Economic evaluation of the Space for Smarter Government Programme (SSGP)

A report for the UK Space Agency

FINAL REPORT

London Economics

2018

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Acknowledgements

We would like to acknowledge the useful guidance and feedback provided by the UK Space Agency, particularly the Space for Smarter Government Programme team, and the assistance of project stakeholders and participants who have kindly contributed their time and expertise to inform this report. Responsibility for the content of this report remains with London Economics.

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Executive Summary

Study aims

This study aims to assess the economic impact of the UK Space Agency's Space for Smarter Government Programme (SSGP) on industry (as contract recipients), and government (as end users). This independent study is intended to review benefits observed to date and assess the case for continued and future funding.

Study scope and methodology

The analysis of industry and government impacts of the programme is based on evidence from a sample of seven grant funded demonstrator projects. These projects were intended to showcase the value of space solutions in government and were undertaken between 2014 and 2017. These findings are based on a combination of interviews with project delivery organisations and government users, and secondary data from grant-level reports and evaluation documentation. Since these projects represent a sample of the SSGP portfolio, these findings may not reflect all the impacts of programme. Nevertheless, the benefits of the programme on the supply chain and wider economy are also estimated to supplement this analysis.

Summary value definition

This study estimates the following sources of SSGP's economic impact to date:

- **Industry:** the immediate and longer-term benefits to SSGP grantee and contract recipients – such as commercial, network, reputation, and knowledge benefits;
- **Government:** The potential benefit to the public sector that could be associated with the operational adoption of several SSGP projects. This value related to operational cost savings, exceptional cost avoidance, better policy decisions and regulation, and catalytic benefits, and
- **Supply chain:** The industrial impact of SSGP grantee expenditure on the supply chain – measured in terms of Gross Value Added (i.e. contribution to the UK economy) and employment created.

The value associated with supply chain impacts and potential benefits to government users are quantified, while the benefits to industry contract recipients are assessed qualitatively.

Study limitations

Estimated value in this study is constrained by the availability of evidence and the time and resource constraints of this study. As a result, while this study has aimed to present an accurate assessment, the true use value of SSGP may be different than that presented in this report.

Key findings

- **Industry participants in the SSGP that were consulted indicated that SSGP was the only viable funding source** given its flexibility, offer of full funding, and general support to connect suppliers to end users in government. **Almost all industry consultees indicated that their project would either not have taken place or as quickly without SSGP funding**.

- **Contract recipients reported a number of key benefits**, which fall into four main areas: commercial, network, reputation, and knowledge. This suggests that the benefits to industry of participating in SSGP extend significantly beyond the value of contracts that are received and reflect the non-funding elements of the programme.
- At this early stage, no SSGP project has been adopted for national use by a public sector end-user, although several SSGP projects have been procured on more limited scales. The consultations with public sector and supplier stakeholders suggest a number of reasons for this (often related to public sector resource constraints), even if they appear to agree on the general success and effectiveness of the SSGP demonstration solutions.
- For this reason, it has not been possible to quantify any realised benefits to government from the projects that have been assessed. Instead, the potential value to the public that could be unlocked following scaled procurements of these projects has been considered. On this basis, these projects could support a total of **over £40 million in potential annual benefits to the public sector** in terms of operational cost savings (£27.8 million or 68%), exceptional cost avoidance (£9.2 million or 22%), and catalytic benefits (£4.1 million or 10%).
- The present value (PV) of industrial effects of SSGP is estimated at **£3.0m,** implying that each **£1 of SSGP grant expenditure generates an additional £0.78 in economic activity**. This is equivalent to a **multiplier of 1.78**. However, this multiplier should be interpreted as a lower bound since it is does not include the actual and potential benefits to grantees and government users, respectively, that are also identified.
- SSGP also appears to support a total of **29 FTEs** over four years, including 10 FTEs that are estimated as having been supported by the grants, and a further 19 in the supply chain.

1 Introduction

The Space for Smarter Government Programme (SSGP) is a UK Space Agency-led and funded programme established in 2014. The programme is delivered in collaboration with the Satellite Applications Catapult and aims to drive the uptake and use of space products and services across the public sector. In the context of significant pressure on public budget and increasing demand, SSGP aims to support the public sector to innovate, save money and make more effective policy decisions. As industry represents a potential supplier of space data and solutions for the public sector, SSGP can also support growth in the UK space industry.

To quantify this impact for programme stakeholders and inform the case for further funding, this report presents an independent assessment of the economic benefits of the SSGP on programme participants (industry) and intended beneficiaries (government). While the overall impact of the programme is assessed using secondary data gathered from programme and grant-level reports and evaluation documentation, the findings of this study are primarily informed by interviews from stakeholders involved in a sample of seven grant funded projects. This scope reflects the study's time and resource constraints and the limited body of existing evidence, given the relatively long-term nature of many of the programme impacts that are considered.

This study is arranged as follows:

- **Chapter 2** details the scope and limitations of the study;
- **Chapter 3** presents a framework for assessing the impact of the programme, including a logic model and estimate of the additionality of the programme;
- **Chapter 4** presents the results of an analysis of the programme's economic impact, and
- **Chapter 5** summarises the study's findings to conclude on the economic impact of SSGP.

2 About the study

2.1 Scope

This study aims to evaluate the economic impact of SSGP on industry, government, and wider society. Given the time and resource constraints of this study, the scope of research and analysis is limited by the following:

- **Definition of economic impact:** economic value has been defined to include the following:
  - **Industry benefits:** involvement in SSGP projects may provide solutions providers in industry with technological and commercial knowledge and IP that can be leveraged to support commercial activity in other areas of the company. These effects are termed 'ripple effects'[1].
  - **Government (end user) benefits:** SSGP aims to improve public sector efficiency and effectiveness by increasing public sector use of satellite applications. The value of this is quantified in terms of the following impacts[2]:

[1] For details, please see following forthcoming publication: London Economics (2018). *Spillovers in the space sector.*

[2] This value framework has previously been used by London Economics for the following study: London Economics (2018). *Value of satellite-derived Earth Observation capabilities to the UK government today and by 2020. Evidence from nine civil use cases.*

- **Operational cost savings:** productivity and efficiency gains that come from the use of SSGP satellite applications to support public sector operational processes over alternative non-space solutions.
- **Exceptional cost avoidance:** additional costs that are avoided as a result of the operational use of the SSGP solution supporting government actions that would not be possible without the SSGP solution.
- **Better policy decisions and regulation:** the value associated with better policy decisions and regulations that are enabled by the operational use of SSGP solutions.
- **Risk mitigation (catalytic benefits):** the value associated with the wider benefits that accrue to third parties from the identified use of end products (i.e. to other areas of government and wider economy and society).

- **Supply chain benefits:** the economic value of SSGP to the national economy is measured in terms of the economic impact of SSGP grant and contract expenditure on goods and services within the UK-based supply chain and spending on (and of) employee salaries. These impacts are quantified and include the following:
  - **Gross value added (GVA):** salaries and post-tax profits earned by the firms engaged in the value chain (direct and indirect effects), and consumer spending in the general economy resulting from the salaries paid to employees working in the value chain (induced effect).
  - **Employment supported:** Number of jobs supported by the firms engaged in the value chain and in the wider economy resulting from employee salaries.

- **Scope of analysis:** supply chain are estimated for the programme as a whole. However, industry and government benefits are limited to a select sample of the following SSGP projects and their respective SME leads:
  - **Air Quality Hotspot Mapper,** EarthSense: EarthSense is a spinoff company from the University of Leicester. The Air Quality Hotspot Mapper is system that uses Copernicus MACC II and other data sources to deliver near real time pollution monitoring over urban areas. The output is a heatmap of pollution hotspots. This provides local authorities with a near real time map of the air quality and can support improved pollution mitigation. SSGP funded three distinct phases of the project: i) engagement with potential end users and delivery partners; ii) development of an operational pilot service, and iii) delivery of a demonstration service to end users in pilot areas.
  - **Always Connected Mobile Health Screening Vehicles,** DEOS Consultancy Ltd: SSGP supported DEOS Consultancy to design and develop satellite-connected mobile breast screening vehicles to replace isolated screening vehicles that previously relied on resource intensive paper-based systems. The programme supported the gathering of user requirements and the design and development of a demonstrator vehicle. This was able to demonstrate the commercial viability of the satellite-connected service, which has since been rolled out in several NHS trusts.
  - **Sea Level Space Watch** – SatOC: The Sea Level Space Watch project aimed to establish a sea level monitoring service to assess sea level variability using space-borne altimeter data combined with tide gauge data. The objective was to devise a service which could: advise the UK's Climate Change Committee on their climate change risk assessment; support the planning of national flood defences and adoption plans, and provide spatial and temporal information on sea level variations for UK climate projections. To date, the potential value of the service has been recognised and generated interest among intended end users.

- **National Flood Warning and Mitigation Service,** Ambiental and Telespazio VEGA UK Ltd: Ambiental and Telespazio integrated the outputs of their respective SSGP Phase 1 projects to develop the Flood Warning and Mitigation Service. This system augments current national capabilities by providing unique real-time urban flood mapping and targeted risk identification. By providing near real time flood forecasts and integrating this data with crowd sourced data using machine learning, this service could improve the capability of authorities throughout the lifecycle of flood incidents. SSGP supported the development and commercialisation of this combined solution.
- **Peatland assessment**, Rezatec: This project aimed to develop a satellite-based tool to monitor the quality of peatland in Scotland and identify hotspots of degraded peatland to prioritise restoration. Degradation of peat soils and land management activities can negatively affect the quality of drinking water in reservoirs. By using satellite data to map the quality of peatland, this project could direct monitoring and mitigation efforts and therefore reduce the costs associated with monitoring and restoration of peatland. SSGP supported two phases of this project. Phase 1 sought to understand how to use satellite data to build a peatlands mapping tool for Scottish water, while Phase 2, set out to scale the tool to the whole Scotland, as well as support the development of more predictive modelling capabilities.
- **Space Applications for Precision Plant Health Information, Response & Evaluation (SAPPHIRE),** Rezatec: The objective of this project was to demonstrate Rezatec's ability to map the spatial distribution and abundance of 3 target deciduous tree species and to be able to monitor indicators of plant stress which are associated with pests and pathogens. This data can be used to direct inspection and mitigation efforts, and therefore improve the capacity of the forestry authorities to manage woodland. SSGP supported the initial development of the system and then its application and validation to a test area. Work done on this project supported follow-on work with the Department for Environment, Food and Rural Affairs (Defra) to map Sweet Chestnut trees and support their response to outbreaks.
- **100 – 1**, SterlingGEO: The aim of this project was to deliver multiple satellite-solutions to multiple end users in the public sector, optimising services and therefore reducing costs. The project team set out with the objective of reducing the cost to a level that is viable for local authorities through delivery at scale – i.e. by developing solutions in response to common problems and pooled user requirements. To support this problem-centred approach, SSGP allowed Sterling-GEO to engage with multiple end-users and develop solutions in response to what was needed. While Sterling-GEO no longer exists as a company, the knowledge and expertise gained from this project have been leveraged to support the UK Space Agency's International Partnership Programme (IPP) funded Earth and Sea Observation System (EASOS) project.

- **Study limitations:** Estimated value in this study is constrained by the availability of evidence and the time and resource constraints of this study. As a result, while this study has aimed to present an accurate assessment, the true use, value of SSGP may be different than that presented in this report.

3 Analytical framework

This section provides an overview of SSGP and sets out the framework used to structure the analysis. This includes the diagrammatic presentation of an 'impact logic model' to demonstrate the link between the activities, outputs and impacts of the programme, and an evidence-based assessment of the counterfactual to identify the additional impact of the programme.

3.1 Overview of SSGP

The Space for Smarter Government Programme (SSGP) is a UK Space Agency led and funded programme established in 2014. The programme is delivered in collaboration with the Satellite Applications Catapult and aims to[3]:

- Raise awareness and increase the number of public sector bodies using space-enabled services and applications by 2020;
- Accelerate the public sector uptake of space-enabled services and applications to make Government policy delivery and operations more efficient, and
- Contribute to the wider UK space sector growth target by 2030 by supporting government use of space services and applications supplied by the UK space sector.

To achieve these objectives, the programme delivers training, events, engagement with stakeholders, provision of data and information, and grants and competitions.

3.2 SSGP in numbers

SSGP's budget has averaged approximately **£1.5m per annum** to date. Actual expenditure on the programme (outturn) has been somewhat lower as indicated in Table 1 below.

Table 1 SSGP budget and expenditure breakdown

	2014/15	2015/16	2016/17	2017/18	2018/19	Total (2014/15 - 2017/18)
Budget	700,000	1,500,000	1,500,000	1,560,500	1,416,205	5,260,500
Outturn	1,023,580	1,602,188	1,476,704	894,949	*TBC*	4,997,421
Expenditure						
Grants	763,580	1,347,604	936,711	774,505	*TBC*	3,822,400
Grant %	*75%*	*84%*	*63%*	*87%*	-	*76%*
Non-grant	260,000	254,584	539,993	120,444	*TBC*	1,175,021
Non-grant %	*25%*	*16%*	*37%*	*13%*	-	*24%*
Total	**1,023,580**	**1,602,188**	**1,476,704**	**894,949**	**TBC**	**4,997,421**

Source: LE analysis based on figures provided by SSGP project team

The majority of this programme outturn (76% between 2014/15 and 2017/18) has supported fully-funded grants to UK industry to develop space applications for the public sector. Of the **154 bids** received by SSGP for this demonstration funding, 51 successful bids (33%) received a total of **£3.9m** in grant funding. This suggests an average grant size of £75,000, as detailed in Table 2 below.

Table 2 Contract values distributed by SSGP

Period	Number of bids	Successful bids (%)	Total grant value	Average grant size
2014/15	60	15 (25%)	£ 763,580	£ 50,905
2015/16	58*	21 (36%)	£ 1,347,604	£ 64,172
2016/17	8*	7 (87.5%)	£ 936,711	£ 133,816
2017/18	28	8 (28.5%)	£ 774,505	£ 96,813
Total	**154***	**51 (33%)**	**£ 3,882,400**	**£ 74,949**

*Note: * Missing values. Actual number of bids likely to be higher than this.*

Source: LE analysis based on figures provided by SSGP project team

[3] Based on internal SSGP strategy document.

The remaining outturn (24%) has funded the wider activities of the programme, including training, events, staff costs, networking events, and data provision.

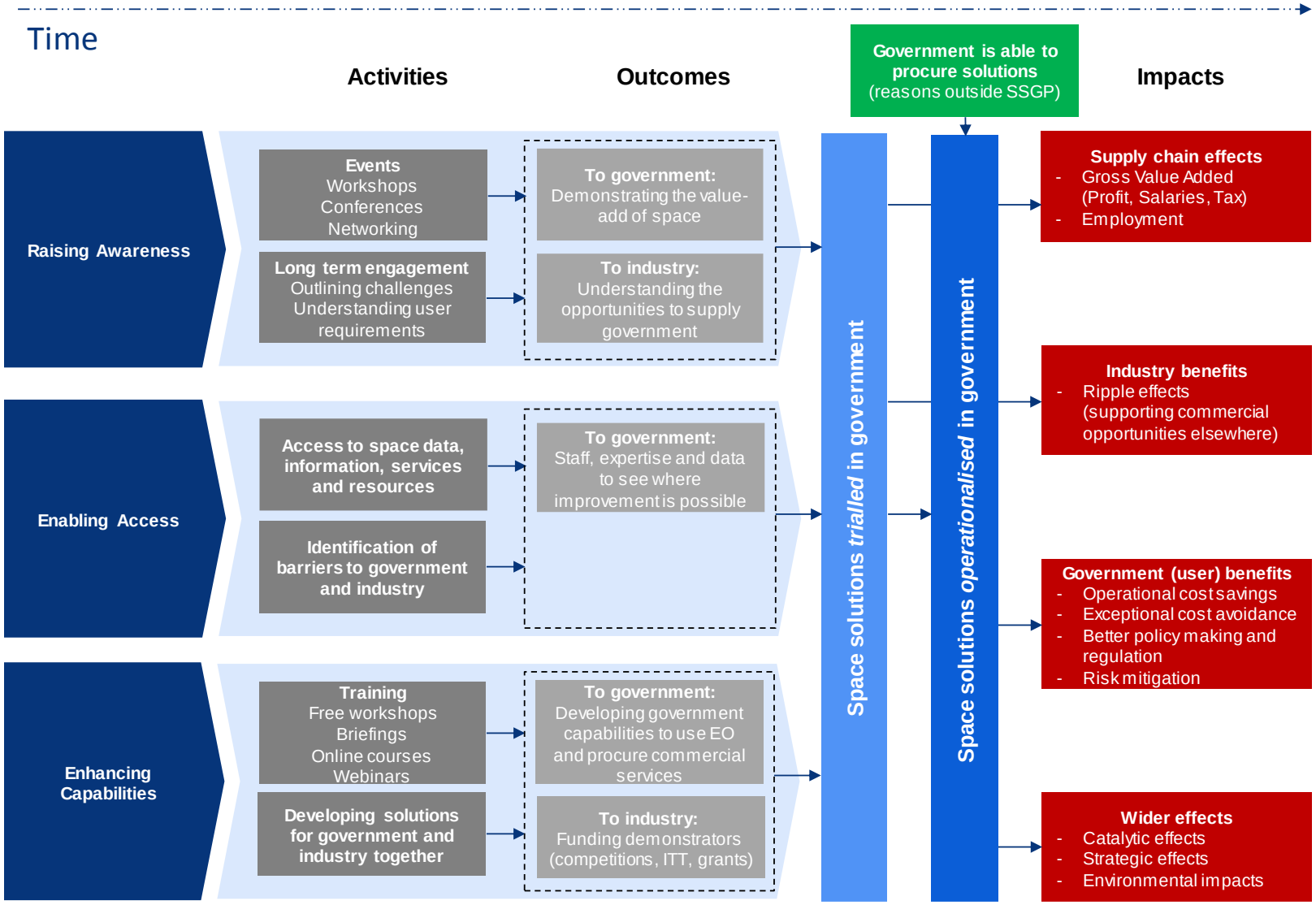
3.3 Logic model

SSGPs activities can be grouped around three core themes:

1) **Raising awareness** of space and satellite enabled services;
2) **Improving access** to data, services and resources, and
3) **Enhancing industry and government capabilities**.

These groups of activities, as well as their associated outcomes and impacts, are presented in the logic in Figure 1 below.

Figure 1 Logic Model of SSGP activities



Source: London Economics

These groups of activities are delivered simultaneously as they address different barriers associated with the uptake of satellite enabled products and services in government.

Awareness raising is done through a combination of events, workshops, conferences, and long-term communications. The objective is to establish a dialogue with: i) government departments so that they understand the value of space; dispel myths around cost and feasibility, and to identify needs and priorities, and with ii) industry and academia to understand the opportunities for supplying to government and the specific requirements of end users.

Some areas of government may face a number of resource, technical expertise and data constraints that limit their ability to use satellite services. The second strand of activities attempts to overcome these barriers by: i) firstly, identifying the barriers to the uptake of satellite applications in government, and the capacity of UK industry to supply to government, and ii) facilitating **access to data, services, and resources** that could enable solution development and support uptake. For example, SSGP's recent 'Satellite Data Imagery Bulk Buy' call aims to acquire high resolution geospatial datasets over the UK so that government entities can access this data for free[4]. This aims to remove cost or data related barriers that may prevent the uptake of satellite application in a resource-constrained public sector.

The last strand of activities aims to move from the identification of user needs and barriers to the development of space solutions for government. This occurs through the full funding of demonstrations to support the joint development, testing, and proofing of public-sector space-applications through a partnership of government customers and industry suppliers. By facilitating collaboration in this way, government can understand the viability of utilising space in service delivery, and industry can develop a solution that fulfils prospective user needs. The combination of SSGP's three activity strands ultimately supports the demonstration of space solutions in government. These demonstrations typically run in parallel to existing non-space systems until their value as an alternative system is proven.

These demonstrations will have immediate impacts, in the form of income and jobs for the solution providers involved in trial delivery. There may also be medium-term effects, as involvement in SSGP projects may provide solutions providers with lessons, expertise or IP that can be leveraged to support commercial activity in other areas of the company. These effects are termed 'ripple effects' and are part of industry's private return from involvement in SSGP[5]. However, longer-term impacts – such as operational cost savings, risk mitigation, and exceptional cost avoidance for government, as well as wider catalytic and strategic effects – will only be realised once trialled SSGP projects are procured and fully operationalised in place of existing non-space systems.

Procurement of SSGP demonstrators on a commercial basis for long-term service delivery are driven by a complex set of reasons. While the demonstrations may prove the effectiveness of space solutions over existing systems, funding pressures make it difficult for officials to procure solutions from industry and to hire staff to utilise these solutions. These barriers are sometimes beyond the scope of SSGP. However, as the value of space solutions becomes more widely understood – itself an objective of SSGP, senior officials may be more likely to provide the funds to support investment in space data and solutions. Similarly, SSGP aims to grow the community of practitioners within government entities, providing them with the skills and resources to be able to use space-solutions.

[4] For details, please see: http://www.government-online.net/uk-space-agency-satellite-data-imagery-bulk-buy/

[5] For details, please see forthcoming: London Economics (2018). Spillovers in the space sector.

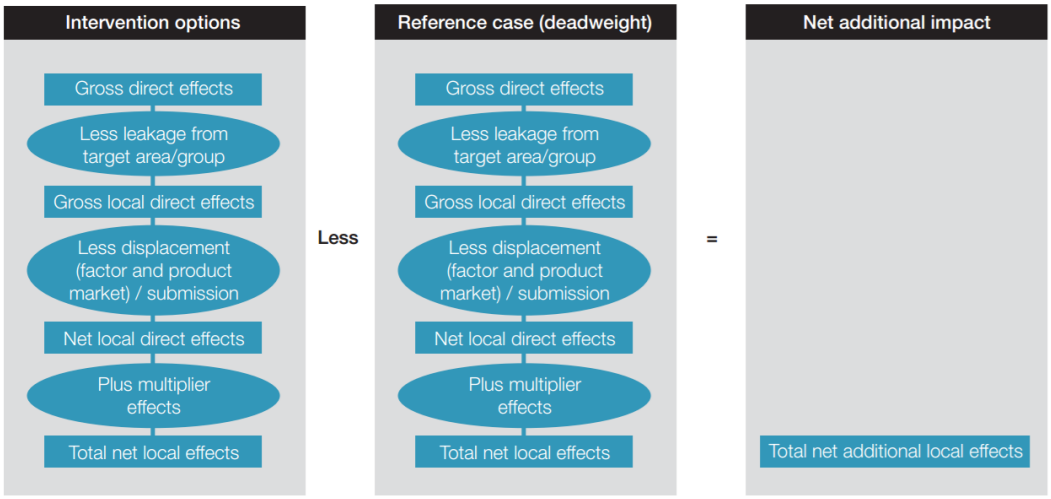
This means that longer-term, SSGP will likely be associated with the increased uptake of space solutions on an operational basis, and therefore these longer-term impacts.

3.4 Assessment of additionality (counterfactual)

To assess the impact of SSGP it is important to compare the outcomes that occur at present with SSGP with the outcomes that are likely in the absence of the programme. This estimation of what would have happened in the absence of this programme is known as the 'counterfactual'. By comparing this counterfactual with the current situation with SSGP, the impacts that we associate with the SSGP are likely to be the result of the programme and would not have occurred anyway.

In other words, it is important to assess the '**additional**' value of the SSGP, which can be, as shown Figure 2 below, defined as: **Gross benefits** (i.e. total benefits from SSGP) *minus* the **deadweight** (i.e. outcomes associated with the counterfactual); *minus* the **leakage of benefits** outside of the UK; *minus* any **displacement** and **substitutions** effects (i.e. foregone benefits from economic activity that might be reduced or replaced); *minus* any **crowding out or in** through general equilibrium effects; *minus* any **unintended consequences**; *plus* any **multiplier benefits** that result.

Figure 2 Assessing additionality



Source: English Partnerships (2008). Additionality Guide: A standard approach to assessing the additional impact of interventions.

3.4.1 Impacts

Relative to the SSGP scenario, the counterfactual scenario implies a world where SSGP's activities of raising awareness, enabling access, and demonstrating capabilities do not take place. The impact of this, however, depends on the extent to which these activities are likely to take place anyway. These impacts are considered qualitatively below:

- **Awareness raising:** this activity aims to coordinate a market for space-enabled public-sector applications by creating demand for capabilities on the government user side and a ready supply of bespoke products and services for the public sector on the industry side through events, training, and longer-term engagement activities. A recently published London Economics study on the value of Earth Observation for the public sector suggests that SSGP has played a substantial role in making the case for the use of satellite applications in government and supported increased engagement between government

and industry[6]. While organisations such as Satellite Applications Catapult encourage the use of satellite services more generally, there is no comparable national programme that raises awareness of satellite services in government to the same extent either directly or through the support of public-sector specific demonstration programmes.

- **Enabling access:** aside from SSGP, there exist several UK, European Space Agency (ESA) and EU programmes that attempt to improve access to space applications, data and services. Examples include H2020, the General Support Technology Programme (GSTP) and National Space Technology Programme (NSTP). However, none of these programmes are focused on improving access to satellite data, applications, and services within the public sector specifically. The proposed UK Government Earth Observation Service (UK GEOS) is intended to coordinate the UK government's EO interests and act as a one-stop-shop for EO data, products, and services, but this would be specific to the EO domain and is still only a concept[7]. For this reason, it is possible to conclude that SSGP has been unique in its role in enabling access to satellite data, applications, and services since its launch in 2014 through its work linking stakeholders to data sources and removing barriers to access.
- **Demonstrating capabilities:** there are a large number of existing UK, ESA and EU programmes that fund downstream applications of satellite data. These include the ESA Business Applications programme, the National Space Technology Programme (NSTP), and competitions run by Innovate UK and the Satellite Applications Catapult. Nevertheless, **most industry participants in the SSGP that were spoken to as part of this study indicated that SSGP was the only viable funding source** given its flexibility, offer of full funding, and general support to connect suppliers to end users in government. **Almost all industry consultees also indicated that their project would either not have taken place or as quickly without SSGP funding**.

Together, these points suggest that the counterfactual scenario would be characterised by fewer demonstration projects that showcase satellite applications for the public sector, relative to the SSGP scenario. As a result, the counterfactual scenario implies fewer industrial and ripple effects.

With a reduced pipeline of demonstration projects, the number of space applications that are ultimately procured and operationalised in place of non-space systems would also be lower. This suggests fewer government benefits, in the form of operational cost savings, exceptional cost avoidance, or better policy and regulatory decisions, and fewer catalytic or strategic effects.

3.4.2 Costs

There would be no direct costs in the counterfactual scenario since there would be no expenditure on SSGP.

4 Benefit analysis

The following section presents the results of a holistic evaluation of SSGP's benefits. Assessed benefits include: i) immediate and longer-term benefits to SSGP participants in industry (recipients of grants and contracts); ii) the potential benefits to government that could be associated with the

[6] London Economics (2018). Value of Earth Observation to UK Government today and by 2020. Evidence from nine domestic civil uses.

[7] London Economics (2018). Value of Earth Observation to UK Government today and by 2020. Evidence from nine domestic civil uses.

operational adoption of example SSGP projects, and iii) the additional impact of SSGP grantee expenditure on the supply chain and economy.

As outlined in the 3.3, the first and third of these benefits are realised over the course of the demonstration project grant, but the second benefit class is only realised once demonstration projects are procured to support operational services. For this reason, the SSGP benefits to government that are reported in this section are 'potential'.

4.1 Industry benefits

Industry benefits refer to the benefits that are achieved by the organisations that deliver SSGP projects. These benefits include: i) commercial benefits that directly result from the SSGP projects, such as related sales, and ii) ripple effects which refer to the indirect or longer-term benefits of the SSGP project on the SSGP delivery organisations. These effects include the knowledge gained from the SSGP project, which can support innovation and increased sales in other areas of the firm. Together, these grantee benefits represent the delivery organisation's private return from their involvement with SSGP.

As part of this study, SSGP grantees from industry were asked to identify the benefits that they have gained to date from their involvement in SSGP. These views have been synthesised into the following benefit areas to identify common themes: i) commercial; ii) network; iii) reputation, and iv) knowledge. These benefits are elaborated in more detail below.

- **Commercial:**
  - Several consultees highlighted how SSGP enabled their organisation to bridge the 'technological valley of death' between the fundamental research and commercial stages of innovation. As a result, all projects that were consulted have been able to progress their satellite application to a stage where it has been marketed to end users on a commercial basis. In most instances, this has resulted in commercial procurement, and in one instance, the spin-out of a new company from academia.
  - Some consultees were able to identify alternative sources of funding but emphasised how the flexibility and relatively light procurement process of SSGP supported fast product development and a first mover advantage in the market place following successful development.
- **Network:**
  - SSGP facilitated collaborative application development between suppliers in industry
  - and end users in government. In many cases, these relationships have been maintained

Figure 3 Quotes from industry participants on SSGP impact

"The funding has had a major effect on [company] and the potential future market in the UK and abroad".

"The funding has resulted in an end user product that is now commercially available".

"This has opened up a new potentially lucrative market in the UK and means we have a service offering that is exportable to other territories internationally…Genuine sales prospects have been identified".

Source: SSGP end of project reports from industry

beyond the project and have therefore enabled collaboration and commercial opportunities for other areas of the business.

- In one instance, SSGP supported the joint solution delivery between two industry suppliers. By providing the first opportunity to collaborate, SSGP allowed these suppliers to build trust and a working relationship. These suppliers have been able to leverage this trust to win and deliver work together beyond SSGP.
- Several consultees highlighted the strength of the SSGP team's network and convening power across industry, funders, and potential end users. Participation in SSGP has allowed project teams to tap into this network e.g. through attendance at showcase events, opportunities to present and feature in publications, formal introductions, etc. As well as supporting the business development of SSGP outputs, these networks have enabled some consultees to access broader space sector R&D and commercial development opportunities, such as the Satellite Application Catapult's 'Business Sprint', ESA's Business Applications programme, and the UKSA's International Partnerships Programme (IPP).

- **Reputation:** the UK Space Agency's profile and credibility as a lead and funder for SSGP was cited as key to supporting consultees to win further grant funding from other sources (e.g. UKSA IPP, ESA and Innovate UK) or to export their product to international markets. In most cases, this benefit was magnified by the fact the SSGP projects feature in case studies on the UK Space Agency-branded SSGP website.
- **Knowledge:** most consultees could identify expertise that they had developed from their SSGP project that has or could potentially be leveraged to support work in other areas of their business. This includes the development of: i) technical expertise – such as in their capabilities to use remote sensing, Sentinel data and machine learning in other areas; ii) commercial expertise e.g. marketing and sales, and iii) project development expertise e.g. through a greater understanding of the importance of developing products or services with the user requirements from the outset.

Figure 4 Quotes from industry participants on SSGP impact

"Our company has gained enormously from the project".

"We cannot underestimate the value brought by the UKSA through the programme in the continual outreach and support provided".

"The impact of the programme on our business cannot be underestimated. This has been a key programme in our development".

"The symbiotic relationship formed throughout the project offered value to both parties, sharing knowledge and understanding of the market".

"We do expect the company to generate additional revenue as a result of the project in the UK and overseas markets".

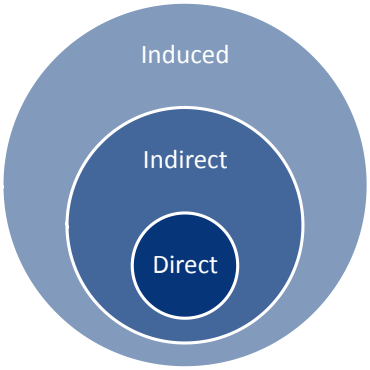
"Regular discussion and information exchange throughout the programme allowed [Company] to follow up on potential opportunities, engage with stakeholders and seek solutions".

Source: SSGP end of project reports from industry and project case studies

4.2 Supply chain effects

The economic impact of SSGP on the economy can be measured in terms of the direct, indirect and induced impacts that result from the grant expenditures of space organisations involved in delivery of SSGP demonstration projects. Each of these firms and their supply chains contribute to economic activity. This economic activity is measured in terms of **Gross Value-Added generation** (GVA, €) **and jobs supported** (FTE). GVA measures the Gross Domestic Products (GDP) contribution of SSGP and is defined as turnover net of the cost of intermediate goods and services sold.

Figure 5 Multiplier effects from SSGP investments



Source: London Economics

The first channel is the **direct effect**. The direct effect can be thought of as the value added to goods and services by the project's employees. It is equivalent to labour costs and profits earned by the value chain. Direct jobs supported represents the total number of full-time equivalent (FTE) employee salaries that are supported within the organisation(s) participating in the project.

The **indirect effect** is linked to the employment supported and value added by domestic organisations that supply to the organisations that are directly involved in SSGP projects. This supply chain will include the supply of data, IT, systems, utilities and consumables. This activity in the domestic supply chain supports employment and value creation in the supplying organisations and industries. Supplying organisations will in turn increase demand from their supply chain resulting in a chain of intra- and inter-industry spending.

The **induced effect** is defined as the economic activity supported by the expenditure of employees in the supply chain within the UK economy. This generates income for organisations within other industries, driving value creation and supporting employment.

These broad effects from the expenditure of SSGP grantee recipients are presented in Figure 5.

Gross Value Added

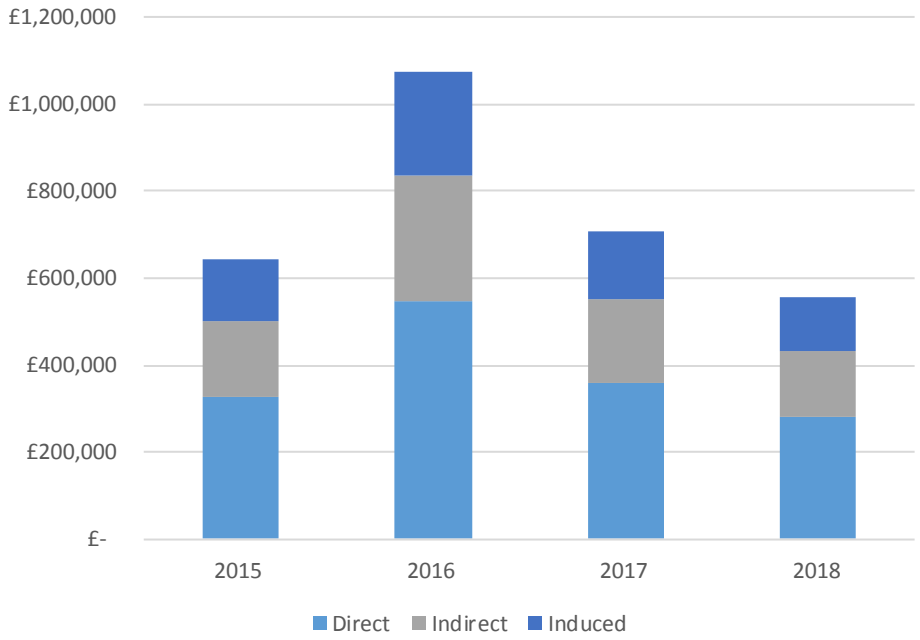
The direct, indirect and induced effects of SSGP grantee expenditure can be estimated using a two-step process. This involves firstly converting SSGP expenditure to GVA using the space-specific GVA share of 36.4%[8]. This is equivalent to saying that for each £1 in SSGP grant expenditure, directly contributes 36.4p to UK GDP. The second step involves multiplying the GVA value by the Type II multiplier. The space-specific multiplier is 1.97. This implies that each £1 of space industry GVA generates an additional £0.97 worth of GVA in the supply chain and supporting sectors[9].

Given SSGP nominal expenditure on demonstration grants of **£3.8m** between 2014 and 2018, the present value (PV) of direct, indirect and induced industrial effects is **£3.0m** over four years. This implies that each pound of SSGP grant expenditure is associated with an additional £0.78 in

[8] London Economics (2016). Size & Health of the UK Space Industry.

economic activity in the rest of the economy. This is equivalent to an industrial effects multiplier of 1.78. The distribution of these industrial effects by year is presented in the chart below.

Figure 6 SSGP industrial effects



Source: London Economics analysis

4.2.1 Employment supported (Full Time Equivalent-years)

The impact of SSGP on employment throughout the supply chain is also a key indicator of SSGP's economic value. Employment in this study is measured in terms of FTE headcount and follows a similar logic to that used for GVA.

Given that employee productivity for space applications is **£138,000 per employee** and is associated with a Type II employment multiplier of 2.96, SSGP appears to support a total of **29 FTEs** over four years[10]. Of this, 10 are estimated as having been supported by grants, and 19 in the supply chain.

4.3 Potential government benefits

SSGP's existence is motivated by a wide body of evidence that suggests that space solutions possess a number of characteristics that make them more cost-effective at supporting public sector processes than non-space solutions. These characteristics include[11]:

- Collection of data at regular frequency (temporal resolution);
- Collection of data over large areas (scale) and in remote, inaccessible areas;
- Fast turnaround of data (supporting in-year use);
- Lower average data processing costs (through automated processes);
- Consistency of data collection (supporting time series);

[10] London Economics (2016). Size & Health of the UK Space Industry 2016.
[11] Adapted from: London Economics (2018). *Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020. Evidence from nine civil use cases.*

- Objectivity and absence of human error or bias in data collection, and
- Re-use potential of data for other applications.

The SSGP demonstration solutions that were assessed for this study possess many of these characteristics based on interviews with SSGP project end users in government. However, these characteristics can only represent realisable value to the public sector once they are operationalised at scale in place of less cost-effective alternatives.

At this early stage, no SSGP project has been adopted for national use, although several SSGP projects have been procured on more limited scales. Consultations with public sector end users[12] and supplier stakeholders suggest a number of reasons for this (often related to resource constraints), even if they appear to agree on the general success and effectiveness of the demonstration solution. For this reason, this section considers the potential benefits to the public sector – in the form of operational cost savings, exceptional costs avoided, and mitigated risks – that could be realised if these barriers to operational adoption are overcome[13].

Given the limited scope of this study, quantification of potential benefits is limited to six of the seven of demonstration projects that were the primary focus of this study.

Air Quality Hotspot Mapper

EarthSense's AQHM integrates Copernicus MACC II data with other data sources to provide local authorities with improved insights for decisions that can mitigate the negative health consequences of poor air quality.

If AQHM is used to support local authority level reporting of air quality (as required under the Local Air Quality Management system) and therefore the adoption of more effective air quality interventions across all local authorities in the UK, the potential benefits are estimated at **£4.1 million** per annum[14]. This is based on the assumption that effective interventions reduce emergency hospital admissions for air quality-related emergencies (Chronic Obstructive Pulmonary Disease and asthma), and therefore the associated cost of these emergency admissions to the NHS.

National Flood Warning and Mitigation Service

Satellite-derived EO can be used by flood response authorities such as the Environment Agency at all stages of the disaster event life cycle, including supporting investment decisions and enhancing the accuracy of flood maps. The potential value of more efficient flood defence allocation has been estimated by London Economics in a recent study at £2.8 million per annum[15]. To the extent that this SSGP demonstrator project can inform flood defence allocation in a similar way, this project could be associated with potential benefits **up to £2.8 million per annum**.

[12] Consultations with the public sector where conducted for the following study: London Economics (2018). *Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020. Evidence from nine civil use cases.*
[13] Some of the EO project benefit estimates in this section build on material from Stott, Z. (2017). *Evaluation of Defra Earth Observation Data Integration Pilot – Strategic Overview.*
[14] It is difficult to distinguish between the effect of improvements to LAQM and air quality modelling and forecasting on improved air quality interventions and their subsequent effect on air quality. For this reason, only one estimate has been provided for the value satellite-derived EO's contribution to both areas.
[15] London Economics (2018). *Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020. Evidence from nine civil use cases.*

Sea Level Space Watch

Remote sensing can help coastal authorities to optimise coastal defence investment to better mitigate the potential loss of coastal habitats and assets. In Scotland alone, coastal floods are estimated to account for £53 million in annual damages alone[16]. By reducing the uncertainty of sea level rise data, Sea Level Space Watch can support more accurate coastal flooding forecasts and more efficient coastal defence expenditure. This could yield potential operational cost savings of up to **£1 million per annum[17].**

Space Applications for Precision Plant Health Information, Response & Evaluation (SAPPHIRE)

At present, tree health mapping requires resource intensive visual surveys e.g. on the ground or from helicopters. By utilising multispectral and SAR satellite imagery in combination with adequate ground-truthing, Rezatec's SAPPHIRE solution can be used to help target ground-based inspections. This can support early and more efficient detection and containment of tree pests and pathogens. To the extent that SAPPHIRE can help secure 2% of UK woodland in this way, the potential exceptional costs that could be avoided are **£9.2 million per annum[18]**.

Always connected mobile medical screening

Medical screening vehicles provide additional screening capacity to the NHS and therefore reduce pressure on busy hospitals. The introduction of satellite connectivity, as demonstrated with this project, can enhance these benefits in a number of ways. These include: increasing the throughput of patients and therefore available screening capacity; supporting faster turnaround of results, reducing medical record errors; improving staff deployment; reducing logistics costs, and providing significant opportunities to streamline the reporting process. Estimates of the potential cost savings associated with this projects are commercially sensitive so cannot be disclosed for this study.

Peatland assessment

Degradation of peat soils can increase the levels organic content that enters water sources. This requires expensive water treatment to achieve required drinking water standards. Satellite-based landscape intelligence can be used to optimise the identification of peatland degradation hotspots and prioritise restoration activities. This can help reduce the operating and restorative costs that are currently associated with this activity and maintain the environmental benefits of peatlands. Based on estimates that Rezatec's solution can reduce ground survey work across the 12,000km^2 of catchment area that is characterised as peatland or with high organic matter content by 80%[19], the potential operational cost savings are estimated at **£24 million per annum[20].** Given potential

[16] Figures obtained from following presentation: SatOC (2016). Sea Level Space Watch – An Operational Service to Monitor Seasonal and Inter Annual Sea Level Variability from Space Report on: A Workshop to Review Requirements and Options for an Operational Service.
[17] London Economics (2018). *Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020. Evidence from nine civil use cases.*
[18] London Economics (2018). *Value of satellite-derived Earth Observation capabilities to the UK Government today and by 2020. Evidence from nine civil use cases.*
[19] Estimate based on interviews with stakeholders.
[20] Minimal cost of monitoring of peatland (excluding management and opportunity costs) is estimated at £25 per hectare. This is based on estimates provided by: Moxey, A., Moran, D. (2014). *UK peatland restoration: some economic arithmetic.* Science of the Total Environment. Total monitoring costs for the relevant catchment area is therefore £30 million.

peatland restorative costs of £1,200 per hectare[21], the exceptional costs that avoided through the Rezatec could be even more substantial.

4.3.1 Summary of potential benefits to government

This section reported on the potential value to the public sector that could be unlocked if six of the SSGP projects that are considered are scaled and procured for operational service. On this basis, SSGP could support a total of **£41.1 million** in potential benefits to the public sector in the form of operational cost savings (£27.8 million or 68%), exceptional cost avoidance (£9.2 million or 22%), and catalytic benefits (£4.1 million or 10%) – as reported in the table below.

Table 3 Potential annual value of SSGP projects to public sector, assuming operational adoption of SSGP solution

SSGP project	Benefit type	Potential benefit, annual
Air Quality Hotspot Mapper	Catalytic benefit	£4.1 million
Flood mapping	Operational cost saving	£2.8 million
Sea Level Space Watch	Operational cost saving	£1.0 million
SAPPHIRE	Exceptional cost avoidance	£9.2 million
Always connected medical screening	Operational cost savings	Not disclosed
Peatland assessment	Operational cost saving	£24.0 million
Total		**£41.1 million**

Source: London Economics

5 Conclusions on the economic impact of SSGP

This report has quantified, wherever possible, the value of the SSGP. The analysis of industry and government impacts of the programme is based on evidence from a sample of seven grant funded demonstrator projects. In addition, the overall impact of SSGP grantee expenditure on the supply chain and wider economy is estimated terms of GVA and jobs supported to supplement this analysis.

Grantee benefits have been clearly evidenced and fall into four main areas: commercial, network, reputation, and knowledge. Together, these benefits suggest that the benefits of participating in SSGP extend significantly beyond the grant into other areas of the business.

At this early stage, no SSGP project has been adopted for national use, although several SSGP projects have been procured on more limited scales. The consultations with public sector and supplier stakeholders suggest a number of reasons for this (often related to public sector resource constraints), even if they appear to agree on the general success and effectiveness of the SSGP-funded demonstration solutions. For this reason, it has not been possible to quantify any realised benefits to government from the projects that have been assessed. Instead, the potential value to the public that could be unlocked following scaled procurements of these projects has been considered. On this basis, these projects could support a total of **£41.1 million in potential annual benefits to the public sector** in the form of operational cost savings (£27.8 million or 68%), exceptional cost avoidance (£9.2 million or 22%), and catalytic benefits (£4.1 million or 10%).

[21] Mean estimate of restorative costs from Climatexchange (2018). *Peatland restoration – a comparative analysis of the costs and merits of different restoration methods.*

The present value (PV) of direct, indirect and induced industrial effects of SSGP is **£3.0m** over four years. This implies that each pound of SSGP grant expenditure was associated with an **additional £0.78 in economic activity in the rest of the economy**. This is equivalent to a **multiplier of 1.78**. However, this multiplier should be interpreted as a lower bound since it is does not include the actual and potential benefits to grantees and government users that are also identified. SSGP also appears to support a total of **29 FTEs** over four years, including 10 FTEs that are estimated as having been supported by the grants, and a further 19 in the supply chain.

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