Some aspects on the sustainable process design in a timber mill using the design for manufacturability/sustainability

Jaishneel Krishant Sharma, Ananthanarayanan Rajeshkannan, Arnit Avinesh Sharma, and Devi Rengamani Seenivasagam

Mechanical Engineering, Faculty of Science, Technology and Environment, The University of the South Pacific, Suva, Fiji; Independent Scholar, Suva, Fiji

ABSTRACT
Process sustainability indicates the proper utilisation of technology to improve productivity, reduce cost as well as environmental impact in the industry. These attributes are vital for an industry to be continuously monitored in order to stand in the market for the long run. In this context, a timber mill has been chosen for a case study in the present investigation. The most produced product is targeted, and a complete audit is made from the product start to end in order to compile the data, which are then used for sustainability study. The sustainable analysis is made with respect to carbon footprint, energy consumption, water, and air impact. This study enables to know the target area to address; accordingly, the process design has been modified using the principles of design for manufacturability/sustainability. The proposed process model ensures production not only for the target product but also versatile for other different products that are produced in the industry. In addition, the proposed model reduces the energy required to produce the target product thereby reduces environmental impact and cost; on the other hand, it improves productivity as well.

1. Introduction
Sustainability emphasises on social, economic and the environment in order for a business to sustain in the competing market (Dyllick and Rost 2017). In the context of manufacturing, sustainability is brought in the initial phase of the product design itself (Salari and Bhuivan 2016). The process is then designed to optimise the sequencing of operations that required minimum resource utilisation for sustainable production. In majority of the developed countries, the design for manufacturability and/or sustainability (DFM/S) are strictly linked to broader perceptions that include: ‘sustainable product-service system, systems innovation and other life cycle based efforts’ where industries are forced to maintain environmental safety and focus towards practices that are planned in a manner to reduce energy utilisation (Sutherland et al. 2008). Sustainable practices are implemented to reduce production cost and prevent environmental problems, which helps to maintain a clean and green atmosphere. The practical aspect of the eco-conscious product or process design involves with minimum material wastage, improve material choices, the design for ease of disassembly, product reuse, minimal energy consumption, manufacture without hazardous waste and use of clean technology (Jan Schoormans 2018). Thus, the choice of the manufacturing process is very crucial as it controls ‘the usage of the product with the amount of energy used for the process of production’ as well as ‘the use of natural resources’. However, industries in developing countries such as Fiji, the lack of awareness about the eco-conscious process or product design is one of the prime concern.

In this context, a case study is conducted to ensure some aspects of sustainable design for a 6x2 (inch) timber manufactured in a sawmill, situated in Pacific Harbour, Fiji, using DFM/S. The case study begins with the identification of a product, which had been manufactured by a company over five decades. The study then engages towards CAD modelling of the product (timber) in SOLIDWORKS followed by sustainability analysis (sustainability Xpress) to determine the environmental impacts in terms of; energy consumption, carbon footprint, water eutrophication, and air acidification. Then the production processes are redesigned using DFM/S, after which the environmental impact is compared, and finally, the cost analysis is carried out for the proposed solution to check its affordability. The purpose of this study is to bring awareness about environmental conscious production process that not only reduces environmental impact but also improves productivity and reduces the production cost and thereby successfully meets the consumer requirement.

2. Literature research
The first phase of the literature review is focused on the tools and techniques that are adopted in carrying out sustainability analysis of a product. Then, the review is extended to examine the sustainability study with respect to the product as well as the process.

2.1 Sustainable product development
Suresh, Ramabalan, and Natarajan (2016) reported that design for environment (DFE) and design for manufacturing and