environmental impact of their operations. Integrating supply chain and logistics data, Footprint enables easy access to digestible information, allowing humanitarian practitioners to improve programming, ensure sustainability, and create metrics for success. Visit: https://footprintproject.io
Puddle Predict – Real-Time Prediction of Malaria Epidemics	Puddle Predict aims to employ malaria predictive models, including real-time precipitation and temperature data, to predict the incidence of malaria. Puddle Predict will be integrated into the Uganda Ministry of Health malaria visualization dashboard. This software will inform key stakeholders as they facilitate appropriate targeting of resources for malaria control. Visit: https://puddlepredict.com
Dogemon	Using Indonesia as the pilot area, the Dogemon mobile application aims to identify unvaccinated dogs in the region through community-based participatory surveillance. App users report a dog that is unvaccinated, characterized by the lack of a red collar, and upload a picture of the canine via the Dogemon app. A veterinarian will receive a notification about the unvaccinated dog in their coverage area and can administer a vaccine.
#MeaslesSucks	#MeaslesSucks created an interactive online platform targeting expectant/young parents. Through graphic smart mapping, past measles outbreaks can be traced and the trail of disease can be plotted. Scenarios are created to improve the understanding of the importance of vaccination. Concepts such as herd immunity are discussed, in addition to a comparison between the naturally occurring disease and vaccine side-effects.
Hunters Helping Hunters	To protect the health and wellbeing of hunters and the greater population, Hunters Helping Hunters developed a two-part approach to reduce the risk of emerging diseases crossing species boundaries. Through a combination of personal protective equipment and accessible zoonotic disease information, zoonotic disease transmission events can be curtailed. Personal protective equipment would be distributed in kits to hunters, along with information on correct meat handling practices, donning/doffing procedures, and reporting methods for unusual findings.
Animal Village	Animal Village is an online mobile platform for rural animal caretakers, veterinarians, and public health officials. This platform allows anyone in a remote location to upload their animal health concern, with options for photo and video inclusion, connecting them to a network of professionals for immediate feedback. Animal Village stores traditional animal health knowledge in a directory for improved identification of animal disease outbreaks.
ProMED Mapper	Working in conjunction with the Program for Monitoring Emerging Diseases (ProMED), ProMED Mapper is a data visualization tool grouping infectious disease outbreak reports accumulated by the disease surveillance network. The software sorts the 53 000+ outbreak reports into relevant, related categories, and improves the user search experience.
Hacking Dengue	Hacking Dengue works to combine the information and efforts of individual scientists and organizations into one, centralized platform. With features such as outbreak mapping tools incorporating weather, demographic, and social media information, the open-access software can be used to identify outbreaks and connect the necessary resources to prevent outbreak propagation.
Outbreak Detection and Diagnosis System – ODDS	ODDS is a mobile-based survey tool that speeds informal diagnosis of medical conditions. With simplistic pictograms, users select a 'yes' or 'no' check when their symptom(s) appears on the survey, which generates a differential diagnosis. The diagnosis is accompanied by treatment recommendations and directs the patient to the nearest registered doctor for advanced treatment.
CAMY – Deep Learning for Early Outbreak Detection	CAMY is designed to predict disease outbreaks using social media and other existing channels of communication while connecting physicians and patients in under-resourced areas. Using temporal and spatial information, in conjunction with analysis of symptom keywords, the program allows earlier and improved accuracy in predicting outbreak events and the movement of diseases.
Multiplexed Early Warning System – MEWS	MEWS proposed a software toolkit that utilizes the many disease tracking models published in the literature combined with cost–benefit analysis of prevention and treatment options. The platform aims to optimize the outcomes of actions taken by governmental and other health-related organizations.
Q808 Wikidata	Q808 supports access to structured and open epidemiological data using the Wikidata platform, ensuring that all of the components are freely available to interested parties.

(Table 3). Teams retained all intellectual property rights generated while participating in the IMED 2016 Hackathon, and no rights were transferred to the organizers, partners, or sponsors.

Ninety-four percent of post-event survey respondents ($n = 50$) agreed that the IMED 2016 Hackathon achieved its goal of promoting innovation, collaboration, and thinking outside traditional boundaries, while 31% of respondents ($n = 16$) wished that they had had additional time to develop their prototype. In total, 94% of survey respondents ($n = 50$) said that they would attend another hackathon.

Sustainability

A hackathon is not a standalone event, rather one part of an innovation continuum to accelerate the development of novel solutions. Beyond the planning and event stages, organizers must evaluate event success, track program progress, and support teams in the post-event environment. Teams should be encouraged to continue prototype development by offering of follow-up awards, for distribution to groups with demonstrated program progress. Other incentives include acceptance to local startup accelerators and incubator challenges, giving teams the environment and resources needed to develop programs further. Beyond their own contributions, these organizations provide access to other potential funding sources such as foundations and governmental grant programs. Additionally, hackathon program organizers should advertise other hackathon events to grow professional social networks and attract new talent to established teams.

Access to mentors and regular communication between teams represent two additional challenges that should be addressed in the hackathon planning stages. Moderated discussion forums, mailing lists, and event registries are examples of suitable communication methods to facilitate discussion between attendees and skilled mentors. Teams should designate a primary contact person before leaving the hackathon, to provide event organizers with updates and requests for assistance. Conversely, organizers should offer teams support in the form of grant identification, proposal review, and professional introductions to aid further program development.

Intellectual property rights must be readily accessible and distributed to all teams. These guidelines will shape final program design and prevent undue hindrance during program scaling and potential commercialization. Property rights created at the event should be retained by the respective participants. This provides

teams an incentive to continue prototype development towards implementation. Acknowledgments and event co-branding should be considered for projects, as event branding may attract financial support through program legitimacy while also promoting hackathon success.

Limitations

Hackathons are not suited to all professions given the multidisciplinary approach and accelerated development process. Event organizers must consider the funding opportunities within the defined event theme for downstream development of prototype solutions. If funding opportunities exist, teams must balance other obligations against the time required to continue program development. For those working in the infectious disease and public health professions, funding opportunities are competitive and time constraints represent considerable challenges for sustained program development.

The projects developed at a hackathon are prototypes and can change as teams attract new talent or compete for funding. To support alterations to prototype solutions, organizers must maintain a diverse pool of mentors and ensure teams have continued access to this professional network with appropriate advisory skills.

While many successful programs can trace their start to hackathons, not all programs that emerge from a hackathon are commercially successful. Understanding why a project fails to thrive in the post-hackathon environment represents another challenge for organizers.

Specific to the IMED 2016 Hackathon, organizers faced obstacles in the event planning stages and post-event environment. Despite growing understanding of the hackathon model and startup support opportunities, hackathons and their purpose were not well known to IMED attendees and regional participants. For this reason, the IMED 2016 Hackathon organizers needed to first educate the target population about the hackathon concept in order to attract talented event participants. Onsite event logistics ran smoothly, with extensive participant interaction and team formation happening with little organizer facilitation. With regard to the post-event environment, sustained collaboration between event organizers and hackathon teams proved challenging. Teams designated a contact person to streamline communication and enhance support efforts. A select few teams took to this role, but sustained communication between all teams was not achieved. E-mail lists and registries of event participants were used to facilitate communication; however, these methods were unsuccessful with limited use.

Conclusions

Interdisciplinary teamwork and international collaboration are needed to address challenges in the area of emerging infectious diseases. The hackathon model and its innovative potential are well suited to the development of infectious disease detection, prevention, and outbreak management tools. International scientific meetings are conducive to hackathon success, as they provide an opportunity to include professionals from diverse backgrounds as event participants. These professionals are crucial, as they first identify and present real-world problems while ensuring the prototype solutions address end-user needs. Partnerships with local organizations and academic centers are essential to attract participants with complementing skills, such as IT, engineering, and entrepreneurship. Collaborations to support monetary awards, incubator space, and downstream funding need to be considered during the pre- and post-event planning to ensure project sustainability. A successful hackathon can be used to drive innovation and promote change in the global health community.

Conflict of interest

No conflicts of interest were reported by any of the authors.

Acknowledgements

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