

Dental technology services and industry trends in New Zealand from 2010 to 2012

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ABSTRACT

Objective: To provide a snapshot of the New Zealand dental technology industry and influencing factors.

Background: Developing an understanding of the commercial dental laboratory environment in New Zealand can provide insight into the entire dental industry.

Methods: A web-based survey was the primary method for data collection, with separate questionnaires used for dental laboratory owners and dental technician employees.

Results: The mean net income for dental laboratory owners in New Zealand was similar to that of the United Kingdom, at \$40.50 per hour. Clinical dental technicians are the highest paid employees, with a mean of \$33.49 per hour. The mean technical charge for complete dentures was \$632.59; including clinical services, it was \$1907.00. The mean charge for a porcelain-fused-to-metal (PFM) crown was \$290.27. Dental laboratory owners expressed fear about the possibility of losing dental clients to overseas laboratories due to the availability and cheap charge of offshore work. Only 25.4% of dental laboratories surveyed had computer-aided design (CAD) facilities, and even fewer (7.9%) had computer-aided manufacturing (CAM) systems.

Conclusion: Clinical dental technology appears to be prospering. The dental technology industry appears to be adapting and remains viable, despite facing many challenges.

Keywords: *clinical dental technology, dental technology, dental technician, dental laboratory.*

INTRODUCTION

Understanding the dynamics of the commercial dental laboratory sector is crucial to forming a comprehensive understanding of the entire dental industry (Olin et al, 1989). Globalisation is an unstoppable trend which is steadily expanding world market boundaries. Advances in technologies and communication have significantly reduced the charge of transportation, making economic globalisation a reality (Dietzenbacher, 2009). Since the 1990s, outsourcing work overseas has been a feature of various industries and has become a major industrial trend (Berggren, 2004; Young, 2007). Young (2007) suggested six main drivers of outsourcing: reducing charges; increasing efficiency; competitive

advantage; flexibility; and the elimination of industrial problems. In the US context, many dental laboratory owners defend their decision to outsource with the rationale that it enables them to meet the needs of cost-conscious dentists while keeping their desired profitability (Rego, 2005). Furthermore, they believe that it saves them the stress and time of recruiting and training new staff. It also allows them to offer the latest services and technology (such as CAD/CAM) without the burden of capital investment (LMT Communications, 2005). However, offshore outsourcing has also raised a lot of concern among dental professionals. Communication with overseas dental laboratories is limited, especially if it has to occur through a broker laboratory. Additionally, patient information may not be interpreted correctly because of language barriers (Pfister, 2010). Overseas countries may not have the same regulations in place as New Zealand, and this could result in lower-quality products (Gills, 2007; Rego, 2010). In the New Zealand setting, clinicians must ensure that the prostheses they are placing are of good quality and do not harm the patient. While the fit and outward appearance of the prosthesis can be scrutinised, the properties of the materials used and the manufacturing processes cannot be determined (Gills, 2007; Pfister, 2010). A study by Waddell et al (2010) revealed that nickel was the major element in the base metal alloys used to manufacture low-cost porcelain-fused-to-metal (PFM) crowns obtained from China. There is also some doubt about the sustainability of outsourcing, because the financial savings may not last due to the source country's developing economy and resultant changes in workforce expectations (Young, 2007).

A New Zealand survey by Tay et al (2008) found that earning potential and efficiency were the most frequent reasons given by New Zealand dentists for investing in a CAD/CAM system. CAD/CAM ranked fifth as a new technology used by those dentists. Even though CAD/CAM systems are part of the modern dental laboratory and some clinical practices, the major drawback of this technology is its initial high cost and ongoing maintenance (van Noort, 2012; Beuer et al, 2008).

Bower et al (2004) observed that, to develop the dental technology profession, the workforce must enjoy their work, be valued by the dental team, and be able to pursue further education and training. Other key factors that may affect job satisfaction are the age of the technician, their working hours, and having a career path. Understanding the dental laboratory market and the factors influencing it could offer insight into the dental industry as a whole (Olin et al, 1989). Currently, there is limited literature available about the New Zealand dental technology industry and the services it provides. Accordingly, the purpose of this study was to investigate the workforce, service, and income characteristics of the New Zealand dental technology industry using a cross-sectional survey.

METHODS

A web-based survey was the primary method for data collection. Two questionnaires were designed using an online website (Survey Monkey; <http://www.surveymonkey.net>). The first questionnaire targeted dental laboratory owners; and the second was directed at their dental technician employees. The dental laboratory owners' questionnaire had six sections (demographic characteristics, workforce, services, business forecasting, revenue, and personal opinion). The dental technician employees' survey comprised three sections seeking information on demographic and workforce characteristics, and personal opinion. Ethical approval for the survey was obtained from the Ministry of Health, Health and Disability Multi-region Ethics Committee prior to commencement. Participants were ensured confidentiality by the use of unique identification numbers.

The source population was registered clinical dental technicians and dental technicians who held a current Annual Practising Certificate (APC). Email addresses for all dental technicians holding an APC were obtained from the register maintained by the New Zealand Dental Council. The dental technology professional body (the New Zealand Institute of Dental Technologists, or NZIDT) was asked to send the email invitation to its 180 members. Dental technicians who were not members of the NZIDT were emailed directly. Seventy-six technicians could not be contacted via email, and therefore were invited by mail.

The invitation email/letter was short and friendly while motivating recipients to participate. The significance of the survey and the importance of participation were emphasised, explaining how the findings could inform the further development of the dental technology industry. This was followed by instructions on how to proceed with the survey. A web-link was included; this provided the participants direct access to the online survey. A follow-up invitation was sent to all participants four weeks after the initial invitation. Researcher contact details were also provided in case they encountered any difficulty completing the survey. The questionnaire was designed to allow the participants to skip any question they did not want to answer. Most questions used closed response options, but all allowed free-form comments to be added. A 10-point scale (1 being low and 10 high) was used to measure the level of job satisfaction and enthusiasm for the job. It was based on the scale used by Bower et al (2004).

A prize draw was offered as an incentive to increase the response rate. This consisted of one prize for each survey. After completing the questionnaire, participants were taken to a separate secure website where they could enter their contact details for the prize draw.

The data were merged into a single database and analysed using the Statistical Package for Social Sciences statistical software (Version 19.0; SPSS Inc., Chicago, USA) with an alpha level of 0.05. Associations between categorical variables were tested for significance using the Chi-square test. Mean and median scores on the career satisfaction scale were compared using the Mann-Whitney Test. Revenue and net profit of dental laboratories was compared using the Friedman test (a non-parametric version of oneway analysis of variance).

RESULTS

Of 344 dental technicians holding a current APC, 268 (77.9%) were contactable. Of the 268 assumed active clinical/dental

technicians, 121 were employees, and 60 of those responded, giving a 49.6% response rate for that group; 63 of the 147 laboratory owners responded, giving a 42.6% response rate for them. Of the 268 assumed active clinical/dental technicians, 107 (39.9%) had an APC allowing them to practise as a clinical dental technician. Not all questions were answered by all respondents, so response rates vary for individual questions.

Data on respondents' demographic characteristics are presented in Table 1. NZ European was the most prevalent ethnic group among both laboratory owners and employees. Chinese was the second most common ethnic origin. Most employees were younger than 39, while most laboratory owners were older ($P<0.001$). The majority of the responding dental laboratory owners were male, while an almost equal proportion of women and men were employees ($P<0.05$). There were more dental technician employees holding Bachelor Degrees than dental laboratory owners. The most prevalent qualification held by dental laboratory owners was the Postgraduate Diploma in Clinical Dental Technology. There were five laboratory owners with Bachelor Degrees in management and science. In addition, there were five respondents with approved experience. A higher proportion of dental laboratory owners than employees were registered with the New Zealand Dental Council.

Twenty-eight of the responding dental laboratories had started their business in the previous 10 years, while 12 had commenced in the 1980s, and 11 in the 1990s. The North Island had the highest number of new dental laboratories having commenced in the previous decade, with 20; for the South Island, there were 8 ($P<0.05$).

When respondents were asked to rate their career satisfaction on a 10-point ordinal scale, the overall mean career satisfaction score was 6.9 (SD=2.5) for dental laboratory owners and 6.9 (SD=2.3) for dental technician employees. The mean career enthusiasm was higher than the career satisfaction at 7.6 (SD=2.1) for laboratory owners and 7.8 (SD=2.1) for employees. There was no significant career satisfaction differences between the laboratory owners and employees ($P>0.05$). Dental technician employees had a slightly higher job-related stress level, with a mean score of 6.8 being slightly higher than the 6.5 for dental laboratory owners ($P>0.05$). A high percentage (72.1%) of dental technicians stated that dental technology had fulfilled their career expectations, but 48.8% stated that they would not study dental technology again if they had the chance. While 57.9% of those aged 36 or older felt that there were adequate career opportunities, 58.3% of younger dental technicians felt that there were not adequate career opportunities.

Data on the services provided are presented in Table 2. All-metal and PFM restorations were the most common fixed prostheses service provided. More laboratories in New Zealand provided removable prostheses services than fixed restorations services. The removable prostheses services were predominantly complete dentures or acrylic partial dentures. The most common clinical service provided by clinical dental technicians was complete dentures. Removable orthodontic appliances were one of the least common dental laboratory services provided.

Data on the charges for services provided are presented in Table 3. A mean charge for fixed laboratory services was calculated by combining all of the different types of fixed restorations produced; the removable mean charge was calculated in the

Table 1 Demographic data for dental laboratory owners and employees

Ethnicity	Laboratory owners n=63 (%)	Employees n=60 (%)	Combined n=123 (%)
NZ European	37 (58.7)	27 (45.0)	64 (52.0)
Chinese	5 (7.9)	6 (10.0)	11 (8.9)
South African	3 (3.2)	2 (3.3)	5 (4.1)
English	4 (6.3)	1 (1.7)	5 (4.1)
German	2 (3.2)	3 (5.0)	5 (4.1)
Korean	2 (3.2)	3 (5.0)	5 (4.1)
Middle Eastern	1 (1.6)	4 (6.7)	5 (4.1)
NZ Maori	1 (1.6)	1 (1.7)	2 (1.6)
Other	8 (12.7)	13 (21.7)	21 (17.1)
Age group (years)	n=60 (%)	n=56 (%)	n=116 (%)
<30	6 (10.0)	19 (33.9)	25 (21.6)
31 to 40	9 (15.0)	16 (28.6)	25 (21.6)
41+	45 (75.0)	21 (37.5)	66 (56.9)
Gender	n=63 (%)	n=60 (%)	n=123 (%)
Male	50 (79.4)	32 (53.3)	82 (66.7)
Female	13 (20.6)	28 (46.7)	41 (33.3)
Qualifications*	n=62 (%)	n=56 (%)	n=118 (%)
None	1 (1.6)	3 (5.4)	4 (3.4)
Apprentice	5 (8.1)	3 (5.4)	8 (6.8)
Certificate in Dental Technology	19 (30.6)	10 (17.9)	29 (24.6)
Advanced Certificate in Clinical Dental Technology	4 (6.5)	4 (7.1)	8 (6.8)
Diploma in Dental Technology	16 (25.8)	19 (33.9)	34 (28.8)
Bachelor in Dental Technology	10 (16.1)	19 (33.9)	29 (24.6)
Postgraduate Diploma in Clinical Dental Technology	27 (43.5)	18 (32.1)	45 (38.1)
Postgraduate Diploma in Dental Technology	1 (1.6)	4 (7.1)	4 (3.4)
Other	13 (21.0)	9 (16.1)	22 (18.6)
Dental laboratory location	n=62 (%)	n=56 (%)	n=118 (%)
North Island	44 (71.0)	27 (48.2)	71 (60.2)
South Island	18 (29.0)	29 (51.8)	47 (39.8)
Registered	n=63 (%)	n=46 (%)	n=109 (%)
Yes	61 (96.8)	40 (87.0)	101 (92.7)
No	2 (3.2)	6 (13.0)	8 (7.3)

* Some respondents held more than one qualification

same manner. The mean charge for a fixed prosthesis in New Zealand was \$298.62. The mean charges for fixed prostheses in the North Island were predominately higher than those in the South Island. However, there were some North Island laboratories charging almost half the price of what South Island laboratories charged. All-ceramic restorations and temporary crowns were more expensive in the South Island than the North Island. Implant-supported fixed restorations were the most expensive service in the fixed prosthesis category. North Island laboratories were charging almost three times the rate for implant-supported fixed restorations than the South Island laboratories. The mean charge for a removable prosthesis was \$522.10, with the South

Island charge being more than the North Island one. Implant overdenture prostheses had the highest charge of \$1589.60, but there was considerable variation observed, with a range from \$165.00 to \$4,500. The mean implant overdenture charge in the South Island was three times more expensive than that in the North Island. Removable orthodontic appliances were slightly less expensive than functional appliances. The mean charge for clinical dental technology services was \$1499.20. Among those, implant overdentures were the most expensive appliances and acrylic partial dentures were the cheapest. Charges for clinical dental technology services in the North Island were cheaper than in the South Island.

Table 2 Type of dental laboratory services provided in New Zealand

Dental laboratory services	New Zealand n=63 (%)	North Island n=46 (%)	South Island n=17 (%)
Fixed prostheses			
All-metal restorations	25 (39.7)	18 (39.1)	7 (41.2)
Porcelain-fused-to-metal restorations	25 (39.7)	18 (39.1)	7 (41.2)
All-ceramic restorations	24 (38.1)	18 (39.1)	6 (35.3)
Implant supported fixed restorations	24 (38.1)	18 (39.1)	6 (35.3)
Surgical stents	23 (36.5)	15 (32.6)	8 (47.1)
Radiographic stents	12 (19.0)	7 (15.2)	5 (29.4)
Temporary crowns	24 (38.1)	18 (39.1)	6 (35.3)
Removable prostheses			
Complete dentures	36 (57.1)	23 (50.0)	13 (76.5)
Implant overdentures	22 (34.9)	13 (28.3)	9 (52.9)
Acrylic partials	36 (57.1)	24 (52.2)	12 (70.6)
Flexible dentures	15 (23.8)	10 (21.7)	5 (29.4)
Metal partials (Co-Cr framework)	24 (38.1)	17 (37.0)	7 (41.2)
Metal partials (titanium framework)	5 (7.9)	5 (10.9)	-
Metal partials (acrylic work)	29 (46.0)	19 (41.3)	10 (58.8)
Additional services			
Denture repairs	38 (60.3)	26 (56.5)	12 (70.6)
Denture relines	36 (57.1)	24 (52.2)	12 (70.6)
Bleaching trays	34 (54.0)	24 (52.2)	10 (58.8)
Bite splints	39 (61.9)	27 (58.7)	12 (70.6)
Mouth guards	37 (58.7)	27 (58.7)	10 (58.8)
Orthodontics			
Removable orthodontic appliances	14 (22.2)	9 (19.6)	5 (29.4)
Functional orthodontic appliances	6 (9.5)	3 (6.5)	3 (17.6)
Other	2 (3.2)	1 (2.2)	1 (5.9)
Clinical dental technology services			
Complete dentures	30 (47.6)	19 (41.3)	11 (64.7)
Implant overdentures	14 (22.2)	8 (17.4)	6 (35.3)
Acrylic partials	28 (44.4)	18 (39.1)	10 (58.8)
Flexible dentures	16 (25.4)	11 (23.9)	5 (29.4)
Metal partials (Co-Cr framework)	24 (38.1)	15 (32.6)	9 (52.9)
Metal partials (titanium framework)	8 (12.7)	6 (13.0)	2 (11.8)
Metal partials (acrylic work)	26 (41.3)	17 (37.0)	9 (52.9)

Data on laboratory revenue from 2009 to 2011 are presented in Table 4. From 2009 to 2011 more than half of the dental laboratories generated an annual revenue over \$250,000, with no statistically significant differences between the years. A high proportion of dental laboratories generated an annual net profit of 16% or more during 2009 to 2011 ($P < 0.001$). There was no significant change in the annual net profit from 2009 to 2011 ($P > 0.05$). Half of the 2011 group of dental laboratories that generated an annual profit of 16% or more also had CAD technology (Table 5).

The mean hourly income of the responding dental laboratory owners in New Zealand overall for 2012 was \$40.50. This was

higher for South Island dental laboratory owners at \$46.47, with a low of \$7.21 and a high of \$108.17. The North Island mean hourly rate was \$38.67, with a low of \$12.02 and a high of \$105.77. For the period 2009 to 2011, 20 (47.6%) dental laboratory owners had no change in their income. Forty percent of dental laboratory owners had a decrease, with only 5 (11.9%) dental laboratory owners having an increase in income ($P < 0.05$). The mean hourly income for dental technician employees in 2012 was \$26.64. Clinical dental technicians earned the highest mean hourly rate of \$33.49, while laboratory assistants were paid the lowest, at \$18.57. Crown and bridge technicians and denture technicians earned almost the same, at \$26.42 and \$26.12 respectively. Half

(19; 50%) of the responding dental technician employees had no change in their income. Fifteen (39.5%) dental technician employees had an increase and 4 (10.5%) had a decrease. Sixty percent of South Island dental technicians had a raise in their income, while the income of 18 (64.3%) North Island dental technicians remained unchanged from 2009 to 2012 ($P>0.05$).

Data on the number of different clients serviced are presented in Table 6. From 2009 to 2012 there was a decrease in the number of regular dental clients serviced by New Zealand dental laboratories ($P>0.05$). South Island dental laboratories experienced a reduction in the mean number of regular dental clients, but those in the North Island were relatively constant.

Of the 24 laboratory owners who provided a reason for a client's departure, 19 (79.2%) reported that they had lost regular dental clients due to them ceasing to practice because they had retired, died or had left New Zealand. Another 18 laboratory owners (75.0%) stated that clients no longer sent them work due to competition from offshore dental laboratories. Fourteen laboratory owners (58.3%) also stated that price cutting from onshore laboratories had resulted in the loss of regular dental clients. Twelve (50.0%) of the responding laboratory owners suggested that dental practices' use of CAD/CAM technology was the reason for a reduction in their regular dental clients. Four (16.7%) laboratory owners had other reasons, such as asking the dental client to stop sending work, and raising their prices.

Twenty six dental laboratories (41.3%) used services from other New Zealand dental laboratories, and 14 (22.2%) were using offshore laboratories ($P<0.05$). A higher percentage of South Island (9; 53.0%) than North Island (17; 37.0%) laboratories outsourced services to other New Zealand laboratories. This is also the case with a higher percentage of South Island (6; 35.3%) than North Island (8; 17.4%) laboratories outsourcing services to offshore laboratories. Metal partial frameworks were outsourced by more than half (8; 57.1%) of the responding dental laboratories using offshore outsourcing services; this included titanium and cobalt-chromium alloy partial denture frames. The remaining of the responding dental laboratories (9; 64.2%) outsourced zirconia, implant abutments, and/or implant-milled bars.

There were 16 (25.4%) dental laboratories with CAD facilities, and 5 (7.9%) dental laboratories had CAD/CAM systems. Only 3 South Island dental laboratories (17.6%) had CAD systems. Thirteen (81.3%) of the dental laboratories operating CAD systems in their practice were using Procera™ (Nobel Biocare, Zurich, Switzerland). Lava Scan ST™ (3M ESPE, Seefeld, Germany) was the second most commonly used scanner system (4; 25%). Some laboratories had more than one scanner system. All of the 5 CAD/CAM systems were located in the North Island. This included 2 Lava 3M™ (3M ESPE, Seefeld, Germany), 1 inLab™ (Sirona, Bensheim, Germany), 1 3Shape™ (3shape, Copenhagen, Denmark) and 1 unnamed system. Almost all responding dental laboratories (20; 95.2%) with CAD and CAD/CAM facilities produced zirconia restorations, while almost half (9; 42.9%) of them offered resin- and silica-based ceramic restorations. Titanium restorations were the second most common service (16; 76.2%) provided, followed by cobalt-chromium restorations (12; 57.1%). Alumina was the least common restoration (5; 23.0%) and was manufactured only by outsourced milling centres.

The future of the industry

Half (19; 50.0%) of the responding dental laboratory owners were concerned about offshore work and how it might affect their business. Some expressed fear of losing their current customers to overseas laboratories due to the availability and cheapness of the offshore work. Sixteen (41.0%) of the responding dental technician employees were also concerned that continued reliance on offshore work may lead to a reduction in workforce demand. This was exemplified in the comments: "Overseas laboratories will kill the industry"; and "Industry will struggle to compete with overseas laboratories".

Thirteen (35.1%) laboratory owners and five (13.5%) employees predicted that more work would be sent overseas. Nine (24.3%) laboratory owners and seven (18.9%) of the employees predicted that the industry will face a harder economic environment and thus job opportunities will be less. Some commented: "I can see the global market being the norm"; "Not a great future"; "It's going to be a lot harder"; and "Dental technology is going down through attrition". Four laboratory owners (10.3%) and one employee thought that more dentists are incorporating clinical CAD/CAM systems into their practices, meaning that a reduced dental technology workforce will be needed. By contrast, seven laboratory owners (18.9%) and five employees (13.5%) were optimistic and saw a brighter future and more job opportunities, exemplified in the comments: "Dental technicians work will increase"; "I see a brighter future for the industry"; and "There will be more development".

Ten laboratory owners (27.0%) and 18 employees (48.6%) agreed that digital technology and CAD/CAM will be an essential part of the industry in the future. Some of them saw this positively; for example, one stated: "With new technology coming, the future seems to be easier for the dental laboratory industry than what it has been in the past/I see a bright and rewarding future for dental labs and the industry." Others saw it as a threat: "Technicians struggling for work due to CAD-CAM machines"; and "People will be replaced by machines".

Nine laboratory owners (24.3%) and 12 employees (30.8%) thought that the poor economic climate and high charges were problems facing the dental technology industry. It was mentioned that keeping up with new technology was expensive, as was compliance with registration requirements (such as continuing professional development). Some thought that the current weak economic situation was preventing patients from seeking dental treatment.

Eleven of the responding laboratory owners (28.7%) and seven employees (17.9%) had concerns about the skill level and experience of technicians working in the industry, and particularly about unqualified individuals working as technicians: "Insufficient number of excellent dental technologists in the industry"; and "Not enough highly skilled personnel". Some employees felt that new graduates do not have enough technical experience, and a typical comment from laboratory owners was: "New graduates are not up to commercial standards in time and quality". Four laboratory owners (10.5%) and five employees (12.8%) felt underappreciated. Some of them felt that certain dentists undervalue their profession and skill level (for example, "Dentists don't respect our skills").

Table 3 Charges for different dental laboratory services in New Zealand

	New Zealand (n=61)			North Island (n=44)			South Island (n=17)		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Fixed prostheses									
All-metal restorations	\$250.20	\$440.00	\$99.00	\$258.17	\$440.00	\$99.00	\$218.33	\$250.00	\$195.00
Porcelain-fused-to-metal restorations	\$290.27	\$440.00	\$99.00	\$292.00	\$440.00	\$99.00	\$283.33	\$295.00	\$275.00
All-ceramic restorations	\$301.40	\$405.00	\$99.00	\$294.25	\$405.00	\$99.00	\$330.00	\$330.00	\$330.00
Implant supported fixed restorations	\$548.05	\$1,100.00	\$145.00	\$566.05	\$1,100.00	\$145.00	\$350.00	\$350.00	\$350.00
Temporary crowns	\$103.18	\$150.00	\$45.00	\$100.50	\$150.00	\$45.00	\$130.00	\$130.00	\$130.00
Removable prostheses									
Complete dentures	\$632.59	\$992.00	\$180.00	\$609.33	\$992.00	\$180.00	\$669.57	\$897.00	\$460.00
Flexible dentures	\$236.50	\$364.00	\$150.00	\$236.00	\$364.00	\$150.00	\$312.00	\$364.00	\$260.00
Implant overdentures	\$1,589.60	\$4,500.00	\$165.00	\$799.60	\$1,500.00	\$165.00	\$2,850.00	\$4,500.00	\$1,200.00
Acrylic partials (single unit)	\$194.19	\$351.00	\$90.00	\$162.91	\$250.00	\$90.00	\$249.17	\$351.00	\$174.00
Acrylic partials (multiple units)	\$271.07	\$450.00	\$120.00	\$232.25	\$325.00	\$120.00	\$322.83	\$450.00	\$225.00
Metal partials (Co-Cr framework)	\$360.43	\$500.00	\$145.00	\$374.71	\$500.00	\$145.00	\$400.00	\$500.00	\$300.00
Metal partials (titanium framework)	\$370.00	\$575.00	\$165.00	\$370.00	\$575.00	\$165.00	-	-	-
Additional									
Denture repairs	\$77.58	\$110.00	\$40.00	\$74.53	\$100.00	\$40.00	\$89.67	\$110.00	\$60.00
Denture relines	\$290.38	\$500.00	\$100.00	\$270.73	\$465.00	\$100.00	\$323.11	\$500.00	\$174.00
Bleaching trays	\$69.23	\$140.00	\$30.00	\$75.18	\$140.00	\$35.00	\$49.00	\$60.00	\$30.00
Bite splints	\$209.13	\$565.00	\$75.00	\$208.47	\$565.00	\$75.00	\$210.71	\$400.00	\$150.00
Mouth guards	\$110.59	\$180.00	\$65.00	\$112.27	\$180.00	\$65.00	\$107.00	\$150.00	\$69.00
Surgical stents	\$140.25	\$195.00	\$85.00	\$127.56	\$180.00	\$85.00	\$178.33	\$195.00	\$160.00
Radiographic stents	\$155.20	\$220.00	\$120.00	\$149.00	\$220.00	\$120.00	\$180.00	\$180.00	\$180.00
Orthodontics									
Removable orthodontic appliances	\$156.88	\$250.00	\$75.00	\$160.83	\$250.00	\$75.00	\$145.00	\$180.00	\$75.00
Functional orthodontic appliances	\$181.67	\$225.00	\$120.00	\$160.00	\$225.00	\$120.00	\$225.00	\$225.00	\$225.00
Clinical dental technology services									
Complete dentures	\$1,907.50	\$2,800.00	\$700.00	\$1,680.42	\$2,800.00	\$700.00	\$2,135.00	\$2,600.00	\$1,450.00
Flexible dentures	\$831.67	\$1,400.00	\$550.00	\$858.75	\$1,400.00	\$585.00	\$713.33	\$800.00	\$550.00
Implant overdentures	\$3,207.00	\$3,500.00	\$2,690.00	\$3,188.00	\$3,188.00	\$3,188.00	\$3,213.33	\$3,500.00	\$2,690.00
Acrylic partials (single unit)	\$614.57	\$950.00	\$400.00	\$483.33	\$500.00	\$450.00	\$692.86	\$950.00	\$400.00
Acrylic partials (multiple units)	\$767.19	\$1,250.00	\$300.00	\$705.00	\$1,000.00	\$300.00	\$847.50	\$1,250.00	\$500.00
Metal partials (Co-Cr framework)	\$1,216.64	\$1,800.00	\$348.00	\$1,054.71	\$1,800.00	\$348.00	\$1,378.57	\$1,800.00	\$400.00
Metal partials (titanium framework)	\$1,950.00	\$2,200.00	\$1,700.00	\$1,275.00	\$1,700.00	\$850.00	\$2,200.00	\$2,200.00	\$2,200.00

Note: There is a margin of error in the charges for services of +/- 15%. Some respondents did not answer all the questions.

DISCUSSION

This cross-sectional survey investigated dental technology services in New Zealand. The aim was to identify patterns in dental laboratory services, and determine what factors were influencing the industry. A snapshot of the 2012 situation was taken and compared to the previous three years. Given the type of information requested and the size of the questionnaire, the 45.9% response rate achieved was reasonable, especially in comparison to a recent United Kingdom survey of dental technicians where only 34% responded (Ross et al, 2012).

The workforce information presented is consistent with the finding of the 2009 Zealand Dental Council Workforce Analysis (NZDCWA; Broadbent, 2009). Both surveys identified that more than half of the responding dental technicians were over 41 years old, and more than half of responding dental laboratory owners and dental technician employees were of NZ European ethnic origin. There were only two New Zealand Maori (1.7%) among the respondents to this survey, while the NZDCWA reported nine (2.9%). There were more than twice the numbers of dental laboratories in the North Island than the South Island. This finding reflects the proportions in Yellow Pages advertisements in 2012, whereby there were 102 dental laboratories in the North Island and 49 in the South Island.

There were a number of design issues with the questionnaire which could be amended were the study to be repeated. The questions on the charges for clinical dental technology services failed to distinguish between the clinical and technical services components. Since dental practices were not part of the survey, the effects of external factors (such as the global financial crisis) cannot be completely determined. It should also be borne in mind that some of the participants may have been reluctant to report some of their offshore outsourcing practices. The questions on the charge of services had an omission in relation to Goods and Services Tax (GST). This resulted in it being unclear whether the charges provided included GST or not. Therefore, there is a +/- 15% margin of error in those data.

There appears to have been growth in the numbers of dental laboratories entering the New Zealand dental industry in the last ten years, with more than half of the responding dental laboratories having started their business after 2000. However, this point needs to be considered with the understanding that the survey does not show how many laboratories were closed during this same period. Despite this, growth in laboratory ownership was also reported by the Global Industry Analysts, in their recent report *Dental Laboratories: A Global Strategic Business Report* (Michmershuizen, 2010).

In this survey, seventy nine percent of the respondents had a high personal interest level and enthusiasm for their career. Over three quarters of dental technicians aged 35 years and above stated that dental technology had fulfilled their career expectations and more than half of them believed that there were enough career opportunities in their field. More than half of the responding dental laboratory owners and dental technician employees rated their job satisfaction at a score of 7 and above. However, the level of job satisfaction is lower than in previous United Kingdom studies, where 50% of respondent dental technicians rated their job satisfaction at 8 or more (Bower et al, 2004).

The mean hourly income for New Zealand dental laboratory owners was similar to that in the United Kingdom, according to a survey conducted between 2008 and 2012 (which indicated

a mean hourly rate of around NZ\$43.80¹). In this study, there was no change in income for 47.6% of the responding dental laboratory owners during 2009 to 2011, and only 11.9% had an increase in their income. However, during the same period, 40% of dental technician employees had an income increase. That more employees than laboratory owners achieved an income increase could reflect the desire to retain staff via wage increases or to reward greater productivity. The mean hourly income (\$26.64 per hour) of a dental technician employee was lower (\$33.50 per hour) than a clinical dental technician employee (Careers New Zealand, 2013²). This may explain the higher number of dental technician employees choosing the Postgraduate Diploma in Clinical Dental Technology (rather than a Postgraduate Diploma in Dental Technology) as a postgraduate qualification.

In 2009, 52.9% of dental laboratories generated annual revenues over \$250,000, but that had fallen to 48.5% by 2011. Although there was a reduction in the number of dental laboratories making over \$250,000, there was no significant difference in the total annual revenue among the laboratories during the three years. This suggests that the economic state from 2009 to 2011 was relatively static for most laboratories. Conversely, in 2011, there was a 16.7% increase in the number of dental laboratories making a net profit of more than 16%. Within this group, half had recently incorporated CAD technology into their dental laboratories. This suggests that CAD technology is helping some dental laboratories to increase their income.

The mean charge for a fixed prosthesis produced in New Zealand was higher than the charge for an outsourced prosthesis. Interestingly, the New Zealand outsourcing charge is comparable to the London dental laboratories' mean charge, which is NZ\$186.78³. This result is also true for the mean charge for an outsourced removable prosthesis in New Zealand, which (again) is similar to the price a London dental laboratory would charge, at NZ\$293.00³. This suggests that there is a benchmark international market rate.

There was a reduction in the number of regular dental clients, with the most common reasons provided by dental laboratory owners being that the dentist had gone overseas, retired or they were deceased. In 2006, the New Zealand Dental Association predicted that a high portion of older dentists would be retiring resulting in a shortage. In addition, almost half of the New Zealand Bachelor of Dental Surgery graduates leave the country every year for overseas experience and earning potential (Bain, 2006). Outsourcing by dentists to overseas dental laboratories was the second most common reason suggested for losing regular dental clients. New Zealand dental laboratory owners were concerned about the low prices offered by foreign dental laboratories. Other dental laboratory owners lost regular dental clients to price cutting offers by New Zealand laboratories. The least common reason provided for losing regular dental clients was clinical CAD/CAM. This goes against international trends, where clinical CAD/CAMs have become widely used among clinicians (Ritter, 2003; Zamanian and Wong, 2012). The findings of this survey are somewhat reinforced by those of Tay et al (2008), who reported that 64 of 326 New Zealand dentists

¹ Dental laboratory owners salary
http://www.mysalary.co.uk/average-salary/Dental_Laboratory_Owner_29408

² Statistics New Zealand. Earnings from wages and salaries, Census 2013

³ MediMatch dental laboratory product price list
<http://www.medimatch.co.uk/doc/medimatch-pricelist.pdf>

Table 4 New Zealand dental laboratories total annual revenue from 2009 to 2011

Total annual revenue	2009 n=34 (%)	2010 n=34 (%)	2011 n=35 (%)
<\$50 thousand	5 (14.7)	3 (8.8)	5 (14.3)
\$ 50–99	4 (11.8)	6 (17.6)	4 (11.4)
\$ 100–249	7 (20.6)	6 (17.6)	9 (25.7)
\$ 250–499	6 (17.6)	7 (20.6)	6 (17.1)
\$ 500–749	3 (8.8)	3 (8.8)	4 (11.4)
\$ 750–999	3 (8.8)	4 (11.8)	3 (8.6)
\$ 1.0 M +	6 (17.6)	5 (14.7)	4 (11.4)

Table 5 New Zealand dental laboratories annual net profit from 2009 to 2011

Percentage of net profit	2009 n=31 (%)	2010 n=30 (%)	2011 n=31 (%)
0 %	4 (12.9)	4 (13.3)	5 (15.6)
1–2 %	2 (6.5)	1 (3.3)	1 (3.1)
3–5 %	2 (6.5)	3 (10.0)	4 (12.5)
6–8 %	5 (16.1)	3 (10.0)	3 (9.4)
9–11 %	1 (3.2)	3 (10.0)	2 (6.3)
12–15 %	4 (12.9)	3 (10.0)	1 (3.1)
16 % and above	13 (41.9)	13 (43.3)	16 (50.0)

Table 6 Mean number of regular dental clients serviced by New Zealand dental laboratories per laboratory from 2009 to 2012

Year	New Zealand n=36	North Island n=24	South Island n=12
2009	30.3 (33.5)	26.0 (46.0)*	40.2 (46.2)
2010	29.9 (37.3)	26.2 (34.6)	39.1 (44.1)
2011	29.6 (34.2)	26.9 (42.9)	36.0 (45.4)
2012	28.5 (45.1)	26.5 (46.0)	32.5 (45.1)

* Standard deviation in brackets

surveyed had a clinical CAD/CAM unit. However, it was also reported a further 70 were considering purchasing one. When considering the purchase of a CAD/CAM unit, it was suggested that the ease of use, and the potential earning a CAD/CAM unit could provide were the dominant factors. Laboratory owners and employees predict that CAD/CAM technology will dominate the industry in the future. Some saw this technology as an opportunity; others saw it as a threat. Sixteen dental laboratories had a CAD system, but only five of them had a CAD/CAM system. Farah and Wisler (2010) and Holst et al (2009) observed that, due to the high cost of training and of integrating a milling system into a dental laboratory, it is more cost-effective to purchase a scanner and outsource the restoration manufacturing to a milling

centre. More than 80% of the laboratories in this survey with CAD systems were using NobelProcera scanners in their practice. Zirconia copings, titanium and cobalt-chromium partials were the most common dental restorations produced by CAD and CAD/CAM dental laboratories. Similar observations on the spreading use of titanium and zirconia in the world market have been reported from other studies (Manicone et al, 2007; Jokstad, 2009; Miyazaki and Hotta, 2011).

This survey brings to light some of the concerns of the industry, but it also shows that it is stable despite a number of challenges. The dental technology industry is adapting and is still viable. Clinical dental technology appears to be an area of growth. There is an element of concern and uncertainty surrounding new technology and globalisation; however, there are those in the industry who see these same factors as opportunities. Despite the challenges, it appears that dental technology businesses are still able to generate a reasonable income; while some businesses are stagnant, others are prospering.

CONCLUSIONS

Dental laboratory owners expressed fear about the cheap price of offshore work and how it could affect their business, but local factors also seem to be influencing their profitability. There are mixed feelings about new technology (such as CAD/CAM). Globalisation and new technology do appear to be influencing the incomes of dental laboratory owners. The earning potential of clinical dental technicians is higher than that of dental technicians. Currently, CAD/CAM technology is not the predominant production method in the New Zealand dental technology industry, but the systems are more prevalent and there are indications that more will be used.

ACKNOWLEDGMENT

The authors acknowledge the funding of this research by the New Zealand Institute of Dental Technologists and their assistance in contacting their members. We thank Professor WM Thomson for his assistance with the questionnaire and analysis of data.

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