The Use of Project Based Learning to Improve Business and Workforce Performance

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ABSTRACT

Purpose: *The evolving global economy in the manufacturing industry requires an educated and skillful workforce to remain current through lifelong learning and apply knowledge for their own employability and for a sustainable world. Accordingly, project-based learning (PBL) programmes have been widely applied in the industry to provide opportunities for employees to acquire knowledge directly from their jobs by using various strategies of learning that are associated with their work. This paper reviews several case studies implemented by the Institute of Productivity (IOP) and Nisai Group, which are based on PBL approaches and informed by action research. In addition, it provides insights about how these strategies have been applied and how they have prepared workers to meet competency requirements set for different industrial problem statements, including their objectives, learning activities, main outcomes, and dissemination of the results.*
Design/Methodology/Approach: *The research was designed as a case study involving four PBL courses implemented by the group. The reports from each PBL were collected and analysed using qualitative content analysis.*
Findings/Results: *The PBL courses implemented by the group were based on the teaching learning theory of constructivism. Here, the findings provided insight into how PBL was implemented in different sectors and how it can contribute to business improvement, lifelong learning capabilities, and professional competencies.*
Originality/Value: *The integrated approach of both action research and PBL demonstrated to be beneficial for different manufacturing industries and communities in the United Kingdom and South-East Asia. The results also provide an opportunity for different stakeholders, including educators to critically reflect on how PBL can be implemented in different sectors to attain similar outcomes.*
Paper Type: *Case study*
Keywords: *Project Based Learning, Business performance, Workforce performance, Lifelong education*

1. INTRODUCTION :

An educated and skillful workforce is one of the most significant global competitive criteria in the modern manufacturing industry, which is continuously subjected to new evolving challenges to meet individual customers' needs. Consequently, sustaining competitiveness in such volatile, changeable, and complex environments may apply constant workforce requirements. Therefore, continuous professional development and lifelong learning are increasingly becoming significant key elements for industrial development.

Accordingly, an emerging theme in the literature that may support the industry development and the workforce in this regard is PB. PBL is a pedagogical practice where students can work in collaboration and create innovative and authentic solutions to real-life industry problems or situations by designing and implementing their own projects [1]. However, there is very limited research about how PBL has been applied specifically in the food manufacturing industry and suppliers, and its impact on the workforce's competency and the overall benefits to businesses.

2. RELATED WORKS :

Food production is one of the largest sectors in the UK Manufacturing Industry [2], which has been subjected to rapid and constant changes led by recent industrial revolution and global competition. Many decades ago, manufacturing was considered a labour-intensive sector, and thus, was characteristically heavily reliant on the effectiveness of its labour-force to underpin business productivity [3]. This weighted reliance on personnel has shifted significantly and created the need for higher skilled operatives and technicians, which has become key to productivity and competitiveness.
Over 500,000 people are employed in the food sector and 9,000 companies provide a turnover of £74 Billion with a £22 Billion contribution to the treasury. However, the relative deficit of Level 3 (pre-degree) skills within the food sector points to the need for training to fuel growth and productivity. This is becoming increasingly important as inflation in the food sector (resultant of a Covid bounce-back and the war in Ukraine) is reaching historically high levels. Therefore, there is a particular need for higher level craft and technical skills provision to underpin overall industry performance using overall effective efficiency (OEE) performance measures as the standards for the manufacturing sector [4]. Consolidation in the sector is contributing to growth. However, this growth is contributing to a tightening in the labour market and is now manifesting itself in terms of a skill and labour shortage at all levels of the skills pyramid to underpin competitiveness, thereby stimulating a demand. Moreover, for every job lost, a new higher order job is created as the sector moves to higher levels of automation and mechanisation. Nationally, both policy makers and industrial spokespeople are raising concerns over the capacity of the sector and the need for better qualified entrants and more highly skilled operational staff in what is now one of the most competitive sectors in the country [5].
The main areas of skills support requirements within the food manufacturing sector have been identified in several key reports. These include the national and regional Foresight Programmes (Food Manufacturing), the Food Faraday Initiative, the Yorkshire and Humber Skills Action Plan, the Regional Food Cluster Strategy, and finally local household surveys. The priority skills shortages/training needs which emerge from these reports include:

- Production management skills
- Project management skills
- Business improvement skills
- Engineering skills –specifically multi skilling
- Product development skills / innovation

Therefore, the manufacturing industries of the future need to provide suitable training strategies that promote learning, facilitate lifelong learning, workplace-based training, and continuous professional development to respond to the transformative effects of the industry [6, 7]. Such training efforts can potentially be observed through PBL In the context of manufacturing, PBL can be defined as a learning teaching strategy where the workforce (i.e., students) obtains new knowledge and skills by addressing and overcoming real-life questions associated with their job roles via designing their own research [8]. In this context, students select the topic they will research and how they will produce a project to share their findings [9]. Here, they are normally provided with a set of parameters by a teacher or mentor that they are required to follow while selecting a topic. Although they have a choice, they are still working on a project relevant to the industry to solve a real-world problem or situation. Therefore, the project and PBL approaches are derived from constructivism theory, specifically social constructivism where collaboration between students and learning within the community is promoted [10].
Throughout the project, students work on skills that are real and authentic as they immerse themselves in inquiry and exploration of their individual research topic [11]. Although there has not been published literature about the impact of PBL in the food manufacturing industry, it has been significantly reported in other sectors. In particular, there are a number of soft skills that can be developed through PBL, including social, teamwork, problem solving, communication, ethics and morals, lifelong learning, leadership, crisis handling, creative thinking, and critical thinking, managing information and entrepreneurship [12].

3. OBJECTIVES :

The objective of this paper is to assess how PBL has been applied in the food manufacturing in UK and fishery industry in Asia and the impact of this approach on the workforce competency and businesses.

4. METHODOLOGY :

For this paper, a case studies evaluation method was applied, where the case studies were the PBL projects implemented by IOP and their partners and the Nisai Group. Accordingly, data was collected from different sources, including project description, stages and methods, final reports, and students' posters. These different sources of data (i.e., data triangulation) were applied to promote the internal validity of this paper and to be able to find common PBL approaches used.

4.1 Subject of the paper:

The IOP and the Nisai Group, along with their partners have been at the forefront of improving business productivity by investing in workplace skills. Both organisations have worked extensively with the UN including UNIDO, FAO and UNESCO, where they have contributed towards the 2030 Strategic Development Goals (SDGs). In particular, towards the SDG 4: Quality Education, SDG 9: Industry, Innovation and Infrastructure, and SDG 11: Sustainable Cities and Communities.

They have designed and piloted a specific, integrated work-based education pyramid that tackles business improvement performance and ensures that is a learning progression route for the individual, throughout their lifetime. To ensure that the learning is focussed on the core issues that will deliver the most outcomes and impact, their courses are firmly based on an action-based research approach. Action-based research can be described as a family of research methodologies which pursue action (or change) and research (or understanding) at the same time. The participants in the research play an active role in contributing to the findings, and thus, ensures that the resultant 'actions' are truly outcome led and has real 'on-the ground' impact [13].

The four levels of development courses are:

- Level 1 - Short courses for Key Operators. This is also a route for the vocational courses at supervisory levels
- Level 2 - Supervisory programmes for first line Managers. This is linked to the management programmes
- Level 3 - Worked-based degrees for Engineers or Production Managers. These are linked to the strategy programmes at Level 4
- Level 4 - Master class strategic management for Business Owners or Directors.

The analysed projects in this paper were implemented by the authors of the article, Dillon and Heap. The approach that has been developed by these authors is centred on PBL by using pragmatic real-life application of new knowledge to issues at the individual, communities, and economic level. In particular, these projects were applied based on PBL teaching and learning methods, which are focused on predominant and challenging problems and where individuals are engaged in projecting, problem solving, decision making, and research activities. Muniandy [14] developed the approach in early work on PBL, technology and constructivism. Such application may be understood as an educational innovation that integrates theory and practical knowledge by solving problems that emerge from professional life. Muniandy, Rossafri, and Soon Fook [15] reported on the benefits of a synergistic approach involving constructivism and technology in PBL in educational performance in elementary schools. Muniandy, Soon Fook and Idrus [16] subsequently investigated technology application in PBL, which concluded that there was an enhancement in student learning using the approach.

4.2 Sample:

The case studies included four projects conducted in the United Kingdom and Indonesia. The projects were applied in the years 2006 to 2020 and varied in length from a few days to four years. Each project was conducted by a delivery team of mentors, including experts from the manufacturing industry who were able to deliver meaningful outcomes and transfer knowledge to individuals, 300 industrial managers, and approximately 10,000 members of the workforce. Each project involved the industrial student, academic mentor and industrial mentor.

4.3 Data collection and analysis:

This paper assessed three completed PBL projects. Firstly, written reports about the implementation of the projects were obtained to make a qualitative analysis of their content. A qualitative analysis is a

systematic method for analysing and describing written material [17]. Accordingly, the following steps for data analysis were used.

A deductive approach for data analysis, where an existing theory about the phenomenon is used against the data collected. Here, the reporting records for each project were read to understand and familiarise with the strategies adopted by IOP in delivering PBL in different manufacturing industries, including the reported impacts in each project. Then, a coding approach was implemented to search, create and review categories for these concepts [18] based on PBL model including identification of the problem, designing a plan for the project, creating a schedule, implementation,

Implementation, monitoring progress, and presenting the final project. The results obtained during the content analysis were organised in an Excel spreadsheet to facilitate this analysis process.

5. RESULTS :

This following section presents the general PBL approaches adopted by IOP and their impact.

5.1 General overview of the PBL approach:

The PBL methods applied by Dillon and Heap are derived from the constructivism learning theory, especially the social constructivism, where individuals are actively encouraged to collaborate between each other in the process of constructing knowledge and learn within the community [10]. Therefore, the process of learning is developed systematically, logically, and rationally with the support and guidance of others. Their PBL projects involve an authentic learning process that is student-directed in the form of action research, including decision-making processes that are grounded on data analysis, collaboration, and that are product-oriented to address pressing issues in an industrial environment or communities. Such activities are facilitated by a mentor.

- ***Identification of the problem.*** Here, individuals select a theme project by identifying something that needs improving. Then, they determine the essential questions to resolve the problem, and brainstorm actions to resolve these. Here, the project theme is relevant both to the real world and to the participants, where an in-depth investigation is started. This is an introductory stage of learning where information and schedules are shared and implemented by participants trying to understand each other by presenting themselves and assess their expectations in the overall project. In this stage, participants are provided the freedom to discuss their preferences of different topics of the project.
- ***Designing a plan for the project.*** In this stage, planning is conducted collaboratively between the expert in the field/mentor and the participants. Here, participants tend to experience a feeling of "ownership" or sense of belonging in the project. A number of selected activities and resources are provided during the planning phase to support individuals in answering the project questions, problem definition, problem causes, and project objectives. In particular, the IOP and Nisai Group have created a Project Improvement Pack [19] to support participants to approach their project in a structured way. For example, the pack included information about how to identify, analyse and evaluate a project, including the tools that can be used to aid this process. This information provided in the pack was then used in an activity to create a Project Start-Up Report, where details of the project proposal were included (e.g., project objectives). Proposals must be approved by the mentor before the team starts working on the project [4].
- ***Creating the schedule.*** The participants and mentor work collaboratively to create a schedule of activities in completing the project. Here, a timeline is allocated to complete the project. These activities can include determining a deadline for its completion, determining roles and targets, guiding participants about planning in new ways and asking them to provide a reason about the ways they have chosen.
- ***Implementation.*** Participants start to work on the project collaboratively by determining the product, collecting, and analysing the data, product development, reporting information, and evaluating alternatives to solve project-related problems as they emerge.
- ***Monitoring participants' progress.*** The mentor monitors the participants' activities while they complete the project. This is applied to facilitate participants' learning in each process.
- ***Presenting the final project.*** Finally, participants do a poster presentation about the project publicly, summarising the procedure used and present the outcome.

5.2 Impact of the PBL approach: Case studies:

5.2.1 CASE STUDY I: Centre of Vocational Excellence (CoVE) - Level 1 feeder programmes:

The CoVE programme has been central to the UK's sector-based skills representatives. It aimed to improve and develop skills identified by employers (supported by an action research approach) required to improve productivity success, economic competitiveness, and social well-being. These programmes were focused on delivering vocational skills that met sector and industry needs through the development and delivery of high quality, specialist training across a range of sectors.

The CoVE Network of approximately four hundred approved centres was completed with an investment of £350 million and led by senior leaders from UK FE Institutes. IOP were responsible for leading the food manufacturing COVE and focused on the introduction of PBL programmes using work-based degrees and related project based vocational programmes. These PBL projects therefore linked with the commercial businesses, their relevant HR departments, and mentors from within their specific workplace alongside the Institute team members leading the programme of work.

The main target group for the Food Manufacturing CoVE was the production workforce and junior management or line technicians involved in food processing operations. Many were key operatives in a production process typified by small batch production, subject to line-changeover issues and shift pattern production. Team leaders, mechanics/fitters and technicians were employed in each shift to maintain productivity. These individuals, who were charged with maintaining productivity, constituted the critical target group to up-skill, both in terms of those already employed in these roles and those who wish to move into them. The CoVE targeted both male and female learners, those people in employment, but unqualified, and the unemployed who wished to progress to team leader/technician roles within the industry.

The approach adopted was based on action research which involved non-passive interaction with all levels of the workforce and the associated value chain. Their views and input were integral to the development of the learning offerings and ensured that there was full acceptance of the programmes when deployed into the workforce.

Grimsby (North East Lincolnshire) based seafood processor Young's Bluecrest Seafood Limited has saved more than £2millon in direct costs through a ground-breaking HR project in conjunction with the Food Manufacturing Technology CoVE (Figure 1). This involved 1000's of their workforce ensuring lifelong learning was in place. The programme was led by the HR team at Young who defined specific tasks and roles for the workforce to integrate pay scales across their group. The strategy for this project then centred around getting more than 1,000 staff up to National Vocational Qualification in food and drink manufacturing at level 1 based on the HR team specification of tasks. The programme covered areas including basic health and safety and food hygiene and the results of this strategy have been clear and resulted in the following key benefits for the organisation. Non-attendance was reduced to 2%, staff turnover was in single figures, productivity has gone up significantly, health and safety performance has improved and there has been a £2m a year saving purely through reduced use of agency staff.

Fig. 1: CoVE Level 1 Feeder Program at Young's Bluecrest Seafood Limited

5.2.2 CASE STUDY II: Cove - Level 2 supervisory programme projects:

A project-based approach (i.e., practical implementation and learning through the workforce applying their new skills in a productive environment) was adopted at level 2 to ensure that the factory supervisors understood how to apply the theory of productivity improvement and use it in their work-place projects. Training standards provided by the National Training Organisation were reviewed and selected. Staff members were trained in the delivery of the National Vocational Qualification modules in Food and Drink Manufacturing, Engineering and Business Improvement. The team was also trained in the use of internationally adopted production software tools for monitoring manufacturing improvement. A standard approach was employed for measuring the skill levels and factory efficiency and PBL was employed with team leaders / supervisors benchmarking the 'before' and 'after' impact on the business.

Over 1000 personnel have participated in the pilot food manufacturing CoVE training programmes which was then expanded (Appendix A). All the supervisory programmes at level 2 involved a project element, which covered a wide range of problems and resulted in social and commercial gains

The education pyramid was used in full and supported by the Institute and relevant HR personnel from partner companies. Furthermore, the project-based degree programme projects at level 3 contributed a further $250,000 per annum.

Appendix B demonstrates the link between job roles and suitable qualifications offered.

The level 1 target group of 1,000 staff from the factory completed training. They were supported by a further group of supervisors who undertook the level 2 programme. A further group undertook the work-based degree-programme and their projects were integrated with the level 2 and impacted on the level 1 the impact on absenteeism and staff retention has been significant with staff retention increasing by approximately 33% and absenteeism also being significantly reduced. The bottom-line impact on the business was a $2.5 Million benefit.

The factory supervisory projects have been put in place and the target skill sets have been improved, e.g., 78% - 90% achievement on qualifications. The projects have also had an impact on business performance, ranging from minor economic impact to $2,500,000 per annum net gain. A range of projects have been completed at level 2 demonstrating productivity gains and savings.

5.2.3 CASE STUDY III: Level 4 Masters (MSc) And Master Class Owners and Directors:

The higher-level programmes began with an MSc in Productivity and Innovation attended by an International group of students from India, Indonesia. Poland and the UK. The MSc students were linked directly with key industry groups seeking new ideas on improving performance in their manufacturing plants through student supported projects. A key aspect of the projects undertaken was that the results and learning were demonstrated through the creation of 'posters' that encapsulates the outcomes on one sheet of 'paper,' normally A1. These were then displayed in the workplace, demonstrating to all the impact of PBL and contributing to the maintenance and the sustainability of improvements by providing a reference point. Appendix C gives an example of a poster related to a project about factory improvement performance using a lean approach role of process mapping with students from the UK and Poland helping to drive improvement.

The masterclass (executive) programme then began with the Irish seafood sector with a pilot of 12 and has now increased to 50 companies on this programme. This was a programme designed for senior executives and develops a "strategic mindset," where the target group are the business owners or directors. This is the 4th level of the pyramid, and the programme here is designed to enable the delegates to think, develop and implement productivity improvement strategies from "out- side" the box. Experienced business owners or directors are used in seminars to lead discussions on how to tackle specific business issues. The group also planned and undertakes study tours to examine best practice from processing to new innovations and markets. In the first year, three trips were undertaken to Canada, Japan, and Grimsby. Projects from the business owners have included joint ventures, mergers to new factory layouts and process lines and the recruitment of factory managers. Finally, a trip to Japan resulted in the launch of an Irish seafood product range in all Guinness outlets in Japan. The SIP (strategic implementation programme) is a continuing phase of this masterclass and companies are now supported through mentoring and in-factory expert support to fully implement their projects. The addition of the strategic mindset to the factory "think-tank" was designed to both demonstrate senior management belief in the approach and to catalyse productivity improvement. The projects varied from

$5,500 per annum (Logistics) to as high as $62500,000 per annum in world class manufacturing, with the average saving being $23,500 per annum per manager. Although some factories were happy to give commercial estimates of gain, others preferred to quote reduction of wastage in or increases in efficiency. The figures quoted are confirmed by the factory management prior to them being entered into the table. Further the projects are accompanied with the before and after data from the key productivity measures used in the programme. Examples of improvement projects and the benefits they deliver are shown in Appendix D.

5.2.4 CASE STUDY IV: Application of PBL in Indonesia:

Dillon and Burgess [20], initially developed a working paper with the UN focussed on driving change through PBL with the aim of benefitting (economically and socially) individuals, the communities in which they live and work and the overall economy. Within this context a specific outcome was the development of trade corridors (new routes to market for higher value fish products) [21] that would increase overseas demand for high value products. In the longer term as SDG's were developed, the approach was developed to contribute to: SDG 4, Quality Education and promoting its contribution to SDG 9, Industry, Innovation and Infrastructure and SDG 11, Sustainable Cities and Communities. The authors reported on an Indonesian project focused on improvement in their fishery value chain.

One of the outcomes of this work was an invitation, from the Indonesian Fisheries Ministry to intervene with the sector to:

- Understand the learning needs of communities and value-chain using action research.
- Develop life-long approach to learning that could be embedded in communities
- Increase the value and exportability of fish products
- Pilot and introduce this approach into the economy and prove the viability
- Scale-up the approach

The Government of Indonesia supported by IOP selected 4 staff from their Fishery Institute to undertake the UK programme to transfer the approach to Indonesia. Initially, the work undertaken in 2010 piloted the approach and potential performance improvements were identified in the sector. The outcomes of the project-based approach were captured in 'poster format' a pictorial approach developed by Dillon.

In terms of scaling the project-up, IOP and Nisai have worked with the Fisheries Polytechnia based in Jakarta but operating throughout Indonesia transferring a project-based learning approach to increase and improve the efficiency and effectiveness of the onshore fisheries industry throughout the entire country.

The PBL approach was employed with Undergraduate and Master's students undertaking supervised improvement projects in real-life fishing environments and making practical improvements to productivity. Therefore, improving the economic and social worth of those involved in the sector and the associated value-chain and local communities.

Each student recorded and reported their projects using the 'poster' concept, developed by Dillon. This refined approach provides an easily communicated summary of the project and the promotion of the benefits of life-long learning. Students employed Standard Operating Procedures (SOPs) to improve the performance of fish farms , vessels and factories and importantly impart their acquired knowledge to fishery workers and owners to the long-term benefit of the sector, and thus, creating a multiplier effect and enhanced 'return on learning'.

The Fisheries Polytechnia continues to operate the programme and have enjoyed much success demonstrating that life-long learning and contributing to SDG's.

Examples of the poster concept are shown in Appendix E and F. These were created by students including: Yunita Sari; Aldy Eku Wahyudi, Hanifa Salma. Faisal Ash Shalih, Eva Fatikha and Dhea Finasthi in 2018 [22]. The projects shown are:

- Adoption of SMART Fish SOP on Grow out Vaname Shrimp Outdoor System at Pond PT Growell Farm Indonesia, Lampung Butaka inc. Lampuna (Appendix E).
- Adoption of Smart Fish SOP's Shrimp Hatchery in Krakatau Burata Inc. Lampuna (Appendix F).

To date 250 Indonesian students have participated in the PBL programme in Indonesia through the polytechnic with the same number of businesses and communities benefiting from their participation. These students across multiple Islands have involved multiple stakeholders in action research projects improving their lifelong learning.

6. RECOMMENDATIONS :

In this paper the implementation of PBL in the food manufacturing industry and suppliers and its impact on the business improvement, lifelong learning capabilities and professional competencies of the workforce are discussed. The following recommendations from this work are provided.

Firstly, the standard PBL methods, and the courses provided to staff, students and industrial supervisors should be included in the curriculum to clarify roles [19]. Here, the module should include the standard problem-based improvement techniques, and all activities need to be defined in terms of achieving problem resolutions in relation to relevant standards. Most importantly, all PBL work should be presented to the industrial and academic stakeholders to obtain feedback about their projects and to open possibilities to present it in other events and other relevant stakeholders or communities.

Finally, since PBL focuses on learning by doing, problem solving, teamwork, social skills, collaboration and taking responsibility, it can be an approach that can be implemented in different sectors to attain similar outcomes or achieve higher and better learning outcomes. It can potentially revolutionise the provision of education and development of skills for students with special education needs, who were reported to have been disproportionately impacted by COVID-19 [23-25] with heightened levels of anxiety, depression [26-27] as well as negative effects on their behaviour, learning, support, and routine [28-30]. Accordingly, PBL along with the social constructivist theory should be included in the school curriculum to provide an opportunity to students with SEN to interact with peers, exchange ideas, enable them to plan their learning, explore the content, and ask questions that will ultimately help them develop their skills and gain new knowledge. Therefore, the assessment criteria for successful completion of the academic award should be based on the completion of the PBL activities. Implementing PBL in schools for students with SEN may potentially contribute to the possible positive redefinition of the education provision and support for these students and innovate their learning experience and outcomes.

7. CONCLUSIONS :

This PBL programme has provided an engaging instructional approach that made the workforce within the food manufacturing active constructors of knowledge. Rooted in social constructivism and collaborative learning, this approach had strong theoretical support for successful achievement. Moreover, it was in line with Muniandy's [14] approach, which is focused on the development of new knowledge to issues at the individual, communities, and economic level. In particular, the PBL projects were focused on predominant and challenging problems, where individuals were engaged in projecting, problem-solving, decision-making, research activities, and displaying the results and learning through posters in the workplace. In this regard, the PBL approaches adopted by Dillon focused on using the factory floor as a learning centre for applying PBL on problems in the workplace. Consequently, a number of significant impacts for the workforce, businesses, and local communities were observed. This included reduction of staff absenteeism, productivity optimization, improved health and safety performance, improved workforce skill sets, and positive economic impact on businesses (e.g., higher per annum net gain), social worth of those involved in the sector and the associated value-chain and local communities. Moreover, it is evident that PBL can be potentially adapted and implemented in other sectors, particularly in different educational contexts such as education provision to students with special education needs. Further research and PBL implementation are recommended for this sector.

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APPENDICES:

Appendix A: Enrolments on the Food Manufacturing Technology CoVE
Appendix B: Job roles and Qualifications Offered
Appendix C: Poster Example - Factory Improvement Project
Appendix D: Poster Example - Improvement projects and their outcomes
Appendix E: Poster Example - Student Improvement project in Indonesia. "*Adoption of SMART Fish SOP on Grow out Vaname Shrimp Outdoor System at Pond PT Growell Farm Indonesia, Lampung*"
Appendix F: Poster Example - Student Improvement project in Indonesia. "*Adoption of Smart Fish SOP's Shrimp Hatchery in Krakatau Burata*"

Appendix A: Enrolments on the Food Manufacturing Technology CoVE

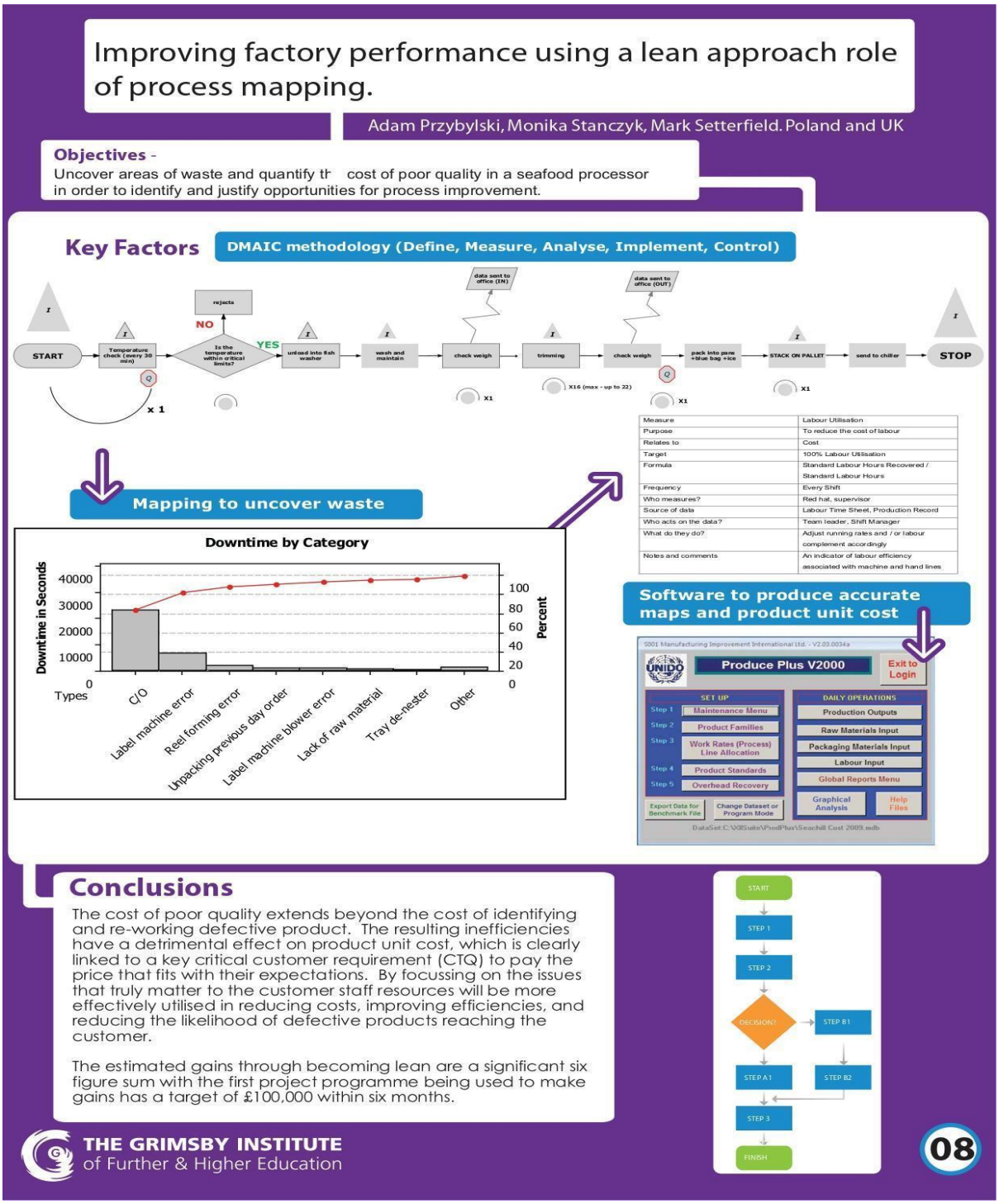
Year	No Learners	Programmes
2002 – 2003	63	Food and Drink Manufacturing Operations. Unitised programmes.
2003 – 2004	243	Food and Drink Manufacturing Operations Short courses in Hazard Control and Critical Points (HACCP) and Food Safety. New Product Development. Refrigeration.
2004 – 2005	366	Food and Drink Manufacturing Operations, Short courses in HACCP and Food Safety, Hospitality, Business Improvement Techniques Engineering Systems Maintenance

2005 – 2006	260	Food and Drink Manufacturing Operations. Short Courses in HACCP and Food Safety, Business Improvement Techniques Engineering Systems Maintenance

Appendix B - Job roles and Qualifications Offered

Level	**Skills/Qualification**
Introductory	Supervisory Level (2) In Food and Drink manufacturing Bespoke IT Business & People Management Skills
Intermediate- supervisory	Bespoke Programmes in: Manufacturing Management General Management Technical Management Project Management
Advanced- management	Degree In Food Manufacturing Operations

Appendix C: Poster Example - Factory Improvement Project

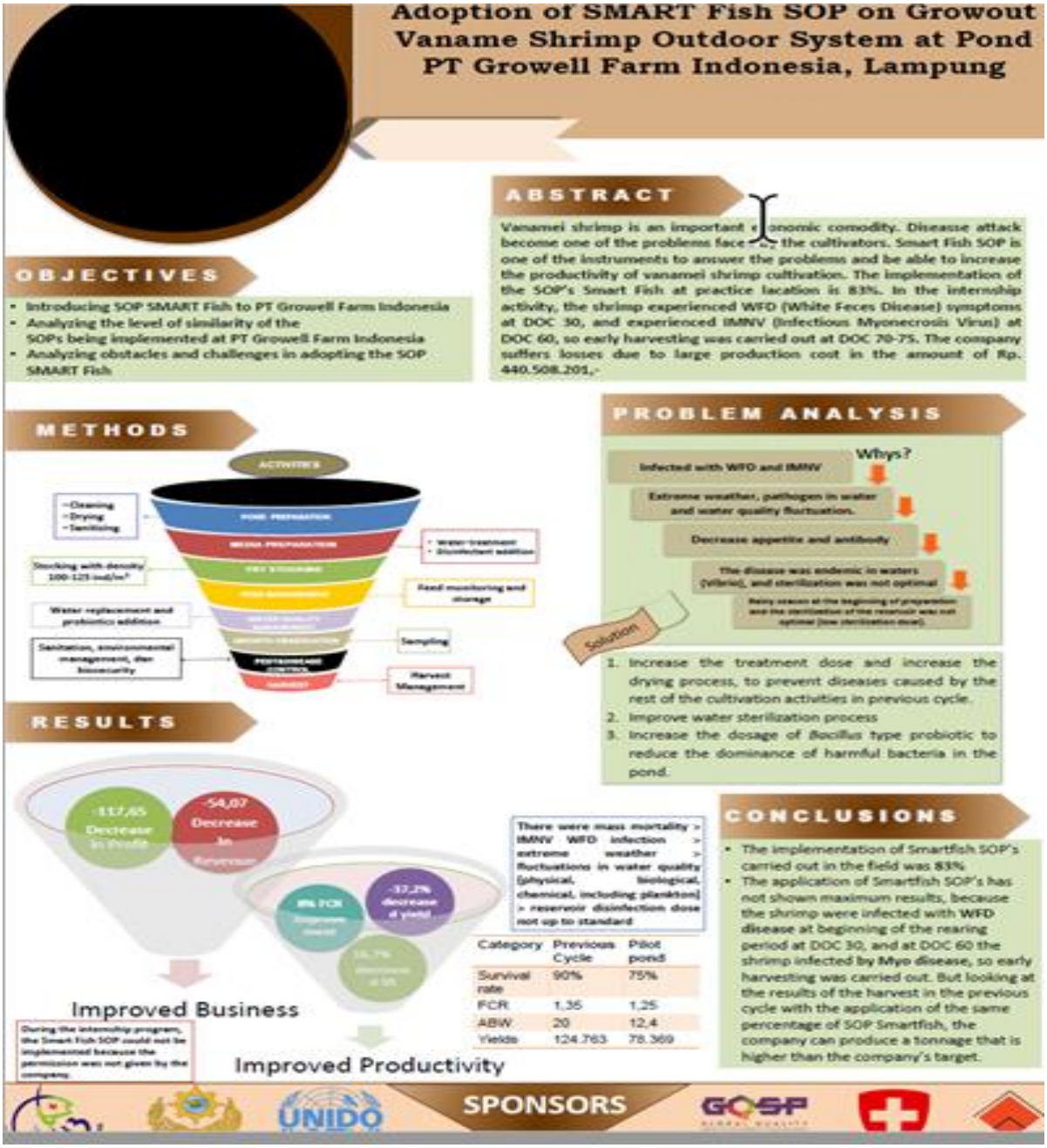


Appendix D: Poster Example - Improvement projects and their outcomes

Co'	No of student	Project Title	Brief Description	Outcome
A	1	Sandwich Waste	High level of returns from retail outlets, quoting sour or unappealing flavours as the cause. Tests undertaken.	Completed – outcome to be confirmed
	1	Process Flow Wrap	Re-arranging the production set-up to improve product flow and reduce labour costs.	Completed – saving $25,000 p/a

Co'	No of student	Project Title	Brief Description	Outcome
B	1	Fish Curing Capacity Analyses	Utilising existing equipment, re-scheduling production cycle.	On-going
C	2	OEE Grading Line	Utilising UNIDO tool to establish performance levels and KPI's, implementing a costing system.	On-going. Standards for plaice have been set up and data monitoring is currently taking place
D	2	OEE Salmon Process Line	Utilising UNIDO tool to establish performance levels and KPI's, implementing a costing system.	On-going. Updated version of Produce Plus installed, monitoring on-going.
E	1	Optimise Ice Production	Investigating shortage of capacity in the summer which was creating a need to purchase ice. Most cost-effective solution was to purchase second-hand ice making equipment.	Completed – saving $4,500 p/a
E	1	Packaging Trials through Cold Chain	Working with a packaging company to create a cost-efficient, environmentally friendly alternative to polystyrene fish crates, which also perform to the same standards. Major controlled trials performed, product still in development.	Commercial launch of new RFID based box company- market value $2.5 million
F	1	Oil Recovery	Excess oil carried over with product. Re-designed discharge chute from fryer. Created to exact specifications and designed to allow excess oil to drip freely and to be recovered.	Completed – saving $3,200 p/a
	1	Availability Process Line	A newly introduced product utilising existing equipment did not match required performance (excessive down-time). Performance of equipment analysed, and engineering improvements introduced, including material handling controls. Equipment modified.	Completed – saving $100,000 p/a
	1	Performance Standard of Process Line	Wastage on depositor. Investigation revealed cause to be different rates of expansion of components causing leakage of product. New depositor introduced to overcome problem. Problem logged in case of future occurrence on other production lines.	Completed – saving $3,200 p/a (after costs)
	1	Waste Reduction in Blocks	Wastage occurring when re-formed fish fillets produced from pure fish fillets, due to breakage of the frozen product in the mould.	Completed – saving $90,000 PA. Waste reduced from 11% to 2%
	1	Performance Process Line Quality	Company policy to reduce labour on process line resulted in an increase of rejects. Historical data was analysed & established this as a fact. Additional employee returned to line and frequency of inspections increased, resulting in a reduction in rejects at final packed stage.	Completed – saving $20,000 p/a
G	8	Process Data Collection	Data collected to illustrate the benefits of moving to a specific commercial paperless software system (Innovation Systems) using hand-held radio scanner	$4,500 net profit reported as impact.

Appendix E: Poster Example - Student Improvement project in Indonesia



Appendix F: Poster Example - Student Improvement project in Indonesia