



A CENSUS OF SOUTH AFRICAN INDUSTRIAL ENGINEERS, BASED ON DATA EXTRACTED FROM LINKEDIN

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ABSTRACT

The first South African Industrial Engineers graduated in 1963. Since then, the number of graduates per annum has grown to more than 200 per annum. Many of these Industrial Engineers use the social network, LinkedIn, to publish their professional profile and to build professional networks. The purpose of this paper is to make use of the information published on LinkedIn to determine who employs South African Industrial Engineers and which skills are attributed to them. LinkedIn-data were harvested, warehoused and analyzed of 362 persons who hold a Bachelor degree in Industrial Engineering from a South African university. In conclusion, the feasibility of this methodology is contemplated and the results of this investigation are discussed.

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1 INTRODUCTION

It is now about a century since Industrial Engineering is recognised as an academic discipline. The first academic department in Industrial and Manufacturing Engineering was established at the Pennsylvania state university in 1909 [1]. In 1963, the University of Pretoria was the first South African university to award degrees in Industrial Engineering [2]. Stellenbosch University [3] and the University of the Witwatersrand followed a few years later. To date these three universities are the only South African universities that provide qualifications that are meeting Engineering Council of South Africa's (ECSA) educational requirement for registration as a professional Industrial Engineering [4]. In 2015 the North-West University will become the fourth South African university that provide this qualification.

Traditionally, arising from the industrial revolution, Industrial Engineering is concerned with the design, management and improvement of manufacturing processes. These days, the Industrial Engineering skill- and mindset that is used to optimize processes and systems in a manufacturing setting are also be used in other product and service contexts to optimize processes and systems.

The problem that is addressed by this paper is that, although there is an awareness of who employs South African Industrial Engineers and for which skills, an census of South African graduates in Industrial Engineering has not recently been conducted.

Social networks brought forward a new way of social and professional interaction. Ellison and Boyd [5] defines a social network site as a "web-based service that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system." LinkedIn is an example of social network which is predominantly used for professional networking and interaction.

The purpose of this paper is to make use of the information published on LinkedIn by Industrial Engineers themselves to determine who employs Industrial Engineers and for which skills. In pursuit of this purpose, three research questions are asked:

RQ 1: How can data contained by LinkedIn data be used to gain information about as Industrial Engineers in South Africa?

RQ 2: Who employs Industrial Engineers?

RQ 3: For which skills are these Industrial Engineers employed?

2 METHODOLOGY

During September and October 2013 data were harvested from the LinkedIn profiles of 362 professionals who obtained a Bachelors in Engineering degree from the either the University of Pretoria, Stellenbosch University of the University of Witwatersrand. The harvested data was then stored in three separate Excel-based data-marts which allowed data aggregation and analysis. The fact tables of these three data marts are indicated in Figure 1.

Employment datamart	Education datamart	Skills datamart
- LinkedIn ID - Employer / - Job description - Date started - Date ended - Number of months (date ended-date started) - Industry	- LinkedIn ID - University which awarded Bachelors degree - Date started - Date ended	- LinkedIn ID - Skills description - Number of endorsements

Figure 1: Datamarts

This harvesting process was done “manually” with copy and paste actions. According to Wu *et al.* [6] Avatara is an in-house online analytical processing (OLAP) system at LinkedIn that provides a generic batch processing platform, allowing any developers to build OLAP cubes with a single configuration file [6]. Unfortunately, Avatara did not provide the analytics operations required for this study. For this reason, the data were extracted from LinkedIn and then, cleaned, stored and analysed offline.

A limitation of this study is that the complementary (“Free”) LinkedIn option (refer to first column of Figure 2) only provides limited profile and search access. The sample size is furthermore limited by the fact that profile-data were only harvested if the profile owner indicated specifically that he/she obtained a Bachelors degree in Industrial Engineering from either the University of Pretoria or Stellenbosch University or the University of the Witwatersrand.

	Free	Business	Business Plus	Executive
View full profiles	Up to 2 nd degree	See full profiles of everyone in your network - 1st, 2nd and 3rd degree.		
Profiles per search	100	300	500	700
Search Filters	None	None	Seniority, Company Size, Interests, Fortune 1000	Seniority, Company Size, Interests, Fortune 1000, Functions, Years of experience, Your groups, New to LinkedIn

Figure 2: Information access and search option, per LinkedIn option

For the past 10 years a total of approximately 200 Industrial Engineers graduated in South Africa. Before that the average annual graduation rate was even less. Hence, this sample of 362 profiles represents about 10% of the total population. If this study is scoped to include only Industrial Engineers that graduated the past 10 years (2003 - 2012) the sample size will be even more than 10%. From Figure 2 it can be seen that the number of profiles of recent graduates included in the sample significantly exceed the number of earlier graduates. Strategies to increase this sample size and representativeness are discussed in the concluding section of this paper.

After the data were stored in an MS-Excel data warehouse, data-filters, pivot tables and manual manipulation were used to clean, aggregate and visualize the data.

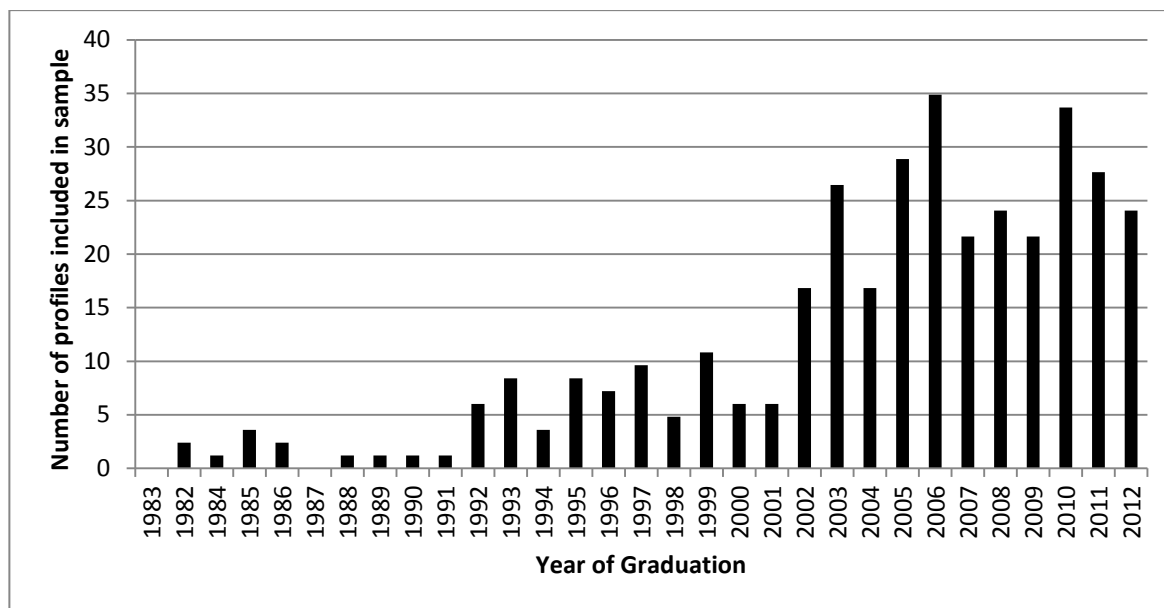


Figure 3: LinkedIn profiles included in sample

3 RESULTS AND DISCUSSION

In the previous section it was explained how data were harvested from LinkedIn profiles, warehoused and aggregated to get a picture of what South African Industrial Engineers are doing. In doing so, the first research question is addressed. The second and third research questions are considered in this section:

3.1 Who employs South African Industrial Engineers?

Some of the companies that employ Industrial Engineers are indicated on the x-axis of Figure 4, Figure 5 and Figure 6. The total experience (expressed in terms of man-years) of Industrial Engineers included in this study are indicated on the y-axis of these figures. Companies that employ the sampled Industrial Engineers for less than 8 man years, are not indicated in these figures, but they are listed in Exhibit 1.

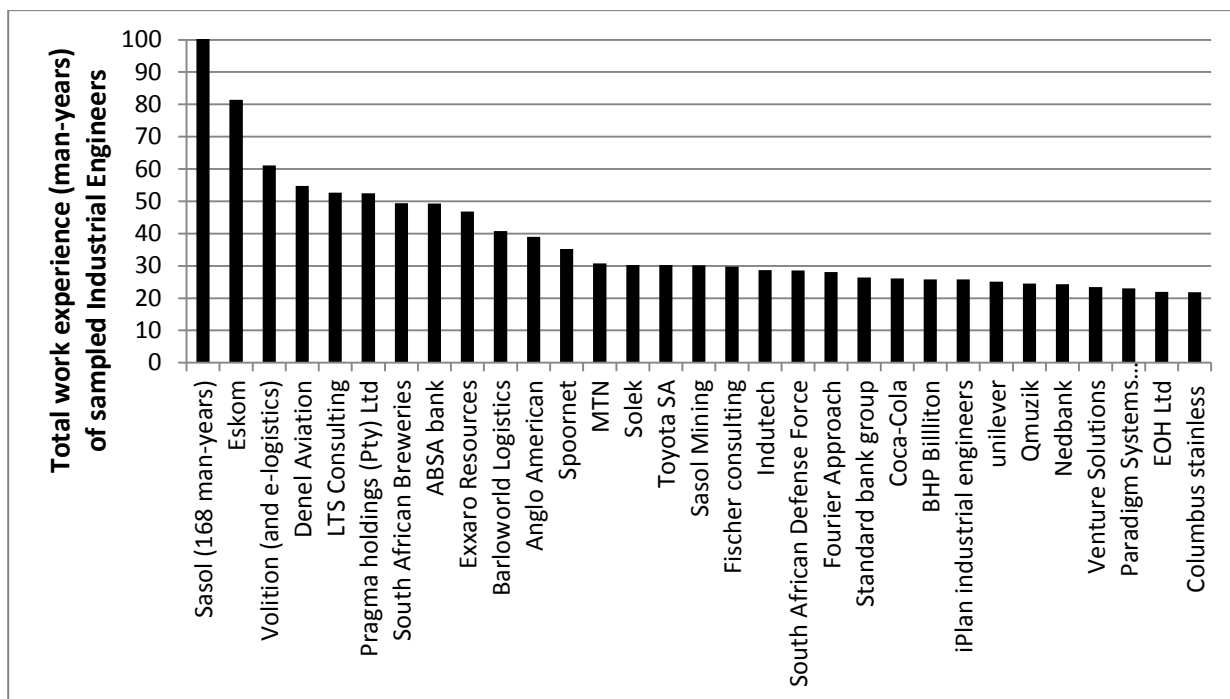


Figure 5: Total work experience (man-years) of sampled Industrial Engineers (1)

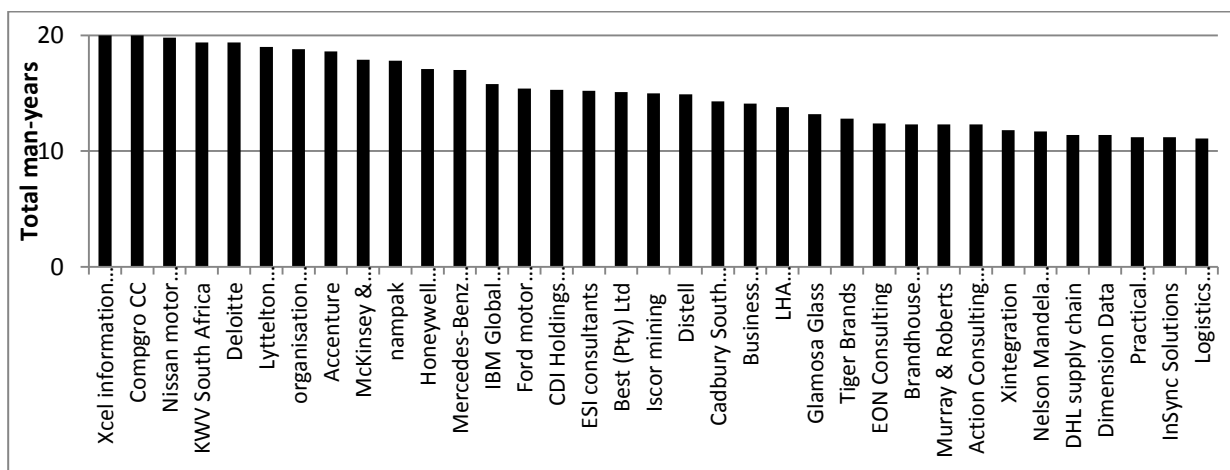


Figure 6: Total work experience (man-years) of sampled Industrial Engineers (2)

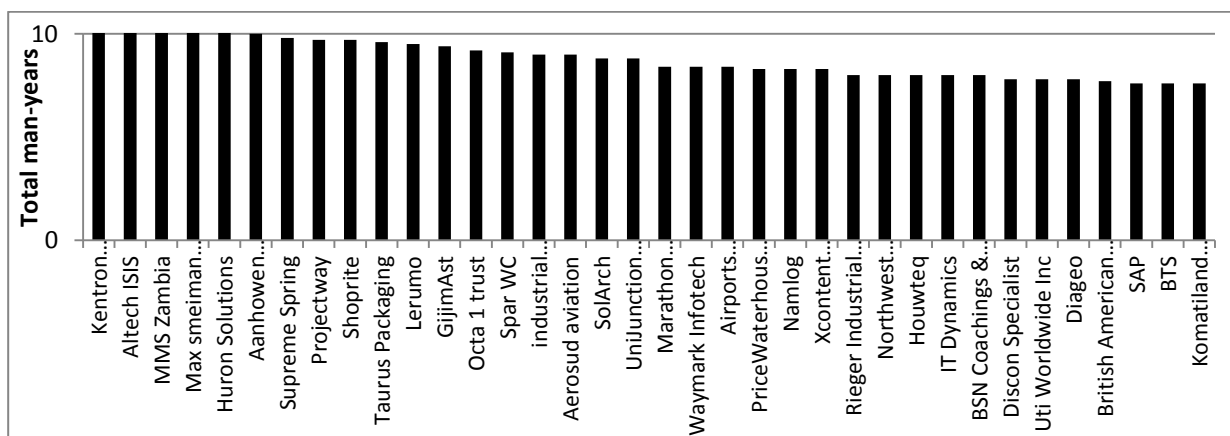


Figure 7: Total work experience (man-years) of sampled Industrial Engineers (3)

Exhibit 1: Other Employers of Industrial Engineers

BevServ; BG Group; Bigen Africa; BKS (Pty) Ltd; Blankbook Website & Online marketing; BMGi; BMW South Africa; BNS; Board Longyear; Bombardier Transport; Bombela concession company; Booyens Beleggings; Bosal; Boxmore; BPLC Manager Consultants; Bragan Chemicals; British International Engineers South Africa; BroadReach Healthcare; Broco logistics management solutions; Bubal; Business improvement facilitation; Business Modelling Associates; Business planning; Business School NMMU; Butyl Seal (Pty) Ltd; Calmasil (PBD Boeredienste); Cape Tech plastics; Cape town container terminal; CBI Electric Solutions; CCI Growthcon (Pty) Ltd; CCSIR Meraka Institute; CDI consulting; Ceenex; Charlotte Maxeke Johannesburg Academic Hospital; CHEP; Chevron; Chillisoft; Chris van Schoor Manufacturing and Logistics Consulting; City of cape town; Clyde Bergemann Africa; Coleus Packaging (Pty) Ltd; Colliers International; Comat International contracted to South African Airways; Commuter Transport Engineering; Consiliarii; Conways aluminium; Corpative; Corvus future design; Council for Scientific and industrial research; Courier and freight group; CPC Project services LLP; Cquential solutions; Crickmay and Associates; Crux Technology; CShell Building and construction; Cside Excellence; CSIR; Cyest corporation; DaimlerChrysler; Dataflow; Dawn wing global express; DCM consulting; De Beers; Degussa; Discovery Health; DNA Jumpoint; DNA supply chains; Donaldson Filtration systems; Dovetail; Dresser-Rand; Duo d'Musique; Duro Pressings Pty (Ltd); DVT; Dynamic Strategies; EC Harris; EcoBoards; Edge Growth; EDS Group; EDS Technologies; EGO; ELPROM; Enerweb; EnhanceEPM; ePostal / Postbank; Ernst & Young; ESS Asset Care specialts; ESTEQ; ETP; Euphoria Golf Estate & Hydro; Exactitude Consulting; Expertool; Fair Cape Dairies; Fairprice; Faritec Holdings; FedGroup; FHRST Management services; Filehound CC; First national bank; FlowCentric Technologies Pty (Ltd); Fortna; Frost & Sullivan; Gain; Gant AB; Gaussian ; Gener-8-Power Solution centurion; General Motors south Africa; GIBB engineering & Science; Glaxo SmithKline; Global Business Excellence; Global challenge; Going North; Golden Frys; Golf Estate Management services; Goodyear SA; Gordon Institute of business Science; Graduate school of Technology Management; Grinaker LTA; Grundfos Management A/S; Guala Closure South Africa; Hall Longmore; Hatch0; House4Hack; HPE (Pty) Ltd; Hugotronics; Huhtamaki Felxible Packaging; Hulamin; Huntleigh Africa; HVAC international; Icon Consulting; IDS Scheer; IESolutions SA; Iluka Resources; Imana Foods; impak; Imperial Distribution; Imperial Group; imperial logistics; Improvement Projects Manager; Imre Consulting; Incito (AST Group); Incoase SA Chapter; independent consultant; Independent researcher and industrial engineering consultant; Industrial Development Corporation of SA Ltd. (IDC); InnovationManager.se; Inpak; Integrear Indicum; Intelligent Africa; IOR Global (EMEA) GmbH; IQ Business; Irvin & Johnson; IS Partners; ISEMSa; IT4Africa; ITE Consulting; Johannes F. Pienaar Consulting; JP Consulting; jumpoint (Pty) Ltd; Just Property Group; Kalahari Plant; Karlson & Higgins; KESSA Engineering Solutions South Africa; Keto Pumps; KFC - Yum! Brands; KHS; Kimberly-Clark; knowledge based engineering; KnowledgeXtend; KPMG Advisory; Learning Strategies; leruma Holdings; Letter27; LEW; LGA Logistics; Licensing Executives Society International; Light project management cc; LO Consulting; Loadtech (Pty) Ltd; LogSystems development; London Underground; L'Oréal; LoveShots Photography; Lugory Consulting; MAC consulting; Macsteel Service Centres S.A.; Magna BC; Magna FS; Main street holdings; Maintenance Consulting africa; Major Telecommunications company; MAN Diesel & Turbo; MAN truck & Bus; Marstec; Martin-Bouwer; MAXAM; MBB Consulting Services; McCain Foods; MCG Industries; media film service; Media24-Spree; Medical services organisation; mediclinic; Medipark; Megkon; melbro; Melrose Atteridge; Meritec; Merrill Lynch; MG & Associates; Midas Group; MIH; Mineral sands; Minova SA; MiX Telematics; Modular Mining Systems; ModusBPS (Pty) Ltd; ModusPBS (Pty) Ltd; Mondi Packaging; moneypenny film accounting services; MorkelErasmus Photography; MOTE Travel; MSO; Murendi Concrete; Namakwa Sands; Nashua mobile; National aerospace centre of Excellence; Navita; NEC Africa; NECSA; Nedq; nestle; Niehaus Ungerer Laboratories; Nigel Metal Industries; Noise Clipper; Nolwana; Nuclear Energy corporation of SA; Nutricor; OIM; Old mutal; On the Dot Distribution; OPSI Systems; Optimum Coal; Optipro Solutions; Oracle corporation; OrderCloud; OTR; Ovations; P3 Group; Panskus GmbH; Paras Africa; parcel express; Partners in Performance; PBMR; PEC metering (Pty) Ltd; PEPPOR logistics; ; PESCO; PFG Building Glass; Pfisterer (PTY) LTD; PG Group; PGAluminium JHB North; Pick 'n Pay; Pieter Pretorius Consulting and training; Pitching-in Foundation; Planet fitness; plessey; PLM Applications Engineer; PPG industries; PQ Africa; Precision Press; Private - house plans; Private Company; ProActive Integrators; Pumptron (Pty) Ltd; Pumptron-Mihandzu (Pty) Ltd; Purdue University; PWC; Q-Core consulting; Qdata business consulting; QGC - A BG Group business; QlikView South africa; Quality engineering development; QuinXi; Engineering & Management consulting; Rainbow Chickens limited; Rand Merchant Bank; Realnet Commercial ; Resolve solutions partners; Resonance Music; Restwise; Rethink management consulting; Rhenish Girls' High School; RIC Consulting; Rieter Feltex; Robertson & Caine International Yachts; Robertsons factory; Romatex (Pty) Ltd; Rotek; S360 Business Business Systems; SAAB; Safair (Pty) Ltd; Safcor Panalpina; Sandvik; Sappi; SARS; Schlumberger; Schnellecke; Sci-Bono Discovery Centre; SCNext - The Youth of Supply Chain; Sea harvest; Sealy; Self-employed; Shikongonyi Transport and Projects; Shivango Technologies; ShopWare; Siemens; Sign & Seal Construction; Silica; SilverBridge; Simulation engineering technologies; Sirius Engineer (Pty) Ltd; SIS Global; Sizwe Africa; Smith International; Softworx; Sole proprietor; Solutions Architecture; South African Venture Capital Association; Southpaw Solutions; SpaceBric; Spearhead Rugby Academy; Spencer Consulting; SPX Corporation; Standard Corporate and invest Bank; Stealth startup; Step advisory; stone Three Venture; Storage management system; Super Group; supply chain services; SWO Consultants Inc.; Synchrony; Syncreon, Netherlands; Synntech; Takata; Techworld Consulting Engineer; Telkom; Tellumat; Tempus publishing; Tenaris; TFM; TFMC; The Centre for Mechanised Mining systes; The Creative Counsel; The Cyest Corporation; The intellectual property show on Summit TV; The IQ Business Group; The nature conservancy; The Rare group; The Sweat Shop; The unlimited world; Thermal Test laboratory; Thinc Business Solutions; Thinking People; Thinkshoppe Web solutions; Tilos; Timken South Africa; TLB; Toll infrastructure Services; Touchstone Renard Ltd; TradeMark Southern Africa; training leadership consulting; Trans50; ; Transnet; transport for London; Tranter Rock Drills; TrenStar (Pty) LTD; Trium Investments Pty Ltd; Tronox; Trupact Consulting; Technology;TurgisConsulting; Turner and Townsend; Tweni Upholstery and interiors; TWP Projects; TYME; Ultramain systems; Umthombo Technologies; union Carriage & wagon; UNISA; Unitrans; UP solutions; UPS SCS; USB-ED & African eDevelopment; Uti Freight forwarding; Uti Integrated Logistics; Uti south Africa; UTI Sun Couriers; Valstand Learning; Value and supply chain consulting; VBKom projects; Vector Logistics; Vega Capital; venture Rosslyn plant; Ventyx; VIEWcc; Vimbli - strategic onboarding Solutions; Virgin; Virtual consulting engineers; VIZIYA Corp; VWWSA; Weatherford; Websoft Maven; Weir Minerals; Wellco Health Limited; WesBank; wiGroup; Wild Eye Destinations & Photography; Wishlist corporation; Xstrata Coal; York Timbers; Zobber

The fact-table of the *Employment datamart* (refer to Figure1) includes a field, named *Industry*. Most of the companies included in Figure 4, Figure 5 and Figure 6 have a company

LinkedIn-profile on which their primary industry is indicated. This information was used to compile Figure 7.

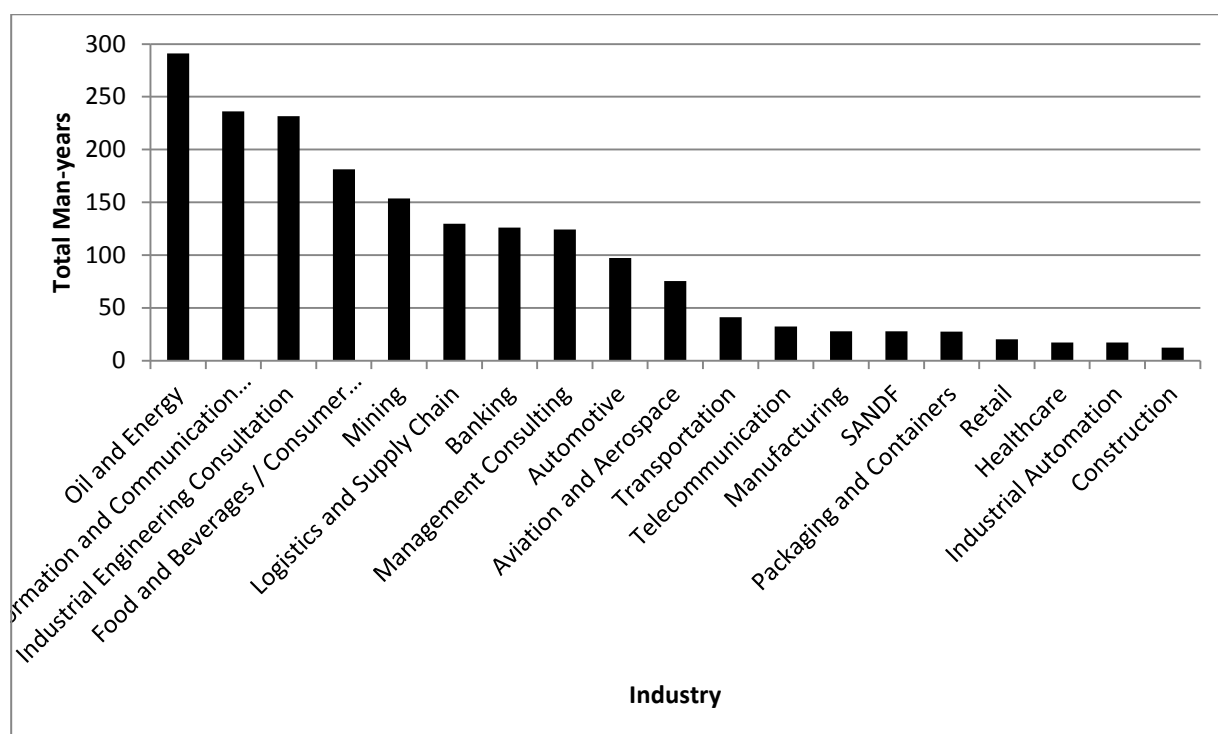


Figure 8: Industries in which most of the 362 sampled Industrial Engineers are employed

3.2 For which skills are Industrial Engineers employed?

LinkedIn provide the option for professionals to indicate on their profiles which skills they attribute to themselves. Their peers can then confirm these skills by endorsing the profile owner. This data were captured in the *Skills Datamart* (refer to Figure 1). The endorsements index is calculated as follows:

x_{ij} = number of endorsements per profile i per skill j

n_i = total number of endorsements per profile

endorsement index for skill i for profile $j = y_{ij} = x_{ij} / n_i$

endorsement index for skill $i = y_{ij}$

Figure 8 indicates the skills that are mostly attributed by Industrial Engineers to themselves and endorsed by their peers. *Industrial Engineering, Supply Chain Management and Business process analysis/ design / engineering* have the largest endorsement index.

Skills	Endorsements Index
Industrial Engineering	28.6
Supply Chain Management	28.3
Business Process Analysis / Design / Mapping	28.2
Process improvement/ optimization	19.0
Project Engineering / Planning / Management	18.1
Business Analysis/ Development / Engineer / Architecture	14.8
Continuous Improvement / Kaizan / Six Sigma	13.0
Data analysis / data modeling / analytics / operations res	9.1
Strategy Management / Planning	8.7
Management	8.5
Process and system simulation	7.7
Engineering	7.6
Logistics	6.7
Lean Manufacturing	5.8
Operations Management	5.3
Mining	4.2
Manufacturing	3.2
Microsoft Office	2.7
ERP	2.6
Business Intelligence	2.5
Change Management	2.5
Microsoft Excel	2.4
Systems analysis/engineering / optimisation / modeling	2.4
Procurement	2.2
Requirements analysis	2.0
Microsoft project	1.8
Change Management	1.7
Program Management	1.7
Maintenance management / strategy	1.6
Matlab	1.5
Integration	1.5
Operations Research	1.5
Entrepreneurship	1.4
Production Planning / management	1.3
Financial Modeling / Risk / Analysis / structuring	1.2
Root Cause Analysis	1.2
Demand planning / forecasting / management	1.1
Warehouse management	1.1
Research	1.0
SAP	1.0
FMCG	1.0

Figure 9: Skills that Industrial Engineers attribute to themselves

4 CONCLUSION AND FUTURE WORK

The purpose of this paper was to make use of the information published on LinkedIn by Industrial Engineers themselves to determine who employs Industrial Engineers and for which skills. In pursuit of this purpose, three research questions were asked

RQ 1: How can data contained by LinkedIn data be used to gain information about as Industrial Engineers in South Africa?

Despite the limitations of the complementary (*free*) LinkedIn-option, it was possible to harvest employment and skills data of 362 persons who graduated as Industrial Engineers in South Africa. This represents about 10% of all persons that graduated the past 20 years. If only the past decade is considered, 20% of these persons are represented. For future work, this sample can be increased if the LinkedIn *Business* or *Business Plus* option is purchased.

For this study, only LinkedIn-data were used. Many BEng(Industrial)-graduates indicated no or only higher qualifications on their profiles. The quantity of integrity of profiles can be increased if the qualifications are validated with actual graduation lists.

Attempts were made to harvest data from the LinkedIn-data directly via LinkedIn-APIs. These attempts were not successful. If successful, this process could enhance the efficiency and effectiveness of the data warehouse process significantly.

The analyses presented in this paper involved simple online analytical processing (OLAP) in terms of the aggregation and visualization of data. Further analytics procedures can produce even more information such as career path and industry-skill correlations. **RQ 2:** Who employs Industrial Engineers?

Although the Industrial Engineering discipline originated from the industrial revolution and mass production age, Industrial Engineers are now designing and improving tangible and intangible processes and systems in all sorts of industries. For future work it may be interesting to determine if there is a correlation between the graduates' universities and their career path or skill set. Furthermore, results from quantitative analyses could be followed up by qualitative studies.

RQ 3: For which skills are these Industrial Engineers employed?

It may not be surprising that *Industrial Engineering* is the most endorsed skill attributed to Industrial Engineers. A follow-up study can be executed to determine the link between what the skills attributed to Industrial Engineers and the content of the undergraduate curriculum.

The purpose of this paper was to make use of the information published on LinkedIn by Industrial Engineers themselves to determine who employs Industrial Engineers and for which skills. Enough answers were generated to conclude that this purpose was achieved. However, this study provided even more avenues for further investigation than answers. Modern technology and techniques of social interaction

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