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Individual Essay, BF992 Research Methods

**Introduction:**

In this essay, I will TODO

**Research lay-out:**

My research topic and methods are different than most other research that takes place at the Strathclyde Business School. It is part of the natural sciences, as opposed to most other research done in this faculty, which is social science.

The official title of my research is “Simulation and Optimisation of Offshore Renewable Energy Arrays for Minimal Life-Cycle Costs”, meaning the research aims to minimize costs of Offshore Renewable Energy Arrays, mostly windfarms in the North Sea. The Life-Cycle Costs can effectively be split in three phases; the installation, the maintenance and the decommission. The primary methods used for this in the literature, and which I plan to use, are simulation and optimisation; the goal is to mathematically model the schedule of an installation, maintenance and/or decommission project in such a way that solving the minimisation-equation(s) can still be done in a reasonable time, and give an efficient schedule.

It should also be noted I am further along with my research than most people taking this course, having started roughly 18 months ago. Due to this, I have already looked into which methods fit my research best, and I have written extensively about them in my first year report. Parts of this essay will come from my writing there.

Because of the above reasons, I have opted to write about Optimisation and Simulation as my two methods. Neither is discussed in the course, but these are the two fundamental methods of my research (area) and they work very well together, which is why I want to talk about both.

**Optimisation**:

Optimisation is an umbrella term for various techniques used to explore the quality of different configurations of a certain system. For the problem described above, the different configurations could be the different possible schedules used for an installation project. Which schedules are possible is restricted in the mathematical model underlying the optimisation; for example a vessel (ship performing the operations) cannot perform multiple tasks at the same time, and each task needs to be assigned exactly once. Within this space of valid schedules, optimisation methods can be used to try and find the best one (or in bigger problems, often simply a good one) based on given metrics, such as expected duration or costs of schedules.

As my research is focussed on improving schedules and scheduling techniques, optimisation is a very well fitting method, and is very broadly used in the literature. In the specific literature regarding my area of scheduling under uncertainty, (mixed-)integer programming and local search are the most common ways of optimising. There are other methods that are used more in different areas where optimisation is used, such as genetic algorithms or dynamic programming. I aim to keep these techniques in mind, as it may be worthwhile to try them out for my research, and there is no clear reason as to why those techniques would not work well for the problems my research looks at.

A big drawback of many optimisation techniques is that it can often be infeasible to solve a problem to optimality due to the amount of time that can take. Within my research, it is impossible to calculate the objectively best schedule due to the sheer number of possible schedules. This is why problems are often simplified, and/or heuristic approaches are taken. For example, integer programming is a technique that by its nature will give an optimal solution, and if given the installation scheduling problem in its full complexity, will simply never return a result. This can be mitigated by splitting the problem into smaller problems that on its own can be solved in reasonable time. This can strongly reduce the amount of possible schedules to consider, which will speed up the process but also means the resulting solution is unlikely to be the best overall schedule.

Other optimisation techniques such as local search are inherently heuristic, which means they are based on estimates and guesses. Local search finds good solutions by taking an existing solution and attempting to improve it with small changes. Repeatedly doing this will improve the quality of the schedule, but it also means it can get stuck in local optima, a situation where the solution is not the optimal solution, but it is better than any solution that can be found only with small changes.

However, one could say these drawbacks of imprecision are a result of the problem considered, not the methods themselves, as there are no known methods to solve the problem within reasonable time. As there is a lot of literature on how to best adapt these methods to any specific problem, I have a lot of options to try if I encounter these problems of infeasibility within reasonable time.

**Simulation**:

TODO

**Conclusion**:

TODO