

of revenues as well as the relative growth of higher-margin merchant solutions products, namely Shopify Capital and referral fees from partners.

Gross profit increased \$216.0 million, or 56.8%, for the year ended December 31, 2018 compared to the same period in 2017. As a percentage of total revenues, gross profit decreased from 56.5% in the year ended December 31, 2017 to 55.6% in the year ended December 31, 2018, due to Shopify Payments representing a larger percentage of total revenue, increasing the functionality and flexibility of our hosting infrastructure, and higher product costs associated with expanding our product offerings. This was partly offset by the relative growth of higher-margin merchant solutions products, namely referral fees from partners, Shopify Capital, and Shopify Shipping.

Operating Expenses

Sales and Marketing

	Years ended December 31,			2019 vs 2018	2018 vs 2017
	2019	2018	2017	% Change	% Change
(in thousands, except percentages)					
Sales and marketing	\$ 472,841	\$ 350,069	\$ 225,694	35.1 %	55.1 %
Percentage of total revenues	30.0 %	32.6 %	33.5 %		

Sales and marketing expenses increased \$122.8 million, or 35.1%, for the year ended December 31, 2019 compared to the same period in 2018, due to an increase of \$70.4 million in expenditures on marketing programs to support the growth of our business, such as advertisements on search engines and social media, brand campaigns, event sponsorships and payments to partners. Employee-related costs increased \$48.7 million (\$14.1 million of which related to stock-based compensation and related payroll taxes) to support the growth of the business including in Shopify Plus and International operations. Computer hardware and software costs increased by \$3.7 million, largely due to the growth in sales and marketing headcount.

Sales and marketing expenses increased \$124.4 million, or 55.1%, for the year ended December 31, 2018 compared to the same period in 2017, primarily due to an increase of \$80.7 million in employee-related costs. In addition to employee-related costs, marketing costs increased by \$39.7 million and computer hardware and software costs increased by \$4.0 million.

Research and Development

	Years ended December 31,			2019 vs 2018	2018 vs 2017
	2019	2018	2017	% Change	% Change
(in thousands, except percentages)					
Research and development	\$ 355,015	\$ 230,674	\$ 135,997	53.9 %	69.6 %
Percentage of total revenues	22.5 %	21.5 %	20.2 %		

Research and development expenses increased \$124.3 million, or 53.9%, for the year ended December 31, 2019 compared to the same period in 2018, due to an increase of \$114.4 million in employee-related costs (\$45.1 million of which related to stock-based compensation and related payroll taxes), a \$7.4 million increase in computer hardware and software costs, and a \$2.5 million increase in professional services fees, all as a result of growth in our research and development employee base and expanded development programs.

Research and development expenses increased \$94.7 million, or 69.6%, for the year ended December 31, 2018 compared to the same period in 2017, due to an increase of \$89.6 million in employee-related costs, an increase of \$3.1 million in computer hardware and software costs, and a \$2.0 million increase in professional services fees, all as a result of growth in our research and development employee base and expanded development programs.